Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement

Supplemental Information Report

FINAL

November 2015

North Pacific Fishery Management Council
National Marine Fisheries Service, Alaska Region

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1 Introduction

The North Pacific Fishery Management Council (Council) developed its groundfish management policy in 2004, following a comprehensive review of the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) groundfish fisheries. The *Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement* (2004 PSEIS; NMFS 2004) evaluated the cumulative changes in the management of the groundfish fisheries since the implementation of the Fishery Management Plan for the Groundfish of the Bering Sea and Aleutian Islands Management Area (BSAI FMP) and the Fishery Management Plan for the Groundfish of the Gulf of Alaska (GOA FMP) and considered a broad array of policy-level programmatic alternatives. On the basis of the analysis, the Council adopted a management approach statement, and nine policy goal statements with 45 accompanying objectives. The management policy is included in full in Appendix 1.

Periodically, the Council conducts a review of the nine policy goal statements and accompanying objectives to assess how they are being implemented, and see whether changes are warranted.[1] In February 2012, in conjunction with this review, the Council also reviewed a discussion paper identifying factors that may influence the timing for supplementing or updating the 2004 PSEIS. An expanded discussion paper was later reviewed in June 2012. To determine if a revision or supplement to the 2004 PSEIS was necessary, the Council and NMFS decided first to conduct a "non-NEPA" evaluation of the 2004 PSEIS using a supplemental information report (SIR).

A SIR is a tool to evaluate the need to prepare a new environmental impact statement (EIS) to supplement a previous EIS. The National Environmental Policy Act (NEPA) requires agencies to prepare a supplemental EIS (SEIS) to either draft or final EISs if the agency (1) makes substantial changes in the proposed action that are relevant to environmental concerns; or (2) there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts (40 CFR 1502.9(c)). An SEIS is required if the new information is sufficient to show a proposed or remaining action will affect the quality of the human environment in a significant manner or to a significant extent not already considered. If a subsequent related Federal action occurs, and new information indicates that the subsequent action will affect the quality of the human environment in a significant manner or to a significant extent not already considered, an SEIS must be prepared. Courts have upheld the use of SIRs, and similar non-NEPA evaluation procedures, for the purpose of determining whether new information or changed circumstances require the preparation of a supplemental EIS.

With this SIR analysis, the Council and NMFS have been able to determine whether the triggers for supplementing the PSEIS have been met. In April 2014, the Council evaluated the information in the draft SIR, and concluded both that a supplemental EIS was not required, and also that they did not choose to reinitiate programmatic changes to the groundfish fisheries that would necessitate an SEIS. NMFS has since finalized the SIR and reached a determination affirming that the 2004 PSEIS continues to provide NEPA compliance for the groundfish FMPs.

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[1] Changes to the management approach statement, the nine policy goal statements, or the 45 objectives would require an FMP amendment.

2 Considerations for Supplementing the 2004 PSEIS

2.1 What triggers the need to prepare an EIS?

NEPA requires that an EIS be prepared on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment (40 CFR 1502.3). EISs are also prepared (1) when the proposed action is novel, (2) when there is controversy in the underlying science used to understand the impacts of the alternatives, or (3) when the potential impacts are unknown. Courts have also found that significant scientific differences of opinion, controversy, and uncertainty require preparation of an EIS.[2]

2.2 What is a programmatic EIS?

A "major Federal action" includes adoption of official policy, formal plans, programs, and specific projects (40 CFR 1508.18). When the EIS addresses a policy, plan, or program, it is called a programmatic EIS or PEIS. PEISs should focus on broad Federal proposals and be timed to coincide with meaningful points in planning and decision making. Preparing a PEIS presents an opportunity to evaluate cumulative impacts of past, present, and reasonably foreseeable future actions under the program or within a geographical area. NEPA's legal requirements for a PEIS are the same as those for an EIS.

2.3 What triggers the need to prepare a supplemental EIS?

NEPA requires agencies to prepare an SEIS to either draft or final EISs if the agency (1) makes substantial changes in the proposed action that are relevant to environmental concerns, or (2) there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts (40 CFR 1502.9(c)). An agency need not supplement an EIS every time new information comes to light. Not every change requires the preparation of an SEIS; only those changes that cause effects that are significantly different from those already studied require supplementary consideration.[3] The Supreme Court explained that "an agency need not supplement an EIS every time new information comes to light after the EIS is finalized. To require otherwise would render agency decision-making intractable."[4]

An SEIS is required if the new information is sufficient to show a proposed or remaining action will affect the quality of the human environment in a significant manner or to a significant extent not already considered.[5] If a subsequent related Federal action occurs, and new information indicates that the subsequent action will affect the quality of the human environment in a significant manner or to a significant extent not already considered, an SEIS must be prepared.[6]

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[2] State of Alaska v. Lubchenco, No. 3:10-CV-00271-TMB, order requiring plaintiffs to prepare an EIS at 8 n.36 (D. Alaska, filed March 5, 2012). See footnote 36.

[3] See Davis v. Latschar, 202 F.3d 359, 369 (D.C. Cir. 2000).

[4] See Marsh v. Oregon Natural Resources Council, 490 U.S. 360, 373 (1989); Oregon Natural Resources Council v. Marsh, 845 F.Supp. 758, 766-69 (D. Ore. 1994), *aff'd in part, reversed in part*, Oregon Natural Resources Council v. Harell, 25 F.3d 1499 (9th Cir. 1995)

[5] Marsh 490, at 374. Colorado Environmental Coalition v. Dombeck, 185 F3d 1162, 1177-78 (10th Cir. 1999), Nat'l Resources Defense Council v. Lujan, 768 F. Supp 870, 885-89 (D.D.C. 1991)

[6] See Marsh, 490 U.S. at 374.

2.4 What is the history leading to the 2004 PSEIS?

The Council and NMFS prepared EISs for the original BSAI FMP and GOA FMP, finalized in 1981 and 1979, respectively. In March 1997, NMFS issued a Notice of Intent to prepare an SEIS on "the Federal action by which total allowable catch specifications and prohibited species catch limits in the groundfish fisheries that are conducted in the Bering Sea and Aleutian Islands Area and the Gulf of Alaska are annually established and apportioned." (62 FR 15151, March 31, 1997). NMFS explained why the SEIS was needed:

> The fisheries have evolved … through the Council process including FMP amendments, regulations, and continued compliance with other Federal laws and executive orders. The frequencies of marine mammal, marine bird, and fish species in the biological assemblage present now are different from frequencies that existed and were displayed in [the EISs prepared for the original FMPs]. Several marine species have been listed under the Endangered Species Act, some of which may be affected by fishery management actions. New information about the ecosystem, impacts of the fisheries, and management tools has become available since the EISs were prepared (62 FR 15152, March 31, 1997).

Given these changes and new information, NMFS stated that the SEIS would incorporate the following:

> … the amendments to the FMPs; the annual process for determining the [total allowable catch] TAC specifications; and the public processes for in place for implementing new regulations, revising existing ones, and incorporating new information. … The SEIS will analyze the process by which annual TAC specifications and prohibited species catch limits are determined, together with the procedures for implementing changes to those processes. The processes encompass decisions about location and timing of each fishery, harvestable amounts, exploitation rates, exploited species, groupings of exploited species, gear types and groupings, allocations, product quality, organic waste and secondary utilization, at-sea and on-land organic discard, species at higher and lower trophic levels, habitat alterations, and relative impacts to coastal communities, society, the economy, and the domestic and foreign groundfish markets. Effects of these decisions are manifested over many years in multifaceted social and biological arenas. Inherent in implementing groundfish fisheries management regime are commitments to provide in-season management, enforcement, monitoring, stock assessment, and summary analyses. In addition to evaluating the no Action Alternative, the SEIS will include a full range of alternatives and discussions of their potential impacts on the biological and socioeconomic environments. (62 FR 15152, March 31, 1997).

Other than the general description alternatives quoted above, no specific alternatives were identified in the Notice of Intent.

NMFS issued a Final SEIS in December 1998 (1998 SEIS; NMFS 1998). The 1998 SEIS stated that the attainment of Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) goals and NEPA regulations require a periodic evaluation of the impacts of the BSAI and GOA groundfish fisheries on (1) the stocks of fish taken as catch and bycatch in the groundfish fisheries, (2) protected species including marine mammals and seabirds, (3) other components of the BSAI and GOA ecosystems, (4) habitat, and (5) those who benefit from consumptive and non-consumptive uses of the living marine resources of the BSAI and GOA.[7] The 1998 SEIS updated the scientific information known about the North Pacific ecosystem, and analyzed this information by considering a range of

[7] 1998 SEIS, at 2.

alternative total allowable catch (TAC) levels: (1) the status quo method of setting TAC levels annually, for each species complex, within the optimum yield (OY) range based on the biological status of the species and "other ecological and socio-economic aspects of the fisheries"; (2) setting TAC levels at the lower end of the OY range; (3) setting TAC levels at the upper end of the OY range; and (4) no directed groundfish fishing. The SEIS did not consider how new information about the affected environment related to other aspects of the fisheries that the FMPs regulate, such as time and area closures, gear restrictions, bycatch limits of prohibited species, and allocations of TACs among vessels delivering to different types of processors groups, gear types, and qualifying communities.

2.5 Why did the court determine a programmatic SEIS was needed?

The adequacy of the 1998 SEIS was challenged in U.S. district court.[8] The plaintiffs argued that NEPA required NMFS to prepare an SEIS that included alternatives commensurate with the broad scope of the FMPs.[9] Because the 1998 SEIS analyzed the new information under a range of alternatives dealing with only one particular aspect of the FMPs – TAC levels – the plaintiffs argued that the scope of the 1998 SEIS was impermissibly narrow.[10] By narrowing the range of alternatives to those specifically dealing with TAC levels rather than the FMPs as a whole, the plaintiffs argued that NMFS failed to take the requisite "hard look" at the environmental consequences of the agency action, the FMPs.[11] NMFS argued that the agency properly defined the scope of the SEIS and considered an adequate range of alternatives.[12]

In July 1999, the court ruled that the 1998 SEIS was impermissibly narrow and thus legally inadequate under NEPA, and remanded the document back to NMFS for additional analysis, directing the agency to produce a "programmatic" SEIS.[13] Briefly stated, the court determined a broad programmatic SEIS that fairly evaluated the dramatic and significant changes that occurred in the groundfish fisheries in North Pacific ecosystem was required by NEPA "[i]n light of the significant changes to the FMPs and the new information about the broad range of issues" covered by the regulations managing the fisheries.[14] Because the 1998 SEIS narrowly focused its analysis on TAC levels, the court determined that it was not sufficiently broad.[15]

In reaching this conclusion, the court first determined that the action under review in the 1998 SEIS should have been the FMPs and the numerous regulations managing the groundfish fisheries. The court noted that the FMPs constituted major Federal actions requiring an EIS,[16] that NMFS seemed to acknowledge that an SEIS to the original EISs was necessary under both the "substantial changes to the action" and the "significant new information" prongs of 40 CFR 1502.9(c),[17] and that the level of detail necessary in an SEIS is directly related to scope of Federal action under NEPA review.[18] Because the FMPs as a whole were the proposed action about which there were significant new circumstances and to which substantial changes had been made, an SEIS that examined only one aspect of the FMPs, TAC

[8] Greenpeace v. National Marine Fisheries Service, 55 F.Supp. 2d 1248 (W.D. Wash. 1999).
[9] Id., at 1270.
[10] Id., at 1271-72.
[11] Id., at 1272.
[12] Id.
[13] Id., at 1273.
[14] Id.
[15] Id., at 1275.
[16] Id., at 1257.
[17] Id., at 1271.
[18] Id., at 1276.

levels, was insufficient to satisfy the requirements at 40 CFR 1502.9(c). The court also found that the SEIS lacked any explanation of why and how analysis of TAC levels "results in a practical analysis" of the impact of the fisheries, as governed by a myriad of regulations.[19] The court's determination that the SEIS must be treated as a broad, programmatic analysis of the FMPs as a whole lead directly to its conclusion that the range of alternatives considered in the 1998 SEIS was inadequate.[20]

The court also determined that NEPA regulations at 40 CFR 1508.7 and 1508.27(b)(7) required NMFS to prepare an analysis that thoroughly examined the cumulative effects of the changes that had occurred to the FMPs.[21] The court concluded that the "vast changes to the FMPs have reached the threshold of 'cumulatively significant impact on the human environment,' thereby requiring preparation of an SEIS addressing these vast changes."[22]

In summary, the court stated that NEPA requires NMFS to analyze the ways in which the groundfish fisheries affect the North Pacific ecosystem, and to provide decision-makers and the public with a document that will help further informed decision-making as to the consequences of the FMPs.[23] The 1998 SEIS, by focusing its analysis only on TAC levels, did not fulfill this mandate.[24]

2.6 Will the Council and NMFS have to prepare a new PSEIS at some point?

As stated in numerous court decisions, Federal agencies have a continuing duty to gather and evaluate new information relevant to the environmental impacts of its actions and to review the continuing vitality of an EIS in light of changing conditions.[25] As stated in Friends of the Clearwater v. Dombeck:

> "…[A]n agency that has prepared an EIS cannot simply rest on the original document. The agency must be alert to new information that may alter the results of its original environmental analysis, and continue to take a "hard look at the environmental effects of [its] planned action, even after a proposal has received initial approval. It must "ma[ke] a reasoned decision based on … the significance or lack of significance – of the new information," and prepare a supplemental EIS when there are "significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts." "If there remains major Federal action to occur, and the new information is sufficient to show that the remaining action will affect

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19 Id., at 1275.

20 Id., 1274.

21 Id., at 1273-74.

22 Id., at 1274.

23 Id., at 1276.

24 Id.

25 See Warm Springs Dam Task Force v. Gribble, 621 F.2d 1017, 1023-1024 (9th Cir. 1980); Monarch Chemical Works v. Exon, 452 F.Supp 493, 500 (D.C. Neb. 1978). See also Southern Oregon Citizens v. Clark, 720 F.2d 1475, 1480 (9th Cir. 1983). This continuing duty is especially relevant where the original EIS covers a series of actions continuing over a decade. … In general, an EIS concerning an ongoing action more than five years old should be carefully examined to determine whether a supplement is needed); Senville v. Peters, 327 F.Supp.2d 335, 355-56 (D. Vt. 2004) – An agency's duty to take a hard look at the environmental consequences of its proposed action does not end with publication of an EIS. NEPA imposes an ongoing obligation to supplement EISs if there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. The decision whether to prepare an SEIS is similar to the decision whether to prepare an EIS in the first place. Major Federal action, plus new information that shows "that the remaining action will affect the quality of the human environment in a significant manner or to a significant extent not already considered," dictates the preparation of an SEIS. Marsh 490, 360-61. The parties do not dispute that the proposed action is major, nor that there is new information. At issue is whether the new information results in impacts that are significantly different in degree or in kind from the impacts previously considered.

> the quality of the human environment in a significant manner or to a significant extent not already considered, a supplemental EIS must be prepared."[26]

The court in Friends of the Clearwater v. Dombeck also stated: "As we have admonished, Compliance with NEPA is a primary duty of every Federal agency; fulfillment of this vital responsibility should not depend on the vigilance and limited resources of environmental plaintiffs."[27] It is the agency, not an environmental plaintiff, that has a "continuing duty to gather and evaluate new information relevant to the environmental impact of its actions," even after release of an EIS.

The Supreme Court has held that supplementation of an EIS is necessary only if there remains major Federal action to occur.[28] As the court in Defenders of Wildlife v. Bureau of Ocean Energy Management, Regulation, and Enforcement stated that:[29]

> Although the case law is not uniform, a reasonable, helpful formulation of the "major Federal action" test provides that if "the actions remaining to the [agencies] ... are purely ministerial, or if the agencies have no discretion that might usefully be informed by further environmental review, then there is no major federal action and no SEIS must be prepared." Hammond v. Norton, 370 F.Supp.2d 226, 255 (D.D.C.2005) (citing Citizens Against Rails–to–Trails v. Surface Transp. Bd.,267 F.3d 1144, 1151 (D.C.Cir.2001)); see also Southern Utah Wilderness Alliance v. Office of Surface Min. Reclamation and Enforcement, 2008 WL 4912058, *12 (D.Utah Nov. 14, 2008) (no "major federal action" requiring supplemental EIS where agency "retained no discretion to decide whether the projects should go forward or to determine the terms and conditions of the projects' approval").

Because fisheries management is dynamic – the FMPs are regularly amended to adjust fisheries management based on new circumstances, and new information on the environment and the impacts of fishing on the environment is continually being developed – and because the Council and the agency have broad discretion to manage fisheries consistent with the requirements of the MSA, the Council and the agency have a continuing duty to gather and evaluate new information relevant to the environmental impacts of its actions and to review the continuing vitality of its PSEIS in light of changing conditions.[30] When the changes and the information is significantly different in degree or in kind from the impacts previously considered, the Council and the agency must prepare a supplement to the PSEIS.

2.7 How do the Council and NMFS decide when it is time to initiate a new PSEIS?

The passage of time alone does not trigger the need for a supplement. However, the Council of Environmental Quality (CEQ) advises in its Forty Most Asked Questions (46 FR 18026, March 23, 1981) that an EIS over five years old should be carefully scrutinized to determine whether there are changes in the action or the affected environment:

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[26] Quoting Marsh 490 U.S. at 374.

[27] City of Davis v. Coleman, 521 F.2d 661, 667 (9th Cir. 1975), see also Coalition for Canyon Preservation v. Bowers, 632 F.2d 774, 779 (9th Cir. 1980)

[28] Norton v. Southern Utah Wilderness Alliance 542 U.S. 55, 72-73 (2004)

[29] 791 F.Supp.2d 1158 (S.D.Ala. May 23, 2011)

[30] NEPA requires an agency to continue evaluating a project's environmental effects, even after preparation of an initial EIS. From Greenpeace Decision at 1259; see also Chemical Weapons v. U.S. Department of Army 935 F. Supp. 1206, 1217-19 (D. Utah 1996) (preliminary injunction denied on allegations of new information with respect to EIS on chemical weapons disposal facility; in this case, the daily operation will itself constitute major Federal action that would require a supplemental EIS if new information is sufficient to show that the remaining action will affect the quality of the human environment in a significant manner or to a significant extent not already considered).

Question No. 32: Supplements to Old EISs. Under what circumstances do old EISs have to be supplemented before taking action on a proposal?

A. As a rule of thumb, if the proposal has not yet been implemented, or if the EIS concerns an ongoing program, EISs that are more than 5 years old should be carefully reexamined to determine if the criteria in Section 1502.9 compel preparation of an EIS supplement.

If an agency has made a substantial change in a proposed action that is relevant to environmental concerns, or if there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts, an SEIS must be prepared for an existing EIS so that the agency has the best possible information to make any necessary substantive changes in its decisions regarding the proposal (40 CFR 1502.9(c)).

To determine if an SEIS is necessary at this time, the Council and NMFS conducted a "non-NEPA" evaluation of the 2004 PSEIS resulting in this SIR. A SIR is a tool to evaluate the need to prepare a new EIS to supplement a previous EIS. Courts have upheld the use SIRs and similar non-NEPA evaluation procedures for the purpose of determining whether new information or changed circumstances require the preparation of a supplemental EIS.[31] This SIR discusses each of the considerations for an SEIS: changes to the action, new information, and new circumstances, and whether these changes are significant and relevant to environmental concerns and the impacts of the proposed action. Depending on the results of this analysis, the Council and NMFS may determine that the triggers for supplementing the PSEIS have not been met and therefore a new PSEIS is not necessary at this time. On the other hand, the SIR may provide detailed information demonstrating that the triggers have been met and that a new PSEIS should be prepared. Note that if the Council and NMFS determine new information or circumstances are significant, the Council or NMFS must prepare a supplemental EIS; a SIR cannot serve as a substitute.[32]

The Council also considered whether to initiate an environmental assessment or a supplemental EIS. The Council considered the following factors in its decision to do a SIR:

- A SIR is not a NEPA document; therefore the Council would retain some flexibility in defining the public participation process as well as general timing issues.
- A SIR could help inform the Council if it chooses to consider whether to revise the objectives, policy statements, or overall management approach for the groundfish fisheries found in the current FMP and NEPA analysis.
- A SIR could also inform the public and serve as a useful focal point for further discussions with the Council.
- Since a SIR cannot serve as a substitute for a proper NEPA document, an environmental assessment (EA) or supplemental EIS, once final, would ensure NEPA compliance.
- An EA or an SEIS would require a proposed action, purpose and need, and a reasonable range of alternatives and the related NEPA requirements for these documents.

The Council chose to move forward with a SIR, to:

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[31] Idaho Sporting Congress, Inc. v. Alexander, 222 f.3d 562, 566 (9th Cir. 2000), Marsh v. Oregon Natural Resources Council, 490 U.S. 360, 383-85 (1989), Laguna Greenbelt, Inc. v. United States Dep't of Transp., 42 F.3d 517, 529-30 (9th Cir 1994), Price Rd. Neighborhood Ass'n v. United States Dep't or Transp., 113 F.3d 1505, 1510 (9th Cir. 1997)

[32] Idaho Sporting Congress, Inc. v. Alexander, 222 f.3d 562, 566 (9th Cir. 2000)

- Evaluate the changes to the action, Federal groundfish fisheries management, since the 2004 PSEIS using readily available information synthesized into a complete picture of today's fishery management so that it could be compared to the fishery management regime described under the preferred alternative in the 2004 PSEIS.
- Identify the new information available and new circumstances since 2004 by summarizing the new information in the stock assessment and fishery evaluation (SAFE) reports, recent analytical documents (EAs, EISs, and biological opinions), and any other sources.
- Evaluate whether the changes in the action, new information, and the new circumstances are significant and relevant to environmental concerns and the impacts of the proposed action by assessing whether the impacts predicted in the 2004 PSEIS for the preferred alternative are still valid given these changes since 2004.

This SIR enables the Council and NMFS to evaluate new information and make a reasoned determination whether it is sufficiently significant to require formal supplementation under NEPA. Courts have upheld an agency's decision not to supplement if it is reasonable. The reasonableness of an agency's decision not to supplement depends on such factors as the environmental significance of the new information, the probably accuracy of the information, the degree of care with which the agency considered the information and evaluated its impact, and the degree to which the agency supported its decision not to supplement with a statement of explanation or additional data.[33] The court plays the limited role of determining, under the foregoing standards, whether the new information is so significant that it would be irresponsible, arbitrary, and capricious for the agency not to act on it. However, the court would determine whether the new information presents a seriously different picture of the likely environmental consequences of the proposed action than the picture already considered. Resolution of this dispute involves primarily issues of fact requiring deference to the informed discretion of the responsible agency.[34]

2.8 What efficiencies are gained by doing an EIS?

EISs are major undertakings, and the process to determine whether or not to supplement an existing EIS also requires substantial effort and analysis. However, as explained above, NEPA analysis is required for major Federal actions and once an EIS is completed, there is a continuing duty to make sure the analysis is relevant in light of new information, circumstances, or changes in the proposed action. Once an EIS is completed for a proposed action and that action is implemented, the EIS is useful for subsequent related actions and for understanding the impacts of specific actions in the larger context. Having an EIS can greatly streamline future NEPA analyses using tools described in the CEQ regulations. A comprehensive programmatic EIS can also allow other efficiencies for future NEPA analyses, such as tiering, incorporation by reference, or in applicable instances, allowing for categorical exclusions (see short summaries of these actions below).

The 2004 PSEIS implemented a change to the groundfish management policy. Each subsequent action to implement the policy has been evaluated in a separate NEPA document. The 2004 PSEIS provides the baseline for conducting NEPA analysis for groundfish management actions. NMFS and Council staff incorporate by reference the information in the 2004 PSEIS, and update as necessary in the NEPA analysis for a specific action. This allows the subsequent NEPA document to focus on recent information and information relevant to the action, without a large amount of background information, or a re-analysis

[33] Oregon Natural Resources Council v. Marsh, 845 F.Supp. 758, 766-69 (D. Ore. 1994)
[34] Oregon Natural Resources Council v. Marsh, 845 F.Supp. 758, 766-69 (D. Ore. 1994)

of the status quo. Also, the 2004 PSEIS provided a comprehensive analysis of the cumulative effects and past actions that are relied on for groundfish action EAs.

Tiering

Tiering means the coverage of general information in a PEIS with subsequent narrower EISs or EAs incorporating by reference the general discussions from the PEIS and concentrating solely on the issues specific to the subsequent project-specific action (40 CFR 1508.28, 40 CFR 1500.4(i), 1502.4(d), and 1502.20). The CEQ regulations encourage agencies preparing NEPA documents to "tier their environmental impact statements to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review." Specifically, 40 CFR 1502.20 states the following:

> Whenever a broad environmental impact statement has been prepared (such as a program or policy statement) and a subsequent statement or environmental assessment is then prepared on an action included within the entire program or policy (such as a site specific action) the subsequent statement or environmental assessment need only summarize the issues discussed in the broader statement and incorporate discussions from the broader statement by reference and shall concentrate on the issues specific to the subsequent action.

In 40 CFR 1508.28, the CEQ regulations further define tiering as "the coverage of general matters in broader environmental impact statements … with subsequent narrower statements or environmental analyses incorporating by reference the general discussions and concentrating solely on the issues specific to the statement subsequently prepared." This section of the CEQ regulations further notes that tiering is appropriate "when the sequence of statements or analyses is … from a program, plan, or policy environmental impact statement to a program, plan, or policy statement or analysis of lesser scope or to a site-specific statement or analysis."

Incorporation by reference

An EIS can incorporate by reference material from other sources (40 CFR 1502.21). Incorporated material must be cited and summarized in the EIS and must be publicly available. Information that is not publically available may not be incorporated by reference into an EA or EIS.

Categorical Exclusion

NOAA Administrative Order 216-6 (NAO 216-6) sets forth requirements for implementing and documenting Categorical Exclusions (CEs). Section 5.05 provides information on the general requirements for CEs. Section 6.03 provides specific guidance on the use of CEs for various types of actions undertaken by NOAA. For example, Section 6.03a.3 provides guidance regarding CEs for management plan amendments (i.e., FMP amendments).

As defined in section 6.03a.3(b)(1) of NAO 216-6, a proposed action would be categorically excluded from the need to prepare an EA or an EIS if the proposed action is a minor change to a previously analyzed and approved action and the proposed change has no effect individually or cumulatively on the human environment.

2.9 What risks might be present if a NEPA-compliant programmatic SEIS is not in place?

It is a statutory requirement to comply with NEPA. The primary means of enforcing NEPA is through lawsuits brought by concerned private citizens, interest groups, and state and local agencies (Bass et al., 2001). Plaintiffs typically ask for declaratory judgments establishing the government's NEPA obligations or a writ of mandamus ordering specific agency action to comply with NEPA (Bass et al., 2001). Plaintiffs may also seek preliminary injunction:

> If a preliminary injunction is granted, courts will enjoin some or all project activities pending NEPA compliance, and may order appropriate NEPA documents to be prepared. … Most courts decide to grant a preliminary injunction by balancing … the plaintiff's probability of success on the merits of the claim, the harm to the plaintiff if the injunction is denied versus the harm to the defendant if it is granted, and whether the public interest would be served by granting the injunction. Courts may also be asked to issue a permanent injunction …. In some cases, a court may find a NEPA violation but deny an injunction based on equitable principles.

It should be noted that if a court does order a new NEPA document be prepared, the court will set the schedule, likely with input from both parties, but that such a schedule might not be favorable for the Council or NMFS.

3 Approach

The primary purpose of this SIR is to evaluate comprehensively whether either of the two requirements for supplementing an EIS has been met with respect to the 2004 PSEIS:

1. if NMFS and the Council have made a substantial change in the proposed action (i.e., the management of the Federal groundfish fisheries) that is relevant to environmental concerns, or
2. if there are significant new circumstances or information relevant to environmental concerns and bearing on the management of the groundfish fisheries or their impacts.

With respect to the first requirement, there have been changes to the management program since the 2004 PSEIS, as documented in the May 2012 discussion paper (NPFMC 2012). All management changes since 2004 have been subject to NEPA analysis. The Council's Scientific and Statistical Committee (SSC) discussed the management changes at their March 2012 meeting in Anchorage, Alaska, and determined that the changes are all consistent with the preferred alternative evaluated in the 2004 PSEIS. The management changes synthesized in this SIR are not identified as substantial changes relevant to environmental concerns.

As a result, this SIR focuses more on the second requirement, to allow NMFS and the Council to make a reasoned determination of whether, since the 2004 PSEIS was completed, there exist new circumstances or information that are sufficiently significant to require supplementation under NEPA. The goal is to evaluate whether information since 2004 indicates that the groundfish fisheries affect the quality of the human environment in a significant manner or to a significant extent that was not considered in the 2004 PSEIS.

This SIR evaluates whether there are significant new circumstances or information relevant to the groundfish fisheries by reevaluating the conclusions from the 2004 PSEIS in light of new information, to see whether there are likely to be changes to the impacts. This SIR provides information to answer two overarching questions:

- Are the impacts predicted in the 2004 PSEIS for the preferred alternative still valid, given any changes since 2004?
- Does the new information present a seriously different picture of the likely impacts of the groundfish fisheries on a particular resource, compared to what was considered in the 2004 PSEIS?

This has been addressed by analysts revisiting each of the 2004 PSEIS conclusions, and considering the following questions in light of new information:

- Has the way that the resource is managed under the groundfish FMPs changed?
- Has the status of the resource changed?
- Is there new information regarding the impacts of the groundfish fisheries on the resource?
- Are there new methods of analysis or protocols for evaluating impacts?
- Based on information that is available imminently or now, would a new analysis using the latest methods and information reach a seriously different conclusion?

Additionally, this SIR builds on the SSC's review of environmental impacts from the March 2012 meeting. The SSC considered whether, on the basis of existing analyses, the Council understands the environmental impacts of the groundfish management program today, by evaluating (1) whether environmental conditions affecting the fisheries have changed, (2) whether the status of fish stocks and other marine life has changed, and (3) the availability of new information. The SSC identified many continuing trends and variability in environmental conditions and status of stocks that were accounted for in the 2004 PSEIS. There were, however, a few distinct areas that merit further investigation. These include the following:

- changes in the spatial and temporal distribution of the groundfish fisheries in response to fishery management changes, together with technical innovations, may have altered the environmental impact of fishing
- changes in species abundance affecting interactions with groundfish fisheries, particularly those species that are listed under the Endangered Species Act (ESA)
    - increase in the abundance of whale populations may be altering lower trophic level energy pathways in the region
    - the continued decline of the western portion of the western distinct population segment of Steller sea lions
    - the declining trend of Northern fur seal populations on the Pribilof Islands
    - increase in short-tailed albatross populations and potential for increased incidental take by fisheries
    - listing of certain crab stocks as overfished and consequent Council action restricting groundfish fisheries
    - increase in arrowtooth flounder and Pacific halibut populations in the GOA and Bering Sea (BS), and changes in the size at age of halibut
- changes in the ice extent and season in the BS and Arctic impacting the distribution and behavior of cetaceans and pinnipeds, as well as lower trophic levels and patterns of productivity. Resulting direct and indirect impacts of fishing activity are not well understood.

The advantage of focusing the SIR more comprehensively on the conclusions of the PSEIS, rather than limiting it specifically to the issues identified by the SSC, is that it provides updated information on the entire management program. By providing a more comprehensive evaluation of the current fisheries baseline, the final SIR can be incorporated by reference with the 2004 PSEIS when analyzing proposed groundfish management actions in future EAs. Even though a SIR is not a NEPA document, it can be referenced in NEPA analyses, especially if the overall conclusion of the SIR is that the PSEIS remains valid. In this way, the SIR will better meet the Council and NMFS' intent to develop a document that also improves efficiency for other management actions.

The approach used in this SIR is similar to that used for the 2010 Essential Fish Habitat (EFH) 5-year review. In that evaluation, stock assessment authors, and other experts, were asked to review EFH information contained in the Council's FMPs (and the 2005 EFH EIS, NMFS 2005) in the context of any new information. The authors were each asked to consider a series of questions about whether new information is available and relevant for identifying EFH for their species, whether changes in fishing activities over the time period were likely to have affected the fishing impacts analysis, and whether, based on these considerations, they concurred with the description of EFH and habitat associations that is included in the FMPs. In the case of the EFH 5-year review, the authors' responses were vetted through the Council's Groundfish Plan Teams, and then compiled into a summary report that was presented to the Council, upon which basis the Council subsequently initiated amendments to the FMPs.

For this SIR, a similar approach has been employed. Scientific experts have been identified for each of the resource components analyzed in the 2004 PSEIS, primarily Alaska Fisheries Science Center (AFSC) staff. In many cases, these are the lead authors that prepared those sections for the 2004 PSEIS, or who prepare annual stock assessments. These experts were asked to review the 2004 PSEIS analysis and conclusions, consider them in light of new information, and determine whether the 2004 conclusions are still valid. In order to provide everyone with a similar understanding of what is required in the review, staff facilitated a kickoff workshop to discuss the project, and prepared a template identifying the questions to be addressed (Appendix 2). The experts completed their review, and their contributions were synthesized by Council and Alaska Region staff into a draft SIR. The draft SIR was presented to the Council's SSC and the Council in April 2014 for review, and a 60-day public comment period was offered at the request of stakeholders who wished to submit written comments. Minor revisions were made to the draft SIR, to address issues raised in public and Council comments. When revisions addressed information in the resource reviews, these were made in collaboration with the expert reviewers. Finally, the SIR was finalized with the agency's determination.

4 Description of the 2004 PSEIS

4.1 History of the 2004 PSEIS

In late1990s, NMFS and the Council realized that they needed to take a broader view of the cumulative effects of their management decisions. Typically, the Council addresses a management problem by developing specific solutions. Staff analyzes alternatives to determine their direct effects in a variety of contexts, and the Council shares that analysis with the public prior to making a decision and forwarding that recommendation to the agency and the Secretary of Commerce for final review and approval.

Beginning in 2000, the Council and NMFS conducted a comprehensive, programmatic environmental review of the BSAI FMP and GOA FMP. The analysis evaluated the management of Alaska's groundfish fisheries from a policy-level perspective, with alternatives ranging from a more aggressive harvest management policy to a highly precautionary one. Each management policy was illustrated and framed with a range of management measures within which the Council would intend to implement the alternative. The 2004 PSEIS, published in June 2004, serves the Council and NMFS as the overarching EIS in support of Federal authorization of the groundfish fisheries off Alaska. It also described the physical, biological, and human environment; every fishery and gear type; and scientific data gaps and research needs.

In April 2004, the Council used this PSEIS as the basis for amending its FMPs to incorporate a new policy statement that communicates its intent to take a more precautionary approach to fishery management decision-making when faced with scientific uncertainty. The Council now routinely reviews its policy goals and objectives when making decisions and when developing its annual workplan.

One aspect of the 2004 PSEIS that made its preparation particularly challenging was that approximately 25 years of management decisions had to be evaluated as a cumulative whole. Both FMPs had over 80 plan amendments that had to be reviewed and analyzed, and the management program had changed substantially during the time period, from a fishery with a large foreign participation, to an exclusively domestic one. The next time it is appropriate to revisit the Council's management policy, and supplement the 2004 PSEIS, it should be more straightforward, as an environmental baseline has been established, and the new analysis will focus on the actions taken by the Council and NMFS since then.

4.2 What did the 2004 PSEIS analysis address?

The Federal action that was analyzed in the 2004 PSEIS was the authorization of the groundfish fisheries under the existing management program. There were four policy-level alternatives included in the PSEIS, from which the Council crafted a fifth, preferred alternative (Table 1). For each alternative, a management approach statement was developed, with accompanying objectives. Example FMPs were included to illustrate how the Council might implement each policy alternative with specific management measures. For all alternatives except the status quo, the policy alternative was illustrated with two example FMPs, which were intended to indicate the range of management measures that might fall within the implementation of that alternative. Although the example FMPs were important to illustrate how a management policy might operate in practice, the adoption of the policy itself was the immediate outcome of the 2004 PSEIS. It was intended that the Council would undertake subsequent amendments to fully implement the new management policy, as illustrated in the example FMPs, over the next five to ten years.

4.3 Data used in the 2004 PSEIS analysis

The data used in the analysis of biological impacts for groundfish stocks was largely based on 2002 stock assessments, using data from the 2001 and 2002 surveys. For some other seabird and marine mammal species, the most recent assessment data may have been from 2000. For the economic analysis, the most recent year included in the detailed fishery analysis was 2001. This was the basis on which the draft PSEIS was prepared, and issued for public comment in 2003. Some adjustments were subsequently made during the preparation of the 2004 PSEIS, to take into account more recent information. For example, the results from the new model for assessing impacts of fishing on essential fish habitat were incorporated in the analysis. In general, however, the most recent information in the document dates from 2000 to 2002.

4.4 Impacts of the Preferred Alternative

The following subsections summarize conclusions for each resource component analyzed in the 2004 PSEIS. The impact analyses started with the baseline status of each resource category, and then evaluated how specific characteristics of each component would respond directly and indirectly to management actions under the preferred alternative (PA) FMP bookends, PA.1 and PA.2. The expected cumulative effects on that stock were also evaluated and discussed, building on the direct and indirect effects evaluations as a starting point, and then bringing in persistent past effects as well as reasonably foreseeable future natural events and human activities external to fisheries management.

Possible evaluations were significant and beneficial (S+), insignificant (I), significant and adverse (S-), and unknown (U). In addition, effects were classified as conditionally significant (CS+ or CS-), if significant effects could be expected under a plausible set of conditions. The intent of the conditional label was to imply uncertainty about whether an alternative FMP would actually result in conditions that led to a significant impact. When the conditional label was applied, a plausible mechanism for the impact and the conditions under which a significant impact would be realized was stated. In cases where data were lacking to rank an effect according to the significance criteria, the effect was determined to be unknown.

Table 1 Alternatives analyzed in the 2004 PSEIS

Alternative	Example FMP bookend(s)
Alternative 1 ***Continue Under the Current Risk Averse Management Policy***	<u>FMP 1</u> • 2002 BSAI and GOA Groundfish FMPs
Alternative 2 ***Adopt a More Aggressive Harvest Management Policy***	<u>Example FMP 2.1</u> • remove constraints (remove buffer between acceptable biological catch (ABC) and overfishing level (OFL) • no OY cap • repeal all closures except Steller sea lion (SSL) measures • no prohibited species catch (PSC) limits or gear restrictions • repeal all catch share programs except American Fisheries Act (AFA) and Community Development Quota (CDQ) • repeal Observer Program and vessel monitoring system (VMS) <u>Example FMP 2.2</u> • remove OY cap • repeal any bycatch reduction incentives and restrictions except for PSC limits or improved retention/improved utilization (IRIU), including seabird avoidance requirements
Alternative 3 ***Adopt a More Precautionary***	<u>Example FMP 3.1</u> • formalize ABC greater than or equal to TAC in FMP

Alternative	Example FMP bookend(s)
Management Policy	• move sharks and skates into target category and develop criteria for all species in “other species” category • accelerate efforts to develop ecosystem indicators for use in TAC-setting • develop marine protected area (MPA) methodology and evaluate efficacy of existing closures • formal procedures to increase Alaska Native participation in management • 0-10% reduction in existing PSC limits • establish PSC limits for GOA salmon and crab • improve Observer Program Example FMP 3.2 • incorporate uncertainty correction into ABC estimation • specify OY separately for each stock rather than for groundfish complex, • incorporate stock-specific reference points (e.g. $F_{60\%}$ rather than $F_{40\%}$ for rockfish) • move stocks from ‘other species’ category • close 0-20% of exclusive economic zone (EEZ) as an MPA to protect full range of habitats • no bottom trawl for pollock in GOA • comprehensive rationalization of all fisheries • reduce existing PSC limits by 10-30% • established PSC limits GOA salmon and crab • 100% observer coverage on vessels greater than 60 ft length overall.
Alternative 4 ***Adopt a Highly Precautionary Management Policy***	Example FMP 4.1 • increase buffer between OFL and ABC ($F_{75\%}$ for Steller sea lion prey species and for rockfish) • reduce *max* F_{ABC} for stocks based on the lower bound of a confidence interval surrounding the survey biomass estimate) • set OY for each stock rather than for the groundfish complex • designate 20-50% of EEZ as no-take marine reserve covering full range of habitats (including Aleutian Islands special management area for coral, and spawning reserves) • reduce PSC limits and bycatch by 30-50% • 100% observer coverage on vessels greater than 60 ft LOA and 30% coverage on all other vessels • mandatory VMS Example FMP 4.2 • no fishing until target fisheries can be shown to have no adverse effect on the resource and its environment

Alternative	Example FMP bookend(s)
Preferred Alternative ***Adopt a conservative, precautionary approach to ecosystem-based fisheries management***	<u>Example FMP PA.1</u> • formalize ABC greater than or equal to TAC in FMP • use harvest control rules to maintain spawning stock biomass • accelerate efforts to develop ecosystem indicators for use in TAC-setting • develop MPA methodology • consider 0-10% reduction of BSAI PSC limits • establish PSC limits or other measures in GOA for salmon, crab, and herring • continue rights-based management as needed • formal procedures to increase Alaska Native participation in management <u>Example FMP PA.2</u> • incorporate uncertainty correction into ABC estimation • periodically review OY caps to determine their relevancy • develop and implement criteria for use of ecosystem indicators in TAC-setting • develop appropriate harvest strategies for rockfish • develop criteria to manage target and non-target species consistently • re-examine existing area closures • consider adopting MPAs (0-20% of EEZ to protect full range of habitats, including as Aleutian Islands management area for coral) • no bottom trawl for pollock in GOA • reduce existing PSC limits 0-20% • establish PSC limits in GOA for salmon, crab, and herring • comprehensive rationalization of all fisheries • increase consultation with and representation of Alaska Natives in fishery management • improve observer coverage on all vessels • establish mandatory economic data collection

4.4.1 Target species direct/indirect and cumulative effects significance ratings under Preferred Alternative PA.1 and PA.2

The 2004 PSEIS examined the potential direct, indirect, and cumulative effects that the implementation of the PA was expected to have on target species, prohibited species, forage fish species, other species, and non-specified species. The significance of these effects was evaluated as to whether the impacts, within the PA fishery management regime, might be reasonably expected to jeopardize the sustainability of each target species or species group. The effects are described below:

Direct Effects

<u>Fishing Mortality</u>: This is the rate at which the stock is depleted by direct mortality imposed by removing the fish from the sea.

<u>Change in Biomass Level</u>: This is the change over time in the biomass of the stock, as measured in metric tons (mt). Two measures are used: total biomass, which is the estimated biomass of the entire stock, and spawning biomass, which is the estimated biomass of all of the spawning females in the stock.

<u>Spatial/Temporal Concentration of Catch</u>: This is the degree to which the fishery will concentrate in a particular geographic area during a particular period of time each season. This pattern in space and time can affect fishing mortality and can also influence habitat suitability for spawning, rearing, and feeding.

Direct and/or Indirect Effects

> Habitat Suitability: This is the degree to which habitat has the right characteristics to support the stock at one or more life-history stages (spawning, rearing of juveniles, availability of food at all stages, availability of refuge areas to allow escape from predators at all stages). Habitat suitability can be affected directly, for example by mechanical damage from bottom trawling, or influenced indirectly, for example by the gradual depletion of corals that provide hard substrate.
>
> Prey Availability: This is the extent to which prey species are present in the environment and available as food to the stock. Like habitat suitability, this measure can be affected directly, for example by the direct removal of prey species by the fishery, or indirectly, for example by a change in the structure of the food web.

The baseline status of the BSAI and GOA stocks was their status in 2002, and the analysis then used a computer-based analytic model to project how specific characteristics of the these stocks would respond directly and indirectly to management actions under the preferred alternative FMP bookends. Relevant data were not always available for all stocks.

Target species were unique, in that thresholds for overfishing and stock size had been developed that relate to sustainability of the stock. As such, these thresholds were used to evaluate the significance of the effects of the example FMPs relative to their impacts on the sustainability of the target species. Fishing mortality rates that exceeded the overfishing mortality rate were considered to jeopardize the capacity of the stock to produce maximum sustainable yield (MSY) on a continuing basis and adversely impact the sustainability of the stock. A related measure of this potential was indicated by change in biomass levels. The significance of effects of the current spatial/temporal concentration of the catch, and the level of prey availability and habitat suitability for target species were evaluated with respect to each stock's current size relative to its maximum stock size threshold (MSST). An action that jeopardized the stock's ability to sustain itself at or above its MSST was considered to adversely affect the sustainability of the stock.

Species or species complexes that fall within Tiers 1 through 5 have estimates of fishing mortality rates, and were evaluated with respect to exceeding the overfishing mortality rate (fishing mortality effect). Species or species complexes that fall within Tiers 1, 2, or 3 have reliable estimates of MSST, and were evaluated for the effects on spatial/temporal concentration of the catch, prey availability, and habitat suitability. Species or species complexes that fall within Tiers 4, 5, or 6 do not have reliable estimates of MSST, and therefore could not be evaluated for the significance of these effects. Since several species or species complexes did not have estimates of abundances-at-age, in the 2004 PSEIS version of the model their abundance levels simply reflected the most recent estimate. This inability to evaluate the significance of the effects also occurs for the forage, prohibited, and non-specified species. For these groups, analysis of the effects of the preferred alternative was limited to catch projections and likely consequences given patterns in related fauna.

For the non-specified species FMP category, grenadiers were the major catch, and were chosen to illustrate potential effects to non-specified species. Non-specified species was a huge and diverse category encompassing every species not listed in the current FMP as a target, prohibited, forage, or other species. Considering a single species group from this category, such as grenadier, cannot possibly represent the diverse effects to all species in the category. However, because information is lacking for nearly all non-specified species, and due to the small or unknown amounts of bycatch (due to a lack of reporting requirements in this category), only potential effects to grenadier were discussed.

Formal stock assessments had not been conducted for grenadier. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under the preferred alternative could be determined due to the lack of information needed to establish the baseline condition.

Changes in bycatch of grenadier were predicted based on modeled changes in target species catches and population trajectories (sablefish target fisheries accounted for the highest grenadier bycatch). While changes in bycatch mortality relative to the comparative baseline were reported, the 2004 PSEIS emphasized that determinations could not be made as to how these changes actually impacted grenadier populations, or whether these impacts might be adverse, beneficial, or insignificant.

Table 2 Target groundfish species significance ratings in the 2004 PSEIS

Effect		Pollock, Pacific Cod, Sablefish	BSAI Atka Mackerel	GOA Atka Mackerel	BSAI Flatfish*	BSAI Other Flatfish	GOA Flatfish*	GOA Arrowtooth Flounder
Mortality	direct/ indirect	I	I	U	I	I	I	I
	cumulative	I	I	U	I	I	I	I
Change in Biomass	direct/ indirect	I	I	U	I	U	U	I
	cumulative	I	I	U	I	U	U	I
Spatial/ Temporal Concentration of Catch - *change in genetic structure*	direct/ indirect	I	I	U	I	U	U	I
	cumulative	I	I	U	I	U	U	I
Spatial/ Temporal Concentration of Catch - *change in reproductive success*	direct/ indirect	I	I	U	I	U	U	I
	cumulative	I	I	U	I	U	U	I
Change in Prey Availability	direct/ indirect	I	I	I	I	U	U	I
	cumulative	I	I	U	I	U	U	I
Change in Habitat	direct/ indirect	I	I	U	I	U	U	I
	cumulative	I	I	U	I	U	U	I

*BSAI flatfish includes BSAI yellowfin sole, BSAI flathead sole, BSAI rock sole, BSAI arrowtooth flounder, BSAI Greenland turbot, and BSAI Alaska plaice

*GOA flatfish includes GOA shallow water flatfish, GOA flathead sole, GOA deep water flatfish and GOA rex sole

Effect		BSAI and GOA POP	GOA Thornyhead Rockfish	BSAI Rockfish*	GOA Rockfish*	GOA Northern Rockfish
Mortality	direct/ indirect	I	I	I	I	I
	cumulative	I	I	I	I	I
Change in Biomass	direct/ indirect	I	I	U	U	I
	cumulative	I	I	U	U	I
Spatial/ Temporal Concentration of Catch - *change in genetic structure*	direct/ indirect	I	I	U	U	I
	cumulative	I	I	U	U	I
Spatial/ Temporal Concentration of Catch - *change in reproductive success*	direct/ indirect	I	I	U	U	I
	cumulative	I	I	U	U	I
Change in prey availability	direct/ indirect	I	I	U	U	I
	cumulative	I	I	U	U	I
Change in Habitat	direct/ indirect	I	I	U	U	I
	cumulative	I	I	U	U	I

*BSAI rockfish includes BSAI northern rockfish, BSAI shortraker/rougheye rockfish and BSAI other rockfish

*GOA rockfish includes GOA shortraker/rougheye rockfish, GOA slope rockfish, GOA pelagic shelf rockfish and GOA demersal shelf rockfish

Table 3 Non-target fish species significance ratings in the 2004 PSEIS

Effect		Other species (squid, octopus, sharks, sculpins, skates)	Forage fish	Non-specified species (Grenadier)
Mortality	direct/ indirect	U	I	U
	cumulative	U	I	U
Change in biomass level	direct/ indirect	U	U	U
	cumulative	U	U	U
Change in reproductive success	direct/ indirect	U	U	U
	cumulative	U	U	U
Change in prey availability	direct/ indirect	*n/a*	U	*n/a*
	cumulative	*n/a*	U	*n/a*
Change in habitat	direct/ indirect	U	U	*n/a*
	cumulative	U	U	*n/a*
Change in genetic structure	direct/ indirect	U	U	U
	cumulative	U	U	U

4.4.2 Prohibited species direct/indirect and cumulative effects significance ratings under Preferred Alternative PA.1 and PA.2

The 2004 PSEIS examined the potential direct, indirect, and cumulative effects that the implementation of the preferred alternative was expected to have on the prohibited species. As described above, the significance of the impacts for prohibited species were evaluated with respect to five effects: (1) fishing mortality, (2) change in biomass level, (3) spatial/temporal concentration of the catch, (4) prey availability, and (5) habitat suitability. The significance of these effects was evaluated as to whether the impacts, within the preferred alternative fishery management regime, might be reasonably expected to jeopardize the sustainability of the species. Because relevant data were not always available for all stocks, for these groups, analysis of the effects of the preferred alternative was limited to catch projections and likely consequences given patterns in related fauna. When data gaps prevented application of the model to a specific stock, the projected direct or indirect effect was evaluated as unknown (U).

Table 4 Prohibited species significance ratings in the 2004 PSEIS

Effect		Pacific halibut	BSAI salmon *	GOA Chinook salmon	GOA other salmon	Pacific herring	BSAI crab*	GOA crab*	GOA red king crab	BSAI and GOA golden king crab
Mortality	direct/ indirect	I	I	I	I	I	I	U	I	U
	cumulative	I	CS-	CS-	I	I	U	U	U	U
Change in biomass level	direct/ indirect	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	I	U	I	U
	cumulative	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	U	U	U	U
Change in reproductive success	direct/ indirect	I	U	U	U	I	U	U	U	U
	cumulative	I	CS-	U	U	I	U	U	U	U
Change in prey availability	direct/ indirect	I	U	U	U	I	U	U	U	U
	cumulative	I	U	U	U	U	U	U	U	U
Change in habitat	direct/ indirect	*n/a*	*n/a*	*n/a*	*n/a*	I	I	U	I	U
	cumulative	*n/a*	*n/a*	*n/a*	*n/a*	U	U	U	U	U
Change in genetic structure	direct/ indirect	*n/a*	U	U	U	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
	cumulative	*n/a*	U	U	U	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*

*BSAI salmon includes Chinook salmon and other salmon
*BSAI crab includes BSAI bairdi Tanner, BSAI opilio Tanner, BSAI red king and BSAI blue king
*GOA crab includes GOA bairdi Tanner and GOA blue king

4.4.3 Marine mammals direct/indirect and cumulative effects significance ratings under Preferred Alternative PA.1 and PA.2

The standard for determining significance for effects on marine mammals in the 2004 PSEIS was whether the impact would be expected to be detectable at the population level. Individual effects categories did not have to cause a measurable population decline or increase to be labeled significant, but data and/or plausible arguments must exist to determine that the action would have more than a negligible impact on the reproduction and/or survival of a species group in a way that could affect the population. The expected effects of each alternative were compared to the baseline conditions to determine the relative significance of the impacts of the alternatives on marine mammals.

Table 5 Marine mammal species significance ratings in the 2004 PSEIS

Effect		W Steller sea lion	E Steller sea lion	Northern fur seal	Harbor seal	Killer whale (transients)	Other pinnipeds *	Other toothed whales*	Baleen whales *	Sea otters
Mortality (incidental take, entanglement)	direct/ indirect	I	I	I	I	I	I	I	I	I
	cumulative	S-	I	I	I	I / S-[1]	I	I	CS-[2] / I[3]	CS- / I[5]
Prey availability	direct/ indirect	I	I	I	I	I	I / U[4]	I	I	I
	cumulative	CS-	I	CS-	CS-	I	I	I	I	I
Spatial/temporal concentration of fisheries	direct/ indirect	I	I	I	I	I	I	I	I	I
	cumulative	CS-	I	CS-	CS-	I	I	I	I	I
Disturbance	direct/ indirect	I	I	I	I	I	I	I	I	I
	cumulative	I	I	I	I	I	I	I	I	I

*Baleen whales include blue whale, fin whale, sei whale, minke whale, humpback whale, gray whale, northern right whale, bowhead.
*Other pinnipeds include Pacific walrus, spotted seal, bearded seal, ringed seal, ribbon seal, elephant seal
*Other toothed whales include sperm whales, beaked whales, white sided dolphin, beluga whale, harbor porpoise, Dall's porpoise.
[1] -The exception to this finding is the AT1 transient group in Prince William Sound.
[2] -Fin, humpback and northern right whales;
[3] -Minke, gray, bowhead, sei, and blue whales
[4] -Northern elephant seals
[5] -Southcentral and southeast stocks of sea otters.

4.4.4 Seabirds direct/indirect and cumulative effects significance ratings under Preferred Alternative PA.1 and PA.2

In the 2004 PSEIS, significance criteria for seabirds were based on whether the proposed action would have been likely to result in population level effects, defined as changes in the population trend outside the range of natural fluctuations. The projection model was used for predictions of fishing effort under the different FMP bookends, especially with respect to different gear types. The analysis also included other factors such as spatial/temporal restrictions and potential gear modifications for seabird avoidance. However, because there are a large number of unpredictable variables and gaps in our knowledge about particular species and ecosystem effects, it was impossible to ascertain significance on a strictly quantitative basis. Species were generally grouped according to the similarity of their response to the groundfish fishery and/or similarity in their management status. Conclusions are based on professional judgment of pertinent data and literature review.

Except for the supplemental food provided by the fisheries in the form of offal, the effects of the fisheries are all considered adverse to individual birds. Low levels of incidental take of seabirds are better for conservation purposes than high levels of take, but no amount of incidental take can be considered beneficial to a seabird population. The significance ratings for incidental take are, therefore, either insignificant or adverse. The same type of situation applies to fishery induced changes in benthic habitat important to benthic-feeding seabirds, so there is no beneficial rating for this effect. Effects of the fishery on food availability could be adverse, insignificant, or beneficial. If there is a plausible mechanism and a reasonable set of conditions under which an effect may occur under a given FMP, the significance rating was labeled conditional. If there is a plausible mechanism for an effect, but not enough data to assess whether it occurs or whether the FMP would create the conditions under which it would occur, the significance rating was unknown.

Table 6 Seabird species significance ratings in the 2004 PSEIS

Effect		Short-tailed albatross	Other albatross*	Shearwaters*	Northern fulmar	Red-legged kittiwakes[1]	Murrelets[1]
Mortality (incidental take)	direct/ indirect	I	I	I	I	I	I
	cumulative	CS-	S-	CS-	I	CS-	S-
Availability of food	direct/ indirect	I	I	I	I	I	I
	cumulative	I	I	I	I	U	U
Benthic habitat	direct/ indirect	no effect	no effect	no effect	no effect	no effect	I
	cumulative	no effect	no effect	no effect	no effect	no effect	I

*Other albatross include Laysan and blackfooted albatross
*Shearwaters include sooty and shorttailed shearwaters
[1] Redlegged kittiwake, marbled murrelet, and Kittlitz's murrelet are species of management concern.

Effect		Other piscivorous species*	Other planktivorous species*	Steller's eiders	Spectacled eider
Mortality (incidental take)	direct/ indirect	I	I	I	no effect
	cumulative	I	I	S-	no effect
Availability of food	direct/ indirect	I	I	I	no effect
	cumulative	I	I	I	no effect
Benthic habitat	direct/ indirect	I	no effect	I	no effect
	cumulative	I	no effect	U	no effect

*Other piscivorous species - alcids (except auklets), gulls, jaegers, terns, and cormorants
*Other planktivorous species - auklets and stormpetrels

4.4.5 Habitat direct/indirect and cumulative effects significance ratings under Preferred Alternative PA.1 and PA.2

The 2004 PSEIS considered adverse effects of fishing on benthic marine habitat from the perspective of ecosystem structure and function, as well as managed fish species. The potential effects of the groundfish fisheries on habitat that were used to compare the alternatives included mortality of, and damage to, living habitat, changes to benthic community diversity, and changes to the geographic diversity of impacts and protection. Specific impacts of groundfish fisheries on habitat are very difficult to predict. Evaluation of effects requires detailed information on the distribution and abundance of habitat types, the life history of living habitat, habitat recovery rates, and the natural disturbance regime. This information is generally incomplete.

Table 7 Habitat significance ratings in the 2004 PSEIS

Effect		Bering Sea		Aleutian Islands		Gulf of Alaska	
		PA.1	PA.2	PA.1	PA.2	PA.1	PA.2
Changes to living habitat - direct mortality of benthic organisms	direct/ indirect	I	I	I	S+	I	CS-
	cumulative	CS-	CS-/CS+	CS-	CS-/CS+	CS-	CS-/CS+
Changes to benthic community structure	direct/ indirect	I	CS+	I	S+	I	I
	cumulative	CS-	CS-/CS+	CS-	CS-/CS+	CS-	CS-/CS+
Changes in distribution of fishing effort - geographic diversity of impacts and protection	direct/ indirect	I	S+	I	S+	I	I
	cumulative	CS-	CS-/CS+	CS-	CS-/CS+	CS-	CS-/CS+

4.4.6 Socioeconomics direct/indirect and cumulative effects significance ratings under Preferred Alternative PA.1 and PA.2

In the socioeconomic impact analysis in the 2004 PSEIS, the term "significant" for an expected change in a quantitative indicator meant a 20 percent or more change (either plus or minus), relative to the comparative baseline. If the expected change was less than 20 percent, the change is not considered to be significant. The same threshold was used to roughly assess changes in qualitative indicators (e.g., fishing vessel safety). However, whereas changes in quantitative indicators were based on model projections, predicted changes in qualitative indicators were based on the judgment of the socioeconomic analysts.

Table 8 Socioeconomic significance ratings in the 2004 PSEIS

Harvesting and processing sectors

Effect		Catcher vessels		Catcher processors		Inshore processors and motherships	
		PA.1	PA.2	PA.1	PA.2	PA.1	PA.2
Groundfish landings by species group	direct/ indirect	I/S+	I/S+/S-	I/S+	I/S+/S-	I/S+	I/S+/S-
	cumulative	I	I	I	I	I	I
Groundfish ex-vessel value	direct/ indirect	I	I/S-	*n/a*	*n/a*	*n/a*	*n/a*
	cumulative	I	I	*n/a*	*n/a*	*n/a*	*n/a*
Groundfish gross product value	direct/ indirect	*n/a*	*n/a*	I	I	I	I/S-
	cumulative	*n/a*	*n/a*	I	I	I	I
Employment	direct/ indirect	I	I	I	I	I	I
	cumulative	I	I	I	I	I	I
Payments to labor	direct/ indirect	I	I	I	I	I	I
	cumulative	I	I	I	I	I	I
Product quality and product utilization rate	direct/ indirect	*n/a*	*n/a*	CS+	CS-/S+	CS+	CS-/S+
	cumulative	*n/a*	*n/a*	CS+	S+/S-	CS+	S+/S-
Excess capacity	direct/ indirect	CS+	S+	CS+	S+	CS+	S+
	cumulative	CS+	S+	CS+	S+	CS+	S+
Average costs	direct/ indirect	CS+	CS+/S-	CS+	CS-/S+	CS+	CS-/S+
	cumulative	CS+	S+/S-	CS+	S+/S-	CS+	S+/S-
Fishing vessel safety	direct/ indirect	CS+	CS+/S-	CS+	CS-/S+	*n/a*	*n/a*
	cumulative	CS+	S+/S-	CS+	S+/S-	*n/a*	*n/a*

BSAI and GOA regions

Effect		Alaska Peninsula, Aleutian Islands		Kodiak Island		Southcentral Alaska		Southeast Alaska		Washington inland waters		Oregon coast	
		PA.1	PA.2	PA.1	PA.2	PA.1	PA.2	PA.1	PA.2	PA.1	PA.2	PA.1	PA.2
In-region processing	direct/ indirect	I	I	I	I	S+	I	I	S-	I	I	I	I
	cumulative	I/CS-	I	I	I	I	I	I	S-	I	I	I	I
Regionally owned at-sea processors	direct/ indirect	I	I	S+	I	S+	I	S+	I	I	I	I	I
	cumulative	I	I	I	I	I	I	I	I	I	I	I	I
Extra-regional deliveries of regionally owned catcher vessels	direct/ indirect	I	S-	I	I	I	I	I	S-	I	I	I	I
	cumulative	CS-	CS-	I	I	I	I	I	CS-	I	I	I	I
In-regional deliveries of regionally owned catcher vessels	direct/ indirect	I	S-	I	I	S+	I	I	S-	I	I	I	I
	cumulative	CS-	CS-	I	I	I	I	I	CS-	I	I	I	I
Total direct, indirect, and induced labor income and full-time equivalents (FTEs)	direct/ indirect	I	I	I	I	S+	I	I	S-	I	I	I	I
	cumulative	CS-	CS-	I	I	I	I	I	CS-	I	I	I	I

Community Development Quota (CDQ) program, Subsistence, Environmental Justice, Market channels, Non-consumptive and non-use benefits

	Effect		PA.1	PA.2
CDQ program	**Allocation of catch to CDQ groups,** including potential revenue and potential funds available for approved economic development activities in CDQ communities	direct/ indirect	I	I
		cumulative	I	I
Subsistence	**Subsistence use of groundfish**	direct/ indirect	I	I
		cumulative	I	I
	Subsistence use of western Alaska salmon and bycatch	direct/ indirect	I	I
		cumulative	I	I
	Subsistence use of Steller sea lions	direct/ indirect	I	I
		cumulative	I	I
	Indirect subsistence use: income and joint	direct/ indirect	I	I
		cumulative	I	I
Environmental Justice	**Alaska Peninsula and Aleutian Islands**	direct/ indirect	I	CS-
		cumulative	I	CS-
	Kodiak Island	direct/ indirect	I	I
		cumulative	I	I
	Southcentral Alaska	direct/ indirect	I	I
		cumulative	I	I
	Southeast Alaska	direct/ indirect	I	I
		cumulative	I	I
	Washington inland waters	direct/ indirect	I	I
		cumulative	I	I
	Oregon coast	direct/ indirect	I	I
		cumulative	I	I
Market channels	**Benefits to U.S. consumers**	direct/ indirect	I	I
		cumulative	I	I
Non-consumptive and non-use benefits	**Benefits derived from marine ecosystems and associated species**	direct/ indirect	I	S+
		cumulative	I	S+

4.4.7 Ecosystem direct/indirect and cumulative effects significance ratings under Preferred Alternative PA.1 and PA.2

Significance thresholds for determining the ecosystem-level impacts of fishing in the 2004 PSEIS involved both population-level thresholds that had already been established for species in the system (MSST for fish species; fishing-induced population impacts sufficient to lead to listing under the ESA, and fishing-induced impacts that prevent recovery of a species already listed under the ESA, for other species) and community- or ecosystem-level attributes that were outside of the range of natural variability for the system. These community or ecosystem-level attributes were more difficult to measure directly, and the range of natural variability of those attributes was not well known. We also lacked sufficient data on population status of some target or non-target species to determine whether they were above or below MSST or ESA-related thresholds. Thus, indicators of the strength of fishing impacts on the system were also used to evaluate the degree to which the preferred alternative might have a significant ecosystem impact.

For the preferred alternative FMP bookends, the possible impacts on (1) predator/prey relationships, including introduction of non-native species; (2) energy flow and redirection (through fishing removals and return of discards to the sea); and (3) diversity were addressed.

Table 9 Ecosystem significance ratings in the 2004 PSEIS

Effect		Ecosystem	
		PA.1	PA.2
Change in pelagic forage availability	direct/ indirect	I	I
	cumulative	CS-	CS-
Spatial and temporal concentration of fishery impact on forage	direct/ indirect	I	CS+ / I
	cumulative	CS-	CS-
Removal of top predators	direct/ indirect	I / U	I / U
	cumulative	CS-	CS-
Introduction of non-native species	direct/ indirect	I	I
	cumulative	CS-	CS-
Energy removal	direct/ indirect	I	I
	cumulative	I	I
Energy redirection	direct/ indirect	I	I
	cumulative	I	I
Change in species diversity	direct/ indirect	I / U	I / U
	cumulative	CS-	CS-
Change in functional (trophic) diversity	direct/ indirect	I	I
	cumulative	CS-	CS-
Change in functional (structural habitat) diversity	direct/ indirect	I	S+
	cumulative	CS-	CS+
Change in genetic diversity	direct/ indirect	I / U	I / U
	cumulative	I	I

5 Synthesis of Changes Since 2004

5.1 Changes in the Management of Fisheries

Since the adoption of the groundfish management policy in 2004, the Council has continued to make changes to its groundfish management program. The changes that have occurred to date can be witnessed in the FMP and regulatory amendments that have been implemented over this time period. Additionally, there have also been national changes affecting the groundfish management program. The Magnuson-Stevens Act was reauthorized in 2006, and contained provisions that have affected the groundfish management program to some extent (for example, annual catch limits and provisions governing the development of limited access privilege programs).

Table 10 lists the groundfish FMP amendments that have been implemented from 2004 to 2015, as well as those for which the Council has taken final action, but regulations are still being developed. The Council has recommended over 20 amendments to the BSAI FMP and GOA FMP since the adoption of its groundfish management policy in April 2004. Additionally, four BSAI and four GOA amendments had been adopted by the Council prior to April 2004, but had not yet been implemented when the PSEIS was written. Table 11 provides a synthesis of the major regulatory amendments that have been implemented during the same period. Between the two lists, the major changes in groundfish management are captured.

In addition, since the 2004 PSEIS, NMFS and the Council have prepared four comprehensive EISs that analyzed changes in the management of the fisheries. The Final Environmental Impact Statement for Essential Fish Habitat in Alaska (EFH EIS, NMFS 2005) evaluates alternatives and environmental consequences for three actions: (1) describing and identifying EFH for fisheries managed by the Council; (2) adopting an approach for the Council to identify Habitat Areas of Particular Concern within EFH, and (3) minimizing to the extent practicable the adverse effects of Council-managed fishing on EFH. In 2010 NMFS and the Council conducted an EFH 5-Year Review that examined information within the 2005 EFH EIS and determined (1) new and more recent information exists to refine EFH for a small subset of managed species; (2) certain fishing effects may be impacting sensitive habitats of Bristol Bay red king crab, however additional analysis is needed; and (3) the non-fishing impacts analysis, including advisory EFH Conservation Recommendations, should be updated with the most current level of information.

The Alaska Groundfish Harvest Specifications Final Environmental Impact Statement (Harvest Specifications EIS, NMFS 2007a) evaluated the environmental, social, and economic effects of alternative harvest strategies for the federally managed groundfish fisheries in the GOA and BSAI management areas. The Harvest Specifications EIS evaluates the effects of different alternatives on target species, non-specified species, forage species, prohibited species, marine mammals, seabirds, essential fish habitat, ecosystem relationships, and economic aspects of the groundfish fisheries. Each year, NMFS prepares a SIR for that EIS to evaluate the need to prepare a supplemental EIS for the groundfish harvest specifications.

The Bering Sea Chinook Salmon Bycatch Management Final Environmental Impact Statement (Chinook EIS, NMFS 2009a) evaluated the Bering Sea pollock fishery and the effects of alternatives to minimize Chinook salmon bycatch to the extent practicable in that fishery.

The Steller Sea Lion Protection Measures Final Supplemental Environmental Impact Statement (SSL EIS, NMFS 2014b) evaluates the environmental, social, and economic effects of alternatives to the Steller sea lion protection measures for the BSAI groundfish fisheries, in particular the Atka mackerel, Pacific cod, and pollock fisheries in the Aleutian Islands.

Finally, the Council also adopted, as Council policy, an ecosystem vision statement that applies to its fishery management as a whole, including the groundfish fisheries, in February 2014. The Council explicitly considered the relationship of the vision statement with the groundfish management policy, and found no inconsistency. The vision statement is included below:

Ecosystem Approach for the North Pacific Fishery Management Council

Value Statement

The Gulf of Alaska, Bering Sea, and Aleutian Islands are some of the most biologically productive and unique marine ecosystems in the world, supporting globally significant populations of marine mammals, seabirds, fish, and shellfish. This region produces over half the nation's seafood and supports robust fishing communities, recreational fisheries, and a subsistence way of life. The Arctic ecosystem is a dynamic environment that is experiencing an unprecedented rate of loss of sea ice and other effects of climate change, resulting in elevated levels of risk and uncertainty. The North Pacific Fishery Management Council has an important stewardship responsibility for these resources, their productivity, and their sustainability for future generations.

Vision Statement

The Council envisions sustainable fisheries that provide benefits for harvesters, processors, recreational and subsistence users, and fishing communities, which (1) are maintained by healthy, productive, biodiverse, resilient marine ecosystems that support a range of services; (2) support robust populations of marine species at all trophic levels, including marine mammals and seabirds; and (3) are managed using a precautionary, transparent, and inclusive process that allows for analyses of tradeoffs, accounts for changing conditions, and mitigates threats.

Implementation Strategy

The Council intends that fishery management explicitly take into account environmental variability and uncertainty, changes and trends in climate and oceanographic conditions, fluctuations in productivity for managed species and associated ecosystem components, such as habitats and non-managed species, and relationships between marine species. Implementation will be responsive to changes in the ecosystem and our understanding of those dynamics, incorporate the best available science (including local and traditional knowledge), and engage scientists, managers, and the public.

The vision statement shall be given effect through all of the Council's work, including long-term planning initiatives, fishery management actions, and science planning to support ecosystem-based fishery management.

Table 10 BSAI and GOA Groundfish FMP amendments since 2004

BSAI amd	GOA amd	Action	Date of Council action	Year of Implementation
48	48	Revisions to the annual harvest specification process for groundfish	2003	2004
62	62	Single geographic location	2002	2009
	63	Move skates to the target species category	2003	2004
65	65	Identify habitat areas of particular concern, and harvest control measures	2005	2006
	67	Individual Fishing Quota (IFQ) – allow category B quota share to be fished on a vessel of any length, in any area	2005	2007
	68	Rockfish pilot program	2005	2006

BSAI amd	GOA amd	Action	Date of Council action	Year of Implementation
	69	Change total allowable catch specification for the 'other species' category	2005	2006
71		CDQ – allow limited non-fishing investments, CDQ oversight, and 3-year allocation cycle *(superseded by provisions of the revised Magnuson-Stevens Act)*	2002	N/A
73	77	Remove dark rockfish from the FMP	2007	2009
	72	Rescind retention requirements in shallow water flatfish fishery	2003	2008
78	73	Revise essential fish habitat descriptions, harvest control measures	2005	2006
79		Groundfish retention standard (suspended as of 2011)	2003	2008
80		Sector allocation and cooperative for head and gut groundfish catcher processors	2007	2007
81	74	Revised management policy	2004	2004
82		Allocation of Aleutian Islands pollock total allowable catch to the Aleut Corporation	2004	2005
83	75	Housekeeping updates to the FMP	2004	2005
84		Exempt certain vessels from salmon bycatch savings area closures	2005	2007
85		Pacific cod sector allocations	2006	2008
86	76	Observer program restructuring	2010	2012
87		CDQ eligibility *(superseded by provisions of the revised Magnuson-Stevens Act)*	2006	N/A
88		Aleutian Islands Habitat Conservation Area boundary adjustment	2007	2008
89		Bering Sea habitat conservation measures	2007	2008
90	78	Allow post-delivery transfers for Amendment 80 cooperatives (BSAI 90) and rockfish program (GOA 78)	2007	2009
91		Revise PSC limit for salmon bycatch, rescind savings areas	2009	2010
	79	Set allowable biological catch and overfishing level specifications for the "other species" category	2008	2008
92	82	Rescind latent trawl gear licenses	2008	2009
93		Modify rules for Amendment 80 cooperative formation	2010	2011
94		Require gear modification to trawl sweeps for nonpelagic trawl vessels targeting flatfish	2009	2010
	83	Pacific cod sector allocations	2009	2012
	85	Remove BSAI stand down provision for catcher processors participating in rockfish pilot program	2008	2009
	86	Add a Pacific cod fixed gear endorsement to GOA licenses	2009	2011
95		Move skates from the other species to the target species category	2010	2010
96	87	Revise FMP species to fit either in target or ecosystem component categories, describe current practice for setting annual catch limits and using accountability measures	2010	2010
97		Allow vessel replacement for Amendment 80 vessels	2010	2012
	88	Central GOA Rockfish Program: allocate exclusive harvest privileges to trawl vessels for Pacific ocean perch, pelagic shelf rockfish, and northern rockfish	2010	2011
	89	Establish area closures around Kodiak for GOA Tanner crab protection, require trawl sweep modification for GOA flatfish	2010	2014

BSAI amd	GOA amd	Action	Date of Council action	Year of Implementation
		fisheries		
98	90	Update EFH descriptions and associated information, and impacts of non-fishing activities on EFH, and extend timing of HAPC process to correlate with the EFH 5-year review	2011	2012
99		Change the freezer longline maximum length overall on License Limitation Program (LLP) licenses	2012	2014
100	91	Add an ecosystem component category for grenadiers to the FMP	2014	2014
	93	Establish PSC limits for Chinook salmon in the Central/Western GOA pollock fisheries, and require full retention of salmon	2011	2012
	94	Revise the vessel use caps applicable to sablefish quota share held by GOA Community Quota Entities (CQE) and add three eligible communities to the CQE Program	2011	2013
	95	Establish PSC limits for Pacific halibut in the Gulf of Alaska	2012	2014
102		CQE program in Area 4B and Area 4B “fish up”	2012	2014
103		Prohibit Pacific cod fishing in Pribilof Islands Habitat Conservation Zone	2010	2014
	96	Provide ability for CQE to buy small blocks of halibut QS	2013	2014
	97	Chinook PSC management measures for non-pollock trawl fisheries	2013	2014
104		Establish habitat areas of particular concern (HAPC) skate sites	2013	2015
105		Provide flexibility for flatfish specifications	2013	2014
106		Allow replacement of AFA vessels	2013	2014
107		Establish transit areas through walrus protection areas at Round Island and Cape Peirce	2014	2015
108	100	Correction on vessel length restriction for small vessel LLP license	2014	2015
109		Allow for small boat CDQ Pacific cod fishery	2015	
110		Chinook and chum salmon PSC limit measures	2015	
	101	Allow use of longline pots for sablefish	2015	
111		Halibut PSC limit reductions	2015	
112	102	Observer coverage for small catcher processors	2015	
113		Aleutian Islands Pacific cod catcher vessel fishery and shoreplant delivery requirement	2015	

Table 11 Major regulatory amendments for the BSAI and GOA groundfish fisheries since 2004
Note: does not include regulations that implement FMP amendments, or are temporary, interim, corrections or clarifications

Subject	Action	Year of Implementation
Harvest specifications	2004 BSAI and GOA harvest specifications	2004
	2005-2006 BSAI and GOA harvest specifications	2005
	2006-2007 BSAI and GOA harvest specifications	2006
	2007-2008 BSAI and GOA harvest specifications	2007
	2008-2009 BSAI and GOA harvest specifications	2008
	2009-2010 BSAI and GOA harvest specifications	2009
	2010-2011 BSAI and GOA harvest specifications	2010
	2011-2012 BSAI and GOA harvest specifications	2011
	2012-2013 BSAI and GOA harvest specifications	2012
	2013-2014 BSAI and GOA harvest specifications	2013
	2014-2015 BSAI and GOA harvest specifications	2014
	2015-2016 BSAI and GOA harvest specifications	2015
Catch restrictions	remove a harvest restriction on the HLA Atka mackerel fishery in the Aleutian Islands	2004
	full retention of demersal shelf rockfish and donation rules	2004
	allow processors to use the offal from halibut and salmon intended for the prohibited species donation program for commercial products (fish meal)	2004
	adjust the maximum retainable allowance (MRA) enforcement period for BSAI pollock from enforcement at any time during a fishing trip, to enforcement at the time of offload	2004
	revise the MRAs for groundfish in the GOA arrowtooth flounder fishery	2009
	repeal groundfish vessel incentive program	2008
	GOA pollock trip limits	2009
	revise the MRAs for groundfish in the BSAI arrowtooth and Kamchatka flounder fishery	2013
	remove groundfish retention standard requirements	2013
	BSAI fixed gear parallel fishery management measures	2012
Bering Sea AFA pollock fishery	remove the expiration date of regulations implementing the AFA	2004
CDQ	simplify the processes for making quota transfers, for authorizing vessels as eligible to participate in the CDQ fisheries, and for obtaining approval of alternative fishing plans	2005
	Revise CDQ regulations for recordkeeping, vessel licensing, catch retention requirements, and fisheries observer requirements to ensure that they are no more restrictive than regulations in effect for comparable non-CDQ fisheries managed under individual fishing quotas or cooperative allocations	2012

Subject	Action	Year of Implementation
BSAI and GOA IFQ sablefish fishery	allow quota shareholders in 4C to fish in either 4C or 4D	2005
	IFQ cost recovery fee reform	2006
	exclude tagged halibut and sablefish catches from IFQ account deduction	2006
	allow transfers of quota share for medical reasons; require VMS for vessels harvesting sablefish in the BSAI; allow category B catcher vessel quota share for Southeast Outside District sablefish to be fished on catcher vessels of any length	2007
	allow processing of non-IFQ species on a vessel with B, C, or D shares onboard	2008
	allow longline pot gear in Bering Sea during June, allow mobilized military personnel to make temporary IFQ transfers	2008
	IFQ online access to IFQ account information	2008
	Allow longline pot gear in Southeast GOA	2015
GOA rockfish program	revise central GOA rockfish fisheries program monitoring and enforcement provisions	2007
	extension of central GOA rockfish program under MSA	2008
seabirds	revise seabird avoidance measures in the hook-and-line fisheries off Alaska to reduce incidental catch of the short-tailed albatross and other seabird species	2004
	revise seabird avoidance measures to strengthen gear standards for small vessels and eliminate certain unnecessary requirements	2008
	eliminate seabird avoidance requirements for vessels less than or equal to 55 ft LOA in 4E	2009
Marine mammals	revise SSL protection measures for the GOA pollock and Pacific cod fishing closure areas near four SSL haul outs and modify the seasonal management of pollock harvest in the GOA	2005
	Revise SSL protection measures for the Aleutian Islands Atka mackerel and Pacific cod fisheries	2010
	Designate critical habitat for the Cook Inlet beluga whale	2011
	Revise SSL protection measures for the Aleutian Islands Atka mackerel, Pacific cod, and pollock fisheries	2014
Research areas	reopen the Cape Sarichef Research Restriction Area in the BSAI to directed fishing for groundfish	2006
	close Chiniak Gully Research Area to all commercial trawl fishing from August 1 to September 20, 2006-2010	2006
Observer program	provide flexibility in the deployment of observers	2004
	electronic reporting for vessels – ATLAS (at-sea observer communication system requirements)	2004
	technical amendment extending the North Pacific observer program beyond 2002	2004
	revise requirements facilitating observer data transmission and improve support for observers (ATLAS 2)	2006
	observer sunset date removal	2007
	Improve operational efficiency of the Observer Program and collected data	2010

Subject	Action	Year of Implementation
reporting requirements	make effective the collection of information under the AFA amendments	2004
	exempt groundfish catcher processors and motherships with operational VMS from check-in check-out requirements	2008
	implement new electronic groundfish catch reporting system, the Interagency Electronic Reporting System (IERS), and its data entry component, eLandings	2009
	exempt vessels using dinglebar gear from the requirement to use VMS	2009
	Miscellaneous recordkeeping and reporting revisions, incl to e-Landings	2008
	BS Chinook salmon bycatch economic data collection for the Bering Sea pollock fishery	2012
	Modify equipment and operational requirements for freezer longliners named on License Limitation Program licenses endorsed to catch and process Pacific cod at sea with hook-and-line gear in the BSAI	2012
	GOA trawl economic data collection	2014
	Revise the at-sea scales program for catcher/processors and motherships that are required to weigh catch at sea.	2014
	Codify type-approval standards, requirements, procedures, and responsibilities applicable to VMS products and services.	2015

5.2 Management changes as they pertain to the Council's policy goals

The following section evaluates the Council's management actions since the completion of the 2004 PSEIS in 2004. The Council's groundfish policy (the approved, preferred alternative from the 2004 PSEIS) is structured with nine goal statements, each supported by specific objectives, see Appendix 1. For each goal statement and set of objectives, we identify the relevant FMP and regulatory amendments implemented over the last ten years, as well as other management steps that the Council has taken with respect to these goals. The discussion in this section is not necessarily comprehensive, as each amendment may satisfy many of the Council's goals and objectives. Rather, it is intended to provide an overview of the major management changes of the last eleven years, and how they compare to the management objectives that the Council set for itself in 2004.

Additionally, we have also looked back to the example FMPs that illustrated the preferred alternative analyzed in the 2004 PSEIS. Given the Council's actions of the last ten years, the current groundfish management program does now fall within the range of example FMPs that were analyzed in the PSEIS.

Each of the sections below identifies one of the Council's policy goals. The specific objectives, sometimes abbreviated, linking to that policy goal are listed after each policy goal. If the objectives are also linked to a specific item on the Council's workplan,[35] that is noted also. After each policy goal and objectives are listed the FMP amendments related to this goal statement, the regulatory amendments related to this goal statement, and other management actions related to this goal statement.

[35] The Council developed a workplan to track the implementation of the various management objectives over time and prioritize issues for consideration. The workplan was developed in June 2004 revised in February 2007. The Council is updated on the status of this workplan at each meeting.

Prevent Overfishing

1. Adopt conservative harvest levels
2. Use existing OY caps
3. Specify OY as a range
4. Periodic reviews of $F_{40\%}$ and adopt improvements
5. Improve management through species categories (on workplan)

FMP amendments related to this goal statement

- revisions to the harvest specifications process (B48/G48)
- moved skates to target category (G63)
- biologically-based specifications for GOA “other species” category (G69, G79)
- amendments to bring FMPs in line with annual catch limit requirements, including moving other species into target category, and creating an ecosystem component category (B95, G87)
- amendment to include grenadiers in the ecosystem component of the FMPs (B100, G91)
- Restructured observer program reduces bias in catch accounting (B86, G76)
- Provide flexibility for flatfish specifications (B105)

Regulatory amendments related to this goal statement

- Annual specifications for setting harvest levels

Other management actions related to this goal statement

- Regular Center for International Experts reviews for stock assessments and harvest strategies
- Ongoing work on accounting for uncertainty in control rules
- Council policy and ongoing discussion of spatial management for stocks

Promote Sustainable Fisheries and Communities

6. Promote conservation while providing for OY
7. Promote management measures that avoid social and economic disruption
8. Promote fair and equitable allocation
9. Promote safety

These considerations are applied to all management actions.

Preserve Food Web

10. Develop indices of ecosystem health (on workplan)
11. Improve ABC calculations to account for uncertainty and ecosystem
12. Limit harvest on forage species
13. Incorporate ecosystem considerations in fishery management

Other management actions related to this goal statement

- Uncertainty and ecosystem considerations taken into account during stock assessment and harvest specifications
- Ecosystem indices reported and assessed in annual ecosystem SAFE report
- Adoption of the Aleutian Islands Fishery Ecosystem Plan, and development of a Bering Sea Fishery Ecosystem Plan
- Development of ecosystem synthesis reports for the Bering Sea and the Aleutian Islands ecosystem areas, and ongoing development of report for the Gulf of Alaska
- Adoption, as Council policy, of an ecosystem vision statement

Manage Incidental Catch and Reduce Bycatch and Waste

14. Continue and improve current incidental catch and bycatch program (on workplan)
15. Develop incentive programs for bycatch reduction (on workplan)
16. Encourage research for non-target species population estimates (on workplan)
17. Develop management measures that encourage techniques to reduce bycatch (on workplan)
18. Continue to manage incidental catch and bycatch through seasons and areas
19. Account for bycatch mortality in TAC accounting (on workplan)
20. Control prohibited species bycatch through PSC limits (on workplan)
21. Reduce waste to biologically and socially acceptable levels

<u>FMP amendments related to this goal statement</u>

- Groundfish retention standard (B79, subsequently removed)
- Bering Sea Chinook salmon bycatch restrictions (B84, B91)
- Trawl sweep elevation requirement in the flatfish fisheries (B94, G89)
- GOA area closures to reduce bairdi crab bycatch (G89)
- Establishment of PSC limits for Chinook salmon in the GOA trawl pollock and non-pollock fisheries (G93, G97)
- Reduce PSC limits for GOA halibut (G95)
- Restructured observer program reduces bias in bycatch accounting (B86, G76)
- Prohibit Pacific cod fishing in Pribilof Islands Habitat Conservation Zone (B103)
- BSAI Chinook and chum salmon PSC avoidance measures (B110 *approved by Council, not yet implemented*)
- Reduce PSC limits for BSAI halibut (B111 *approved by Council, not yet implemented*)

<u>Regulatory amendments related to this goal statement</u>

- Annual specifications for setting prohibited species limits
- Revisions to MRAs
- Revision to regulations for prohibited species donation program and fishmeal

<u>Other management actions related to this goal statement</u>

- Upcoming discussion paper on BSAI crab bycatch
- Council encourages research through annual research priorities
- NMFS and observer program work on improving statistical methods for bycatch accounting (as part of National Bycatch Report initiative)
- Development of a halibut management framework

Avoid Impacts to Seabirds and Marine Mammals

22. Continue to protect ESA-listed and other seabirds
23. Maintain or adjust SSL protection measures (on workplan)
24. Encourage review of marine mammal and fishery interactions
25. Continue to protect ESA-listed and other marine mammals (on workplan)

FMP amendments related to this goal statement

- Walrus protection areas around Round Island and Cape Pierce, including transit corridors for Federal fishing vessels (B107)

Regulatory amendments related to this goal statement

- Revisions to seabird avoidance measures, including in Area 4E
- Revisions to Steller sea lion closures for pollock and cod fisheries in the GOA
- Revisions to Steller sea lion protection measures for Atka mackerel, Pacific cod, and pollock fisheries in the Aleutian Islands
- Designation of critical habitat for Cook Inlet beluga whale

Other management actions related to this goal statement

- ESA consultations on fishery impacts on listed seabirds and marine mammals
- Council receives protected species report at each meeting, monitoring issues with seabirds and marine mammals
- Reconsideration of Steller sea lion closures in 2014 biological opinion and 2014 EIS

Reduce and Avoid Impacts to Habitat

26. Review and evaluate efficacy of habitat protection measures for managed species (on workplan)
27. Identify EFH and HAPC, and mitigate fishery impacts as necessary (on workplan)
28. Develop MPA policy
29. Encourage research on baseline habitat mapping (on workplan)
30. Develop goals and criteria for MPAs; implement as appropriate (on workplan)

FMP amendments related to this goal statement

- HAPC (B65/G65) and EFH (B78/G73) amendments, and associated fishery area closures in the GOA and Aleutian Islands (AI)
- Bering Sea Habitat Conservation (B89) with area closures for non-pelagic trawling
- Trawl sweep elevation requirement in the flatfish fisheries (B94, G89)
- Update to EFH information with findings from the 2010 EFH 5-year review (B98/G90)
- Designation of skate nurseries in Bering Sea as HAPC (B104)

Other management actions related to this goal statement

- Discussion of protected areas for Bering Sea canyons
- Discussion paper resulting from EFH 5-year review to look at groundfish impacts on crab EFH (especially red king crab in southwestern Bristol Bay)
- Ongoing 2015 EFH 5-year review, including updates to fishing effects model and EFH descriptions
- Discussion of a Northern Bering Sea Research Area Research Plan (subsequently tabled)
- Council discussion regarding nominating Alaska MPAs to national MPA center register (tabled)
- Council encourages research through annual research priorities

Promote Equitable and Efficient Use of Fishery Resources

31. Provide economic and community stability through fair allocation
32. Maintain LLP and initiate rights-based management programs (on workplan)
33. Periodically evaluate effectiveness of rights-based management programs
34. Consider efficiency when adopting management measures (on workplan)

FMP amendments related to this goal statement

- Sector allocations for Pacific cod (B85, G83); fixed gear endorsement in GOA (G86)
- Sector allocations and cooperative formation for 3 flatfish species, POP, and Atka mackerel in BSAI (Amendment 80); vessel replacement and cooperative revisions (B80, B90, B93, B97)
- Latent licenses rescinded (B92/82, G86)
- Cooperative program for rockfish in central GOA (G68); program revisions (G78, G85); new program authorized (G88)
- BSAI freezer longline maximum length overall adjustment (B99)
- AI pollock to the Aleut Corporation (B82); Single geographic location amended for pollock motherships (B62, G62); AFA vessel replacement (B106)
- IRIU rescinded in GOA for shallow water flatfish (G72)
- IFQ B quota shareholders can fish on any size vessel (G67), "fish up" in Area 4B (B102)
- Revisions to GOA CQE program entities, revise vessel use caps, allow purchase of small blocks, establish CQE program in Area 4B (G94, G96, B102)
- Allow for a small boat CDQ Pacific cod fishery (B109, *approved by Council but not yet implemented*)
- Allow use of longline pots for sablefish (G101, *approved by Council but not yet implemented*)
- Aleutian Islands Pacific cod catcher vessel fishery and shoreplant delivery requirement (B113, *approved by Council but not yet implemented*)

Regulatory amendments related to this goal statement

- Modify monitoring and reporting requirements for BSAI cod freezer longliners
- BSAI fixed gear parallel fishery management measures
- Minor revisions to AFA, CDQ, IFQ, Rockfish Programs
- GOA pollock trip limits

Other management actions related to this goal statement

- Permit fee authorization (all FMPs)

Increase Alaska Native Consultation

35. Incorporate local and traditional knowledge into fishery management
36. Consider ways to enhance local and traditional knowledge collection
37. Increase Alaska Native participation in fishery management (on workplan)

FMP amendments related to this goal statement

- AI pollock to the Aleut Corporation (B82)
- Revisions to GOA CQE program eligible entities, revise vessel use caps, allow purchase of small blocks, establish CQE program in Area 4B (G94, G96, B102)
- Allow for a small boat CDQ Pacific cod fishery (B109, *approved by Council but not yet implemented*)
- Aleutian Islands Pacific cod catcher vessel fishery and shoreplant delivery requirement (B113, *approved by Council but not yet implemented*)

Other management actions related to this goal statement

- Community outreach and consultation policy adopted by Council in 2008
- Community committee helps prioritize outreach (currently focused on BSAI salmon analyses)
- Website redesigned to include a rural outreach component

Improve Data Quality, Monitoring, and Enforcement

38. Increase utility of observer data (on workplan)
39. Develop equitable funding mechanisms for the NPGOP (on workplan)
40. Increase economic data reporting requirements (on workplan)
41. Improve technology for monitoring and enforcement (on workplan)
42. Encourage development of an ecosystem monitoring program
43. Cooperate with NPRB to identify needed research
44. Promote enforceability
45. Coordinate management and enforcement programs with Federal, State, international, and local partners

FMP amendments related to this goal statement

- Observer program restructuring (B86/G76)
- Remove dark rockfish from FMP, allow management by State of Alaska (B73/G77)
- Change observer coverage category exemptions for small catcher processors (B112/G102, *approved by Council but not yet implemented*)

Regulatory amendments related to this goal statement

- Electronic reporting, online accounting
- Changes to VMS requirements (required for sablefish in BS, no longer required for dinglebar lingcod in GOA)
- Repeal of vessel incentive program
- Changes to observer program to provide flexibility in deployment and improve operational efficiency
- Bering Sea Chinook salmon bycatch economic data collection
- GOA trawl economic data collection

Other management actions related to this goal statement

- Annual refinement of observer data through the deployment plan
- Ongoing work to improve Catch Accounting System
- Discussion paper on VMS use and requirements
- Electronic monitoring is being developed as a tool for catch monitoring. Pre-implementation program approved for 2016.
- Council encourages research through annual research priorities, cooperates with North Pacific Research Board
- Council initiated and participates in Alaska Marine Ecosystem Forum, as well as maintaining other relationships with partner entities

5.3 Changes in groundfish and environmental conditions

The following is a brief summary of Council documents that evaluate groundfish and environmental conditions.

Groundfish SAFE reports

The Council's annual Groundfish Stock Assessment and Fishery Evaluation (SAFE) report provides a detailed analysis of the status of groundfish stocks each year. No groundfish species is currently, nor has been, overfished or subject to overfishing, since the analysis that was conducted in the 2004 PSEIS.

Ecosystem Assessments in the annual Groundfish SAFE report

The AFSC prepares an Ecosystem Considerations appendix to the annual SAFE reports (Zador 2014) that provides a comprehensive overview of environmental conditions in the BSAI and GOA on an annual basis. The appendix includes an ecosystem assessment for the Bering Sea, Aleutian Islands, and Gulf of Alaska, as well as various data series that are ecosystem status and management indicators.

The AFSC staff has developed a format for reporting various indices over time, and comparing the most recent five years against the historical record for each indicator. The first section of the Ecosystem Considerations appendix includes abbreviated report cards for the Eastern Bering Sea and the Aleutian Islands (a report card for the GOA is being prepared), as well as an executive summary of recent trends. The report shows climate indices for the North Pacific, including the Pacific Decadal and Arctic Oscillations, and eastern Bering Sea ice retreat and cold pool volume indices. All of these are within one standard deviation of the historical mean for the data set. The report also shows ecosystem indices for the groundfish fishery regions, and fishery indices for the Bering Sea, Gulf of Alaska, and Aleutian Islands. The 5-year mean is generally within one standard deviation of the historic mean.

2010 EFH 5-year review

Additionally, the 2010 EFH 5-year review (NPFMC and NMFS 2010) evaluated changes in fishing impacts on habitat from the period analyzed in the EFH EIS (and incorporated by reference in the 2004 PSEIS) and the subsequent five-year period. Total trawl fishing effort decreased in all regions for pelagic and non-pelagic trawling, between the period analyzed in the EFH EIS (1998 to 2002) and the subsequent period (2003 to 2007). The report included figures plotting both the average fishing intensity, by five year period, as well as the difference in intensity between periods. The principal shifts in fishing intensity are summarized in the following paragraphs.

<u>Bering Sea trawl</u>: There has been no radical shift in the distribution of nonpelagic trawl fishing intensity in the Bering Sea from the period 1998 to 2002 to the period 2003 to 2007. The large area of the central Bering Sea that was subject to particularly high bottom trawl intensity in 1998 to 2002 received moderately lighter intensity from 2003 to 2007. Four principal areas were subject to increased bottom trawl intensity; (1) along the northwest border of the Pribilof Islands Habitat Conservation Zone, (2) off of Kuskoquim Bay, (3) along the southern border of the King Crab Protection Zone, and (4) western side of the Nushagak Peninsula (inner Bristol Bay). Most of the increases were moderate, though two of eight blocks in the fourth area along the western side of the Nushagak Peninsula (inner Bristol Bay) had strong increases. The area of high intensity effort north of Akutan Island, Unimak Pass and Unimak Island remained a high intensity area. Many of the shifts within that area registered as moderate or strong changes because of the high absolute levels of fishing intensity. The central Bering Sea showed a pattern of higher intensity in pelagic trawling around a central area of lower intensity near the border of management areas 509 and 513. Decreases in fishing intensity occurred on the west side of the Nushagak Peninsula, off of Kuskoquim Bay, northeast of St George Island, and Pervenets Canyon to the far northwest. Intensity dropped in the area north of Akutan Island, Unimak Pass, and Unimak Island, while there were increases on the southwest and eastern sides of that area.

<u>Aleutian Islands trawl</u>: There was a trend of decreases in bottom trawl fishing throughout the region, from the 1998 to 2002 period to the 2003 to 2007 period, with moderate decreases noted in the Adreanof Islands and Petrel Bank, as well as throughout the western portions of Rat Islands. Stronger increases in intensity occurred around Buldir Island and west of Tanaga, with moderate increases found in the Near Islands. Pelagic trawling in the Aleutian Islands decreased from 416 blocks fished in the first period, mainly on the 541/518 (Bering Sea) border, to only 16 blocks fished in the most recent period. Fishing intensity for pelagic trawl fisheries in the Aleutian Islands is currently very minor.

Gulf of Alaska trawl: Moderate decreases were seen in intensity of nonpelagic trawl fishing throughout the region, from the earlier (1998 to 2002) time period to the later (2003 to 2007), with overall blocks fished decreasing by approximately 40 percent. Largest drops in intensity occurred near Chiniak and south of Chirikof Island with moderate increases in intensity to the northwest of Chirikof Island and south of Ugak Island. Very minor changes in intensity were seen in pelagic trawling in the GOA, with moderate increases in Shelikof Strait, but decreases in intensity in most Kodiak nearshore waters, as well as in isolated areas of 610 and 620.

Aleutian Islands Fishery Ecosystem Plan

In December 2007, the Council completed a Fishery Ecosystem Plan (FEP) for the Aleutian Islands ecosystem area. The FEP evaluates physical, biological, and socioeconomic relationships among ecosystem components, to identify areas of uncertainty and associated risk. Key ecosystem interactions, including climate and physical factors, predator-prey relationships, fishing effects, regulatory constraints, and socioeconomic (both fishing and non-fishing) activities occurring in the area are identified and associated with monitoring indicators. These indicators are tracked on an annual basis through the Aleutian Islands Ecosystem Assessment, in the Groundfish SAFE report.

6 Review of conclusions in the 2004 PSEIS

This section summarizes the results from the expert team that reviewed the 2004 PSEIS conclusions. Each expert was asked to review the description of the impacts of the groundfish fisheries on his or her resource component (e.g., assessed species or species complex), based on new information that has become available since the PSEIS analysis was completed. The expert followed a template to consider whether management of or the status of the resource has changed, whether new information is available regarding the impacts of the fisheries on the resource, whether there are new methods of analysis or protocols for evaluating impacts. A copy of the template is included in Appendix 2 of the SIR. Based on these considerations, the expert was asked to conclude whether, based on information available at the time of the review, a new analysis using the latest methods and information would reach a seriously different conclusion.

The sections below synopsize the experts' review of the 2004 PSEIS conclusions. Each section begins with a summary table for the group of resource components, identifying the expert's conclusion and a short rationale. Additional points of rationale are captured in bullets following the summary table. The complete reviews for each resource component are included in Appendix 4 of the SIR. In some instances since the publishing of the draft SIR, and the completion of the reviews, staff have followed up with the expert reviewers to ensure that responses are consistent and complete across all respondents.

6.1 Target groundfish species

Table 12 through Table 15 provide short summaries of the target groundfish species reviews,[36] with respect to whether a new analysis using the latest methods and information would reach a significantly different conclusion than is articulated in the 2004 PSEIS. The tables also provide a short statement of rationale for each species. The complete review for each species may be found in Appendix 4 to this SIR.

[36] Note, in the BSAI FMP and GOA FMP there have been some changes of species names and species complexes since the 2004 PSEIS. A summary of these changes is included in Appendix 3 of this SIR.

Table 12 Summary of expert review of round groundfish species

Species	Would a new analysis reach a significantly different conclusion?		Comments / Rationale
	BSAI	GOA	
pollock	No	Possibly	**BSAI:** A difference with a new analysis would be the increased difficulty in adapting the technical interaction model to account for increased complexity in management and to predict outcomes of the TAC-setting process. **GOA:** Groundfish fisheries and their management have been fairly stable since 2002, which inclines towards an assumption that the conclusions would be similar. There are two changes in the GOA ecosystem that may merit further evaluation, however: increase in abundance of arrowtooth flounder (predator of pollock); and a resurgence of large whales, in particular the humpback whale.
Pacific cod	No	No	**BSAI:** In the future, analysis of the age-structured model for the Aleutian Islands stock, which is under development, will be informative. **GOA:** The stock assessment applies current analytical methods and produces stable and biologically consistent estimates for characterizing the condition of the population.
sablefish	No	No	**BSAI and GOA:** The stock assessment applies current analytical methods and produces stable and biologically consistent estimates for characterizing the condition of the population.
Atka mackerel	No	No	**BSAI and GOA:** New and updated information for the BSAI, and limited new information for the GOA, have been incorporated into the stock assessment, but have not resulted in a different conclusion.

Pollock, Pacific cod, sablefish, and Atka mackerel

Management changes:
- There have been no changes to the harvest control rules for the stocks.
- Some other management changes have affected the timing and/or distribution of the fisheries, including Chinook salmon PSC limits for the pollock fisheries, cod sector allocations, and Steller sea lion harvest restrictions.

Status changes:
- Stocks are within the range of variability estimated in the 2004 PSEIS.

New information on impacts:
- There have been changes in observer coverage requirements, resulting from the salmon bycatch measures in the Bering Sea, and observer restructuring.
- Some added acoustic survey years have provided additional information

New methods to assess impacts:
- Methods are being developed to explore the implications of incorporating stock-specific uncertainty buffers to establish ABCs.

Table 13 Summary of expert review of flatfish species

Species	Would a new analysis reach a significantly different conclusion?		Comments / Rationale
	BSAI	GOA	
yellowfin sole	No	*n/a*	**BSAI:** Some new information regarding temperature-dependent growth has become available, and is incorporated into the assessment, but it has not resulted in a different conclusion about the effect of the fishery on the resource.
greenland turbot	No	*n/a*	**BSAI:** The stock assessment applies current analytical methods and produces stable and biologically consistent estimates for characterizing the condition of the population.
arrowtooth flounder	No	No	**BSAI:** New information may change the estimate of arrowtooth flounder female spawning biomass, but would not change the PSEIS conclusions. **GOA**: Arrowtooth biomass is consistently increasing, as identified in the PSEIS.
Kamchatka flounder	No	*n/a*	**BSAI:** fishery-independent information is on the same order as before, and fisheries mortality remains at a moderate level.
northern and southern rock sole[37]	No	No	**BSAI:** some new information regarding temperature-dependent growth is available and will be incorporated in the assessment, but will not result in a different conclusion. **GOA:** The stock assessment applies current analytical methods and produces stable and biologically consistent estimates for characterizing the condition of the population. The status of stocks is within the range of variability of the 2004 PSEIS analysis.
flathead sole	No	No	**BSAI and GOA:** Qualitatively, the status of flathead sole has not changed since the 2004 PSEIS.
Alaska plaice	No	*n/a*	**BSAI:** The stock assessment applies current analytical methods, and Alaska plaice resource is high in abundance and lightly harvested.
shallow water flatfish	*n/a*	No	**GOA:** The majority of shallow water complex biomass is rock sole, for which an assessment model was developed in 2012. Other flatfish in the complex have been increasing or showing no trend in biomass since 2004.
deepwater flatfish	*n/a*	No	**GOA:** The deepwater flatfish complex is lightly exploited and current methods would reach similar conclusions.

[37] The BSAI assessment is limited to northern rock sole.

Species	Would a new analysis reach a significantly different conclusion?		Comments / Rationale
rex sole	*n/a*	No	**GOA:** Rex sole is lightly exploited and current methods would reach similar conclusions.
other flatfish	No	*n/a*	**BSAI:** The stock assessment applies current analytical methods, and Alaska plaice resource is lightly harvested, primarily as bycatch.

Flatfish

Management changes:
- Implementation of Amendment 80 in the BSAI has significantly changed the timing and utilization of flatfish fisheries.

Status changes:
- Stocks are within the range of variability estimated in the 2004 PSEIS, with the exception of BSAI flathead sole, which has a larger biomass than previously estimated.
- The Greenland turbot stock assessment was revised in 2012.

New information on impacts:
- Trawl sweep modifications in the BS and GOA have reduced the fishery impact on the seafloor, and unobserved mortality of shellfish.
- Observer restructuring has resulted in new observer information, particularly on small boats in the GOA.

New methods to assess impacts:
- Some stocks are now being assessed in a higher tier, resulting in differences in the way the productivity of the stock and risk are incorporated into the ABC calculation.

Table 14 Summary of expert review of rockfish species

Species	Would a new analysis reach a significantly different conclusion?		Comments / Rationale
	BSAI	GOA	
Pacific ocean perch	No	No	**BSAI:** A sharp rise in biomass has occurred in recent years across all spatial subareas. In the future, work on the impact of disproportionate harvest on yield and biomass for stocks that exhibit spatial structure will be informative. **GOA:** The assessment uses the same assessment model as the 2004 PSEIS, and stock status is within the range of variability analyzed in that document.
northern rockfish	No	No	**BSAI:** Future work will be informative for northern rockfish, which exhibits stock structure at spatial scales smaller than our current management units, and which occasionally shows disproportionate harvesting patterns. **GOA:** The stock assessment applies current analytical methods, and the assessment model indicates that conclusions are still valid.
shortraker rockfish	No	No	**BSAI:** Shortraker rockfish exhibit spatial structure, and consistent disproportionate spatial harvesting would be expected to result in reductions of biomass and yield. Limited genetic samples currently exist for shortraker, however, to undertake spatial stock analysis. **GOA:** Stock status can still not be determined. The fishery is not open as a target fishery, and it is unlikely that a conservation concern has developed since the 2004 PSEIS.
blackspotted/ rougheye rockfish	No	Yes	**BSAI:** Future work will be informative for these species, which exhibit stock structure at spatial scales smaller than our current management units, disproportionate harvesting patterns and high subarea exploitation rates, and declines in subarea population abundance. **GOA:** There is now an age-structured stand-alone assessment for these stocks, so the impact of the fisheries on the resource can be better monitored. The impacts of the fishery on change in biomass can be changed from "unknown" to "insignificant."
dusky rockfish	*n/a*	Yes	**GOA:** There is now an age-structured stand-alone assessment for dusky rockfish, so the impact of the fisheries on the resource can be better monitored. The impacts of the fishery on change in biomass can be changed from "unknown" to "insignificant".
demersal shelf rockfish	*n/a*	No	**GOA:** The current analyses indicate that the conclusions of the 2004 PSEIS are still valid, however if demersal shelf rockfish are moved to a different tier status after review of a new model in 2014, then the category "change in biomass level" could change from "unknown" to a different rating.
thornyhead rockfish	*n/a*	Yes	**GOA:** Beginning in 2004, the thornyhead rockfish complex was downgraded to a Tier 5 species, primarily because of uncertainty in the validity of age readings for shortspine thornyhead. As a result, the conclusions of "insignificant" in the 2004 PSEIS should be changed to "unknown." However, it is unlikely that a conservation concern has developed.
other rockfish	No	No	**BSAI:** Given the absence of new information, it is unlikely a new analysis would result in a different conclusion. **GOA:** Data for most "other rockfish" species is sparse. Since the fishery is not opened as a target fishery, it is unlikely that a conservation concern has developed since 2004.

Rockfish

Management changes:	• Implementations of Amendment 80 in the BSAI, and the rockfish programs in the Central GOA, have extended the timing of some rockfish fisheries.
Status changes:	• Stocks are within the range of variability estimated in the 2004 PSEIS, except BSAI Pacific ocean perch, for which the estimated biomass has doubled since 2004.
New information on impacts:	• There is new information about spatial structure for some rockfish species. • The use of pelagic trawl gear in the GOA rockfish fisheries has been increasing, reducing impacts of the fishery on habitat. • Bycatch estimates decreased for the majority of species in the Central GOA following the implementation of the rockfish program.
New methods to assess impacts:	• Some stocks are now being assessed in a higher tier, resulting in differences in the way the status relative to stock size reference points are determined. • A template has been developed for evaluating the types of information to be considered when defining the spatial bounds of "stocks," and which is in the process of being applied to many rockfish species.

Table 15 Summary of expert review of squid, octopus, shark, sculpin, and skate species

Species	Would a new analysis reach a significantly different conclusion?		Comments / Rationale
	BSAI	GOA	
squid	No	No	Some new information is available from the observer program, and a separate squid complex in the GOA will improve management, but these are not likely to result in a different conclusion.
octopus	No	No	Since the status of octopus is unknown, the effect of the fishery remains unknown.
sharks	No	No	The status of sharks remains unknown, and it is unlikely that a conservation concern has developed since 2004.
sculpins	No	No	Alternative methodologies have been explored in the assessment, but they do not result in significantly different conclusions.
skates	No	No	A new analysis could provide more detailed description of impacts, but would not reach a different conclusion.

Squid, octopus, sharks, sculpins, skates

Management changes:	• These species are now all managed as separate target species assemblages, rather than under the "other species" group.
Status changes:	• Status remains unknown for most stocks within these complexes. Where more is known, there is estimates of abundance have not changed significantly since 2004.
New information on impacts:	• Species-level identification within the complexes and recording of other biological information has improved. • For octopus, recent discard mortality information suggests that the impacts of the fishery on the resource have been overestimated. • Observer restructuring has resulted in improved coverage of fisheries that encounter some of these species.
New methods to assess impacts:	• Assessments have been developed for some species within the complexes. • Development of ecosystem models has allowed greater exploration of how various ecosystem impacts might affect stocks and their predators.

6.2 Ecosystem component (prohibited and forage fish) and non-specified fish species

Table 16 provides a short summary of the reviews for prohibited species, forage fish, and grenadiers. Additional points of rationale are captured in bullets following the summary table. The complete reviews for each resource component are included in Appendix 4.

Table 16 Summary of expert review of prohibited species, forage fish, unspecified species

Species	Would a new analysis reach a significantly different conclusion?	Comments / rationale
Pacific halibut	No	No new information concerning bycatch impacts is currently available. International Pacific Halibut Commission is investigating the relationship of bycatch mortality to long-term yield from the halibut resource. Bycatch of all sizes comprises a larger fraction of total mortality than in previous analyses, due to the decrease in total abundance of halibut since the 2004 PSEIS, and as a result the Council has analyzed and reduced halibut PSC limits in both the BSAI and the GOA.
Pacific salmon	Possibly	New stock origin information provides finer resolution to groundfish fishery impacts on Chinook salmon, highlighting that the stock composition of intercepted salmon in the BS and GOA trawl fisheries are very different, and providing a basis to analyze the impact of the BS pollock fishery on BS Chinook and chum salmon. The analysis, contained in the Chinook and chum salmon EA and other reports to the Council, shows very low impact of the fishery on aggregate returns.
Pacific herring	No	The 2004 PSEIS concluded that the groundfish fishery impacts on herring are insignificant. Mortality of herring in the BSAI is capped at 1% of biomass, and while BSAI herring biomass is currently known with considerably less certainty than 2004, it is still expected that the 1% limit will not adversely affect the population.
BSAI king crab	No	Abundance of king crab stocks has varied over the years, but the status of these stocks relative to the status determination criteria has not changed.
BSAI Snow crab	No	Since 2004, the snow crab stock has been declared rebuilt, based on a new assessment model. Stock assessment models have improved greatly, and crab bycatch is accounted for in the estimate of total catch used in stock assessment models.
BSAI Tanner crab	No	Effective status remains unchanged; however, the stock is no longer overfished. It remains at a relatively low abundance compared with historical levels. Stock assessment models have improved greatly, and crab bycatch is accounted for in the estimate of total catch used in stock assessment models.
GOA king and Tanner crab	No	The abundance of GOA crab stocks is similar to that reported in the 2004 PSEIS, and the prevailing conditions that likely drive these trends remain unchanged.
forage fish complex	No	Forage fishes continue to be caught only incidentally, and there is no new data to suggest that their status has changed.
grenadiers	No	Catch in the groundfish fisheries is low compared to estimated biomass of grenadiers.

Pacific halibut

Management changes:

- PSC limits for halibut in the GOA groundfish fisheries are being reduced over the 2014 to 2016 period.
- PSC limits for halibut in the BSAI longline and trawl groundfish fisheries will be reduced with the approval and implementation of BSAI FMP Amendment 111, likely in 2016.
- A limited access program for the charter fishery, and a catch sharing plan between the commercial and guided recreational harvesters, have been implemented in southeast and southcentral Alaska in 2014.

Status changes:

- Current status is within the range of historic assessments, near the long-term average abundance for the stock, but has declined from historic high levels in the late 1990s.

New information on impacts:

- Impacts of groundfish fisheries on the halibut resource are believed to have decreased since 2004, due to reductions in estimated halibut mortality in groundfish trawl fisheries (particularly in the BSAI Amendment 80 trawl fleet).

New methods to assess impacts:

- The IPHC has conducted additional analyses of the impacts of trawl bycatch mortality on lost yield and spawning biomass for the halibut stock. This information was included in the NEPA analysis accompanying GOA FMP Amendment 95 (reducing halibut PSC limits in the GOA) and that accompanying BSAI Amendment 111. Beginning in 2013, observers are now deployed in small boat groundfish and halibut fisheries to assess halibut mortality and discards.

Pacific salmon or steelhead trout

Management changes:

- The Council and NMFS implemented new Chinook salmon PSC limits in the Bering Sea and the GOA, and requirements for incentive plan agreements to reduce Chinook and chum salmon encounters for Bering Sea pollock fishery participants.

Status changes:

- Various Alaska Chinook salmon stocks have declined since 2004.
- The annual run size of the chum salmon indicator species has varied significantly since 2004, but is generally trending back to 2004 levels in recent years.

New information on impacts:

- New genetic stock composition analyses are available for the bycatch of Bering Sea Chinook and chum salmon, and GOA Chinook salmon, and more robust sampling protocols have been instituted.

New methods to assess impacts:

- Impacts of Bering Sea Chinook and chum salmon bycatch relative to escapement and maturity have been completed and reported in the Chinook EIS and EA for Chinook and chum salmon PSC limit measures.

BSAI King Crab

Management changes:	• Management is essentially unchanged; however the implementation of BSAI Amendment 80 has changed fishing patterns and partitioned the red king crab PSC limit among fishery cooperatives. • A trawl sweep modification requirement was implemented in the BS flatfish fishery in 2011. Research has demonstrated that this reduces unobserved mortality of crab. • New overfishing definitions and total catch accounting were implemented for BSAI crab stocks in 2008, and annual catch limits have been set since 2011.
Status changes:	• Abundance of king crab stocks has varied over the years, but the status of these stocks relative to the status determination criteria has not changed.
New information on impacts:	• The implementation of Amendment 80 has reduced the rate of bycatch per target catch metric ton. • The Council is in the process of evaluating the historical bycatch of crab stocks by groundfish fisheries.
New methods to assess impacts:	• Stock assessment models have improved greatly, and crab bycatch is accounted for in the estimate of total catch used in stock assessment models.

BSAI Snow Crab

Management changes:	• Management is essentially unchanged; however, the implementation of Amendment 80 has reduced the rate of snow crab bycatch per target catch metric ton.
Status changes:	• Since 2004, the snow crab stock has been declared rebuilt, based on a new assessment model.
New information on impacts:	• A trawl sweep modification requirement in the flatfish fishery was implemented in 2011. Research has demonstrated that this reduces unobserved mortality of crab.
New methods to assess impacts:	• Stock assessment models have improved greatly, and crab bycatch is accounted for in the estimate of total catch used in stock assessment models.

BSAI Tanner Crab

Management changes:	● Management is essentially unchanged; however, the implementation of Amendment 80 has reduced the rate of Tanner crab bycatch per target catch metric ton.
Status changes:	● Effective status remains unchanged, however the stock is no longer overfished. It remains at a relatively low abundance compared with historical levels.
New information on impacts:	● A trawl sweep modification requirement in the flatfish fishery was implemented in 2011. Research has demonstrated that this reduces unobserved mortality of crab.
New methods to assess impacts:	● Stock assessment models have improved greatly, and crab bycatch is accounted for in the estimate of total catch used in stock assessment models.

GOA Crab

Management changes:	● Management is essentially unchanged; however, the Council closed Marmot Bay to protect Tanner crab.
Status changes:	● GOA red king crab remains at historically low levels and the Tanner crab stock continues to show high variability in recruitment. Little is known about golden or blue king crab. The prevailing conditions identified in the 2004 PSEIS that likely drive these trends remain unchanged.
New information on impacts:	● The Council analyzed impacts of the GOA groundfish fisheries on Tanner crab in two NEPA analyses, and instituted a trawl-gear area closure and a trawl sweep modification requirement in the GOA flatfish fishery. Research has demonstrated that the sweep modification reduces unobserved mortality of crab. ● Changes to observer coverage requirements may shed additional light on groundfish fishery interactions with crab in the future.
New methods to assess impacts:	● No. There have been no changes to the state assessment methodology, and no regulatory changes to the harvest strategy or management structure.

Pacific herring

Management changes:	• Management of Pacific herring under the groundfish FMPs has not changed since 2004.
Status changes:	• Due to reduced funding for herring surveys and the difficulties of surveying the region, very little is known about the status of Bering Sea herring populations other than the Togiak stock. Climate change and regime shifts are expected to have a direct effect on herring habitat, mortality, and prey, but the magnitude is unknown.
New information on impacts:	• The impacts of groundfish fisheries on the herring resource are believed to be similar to what was analyzed in 2014. Most herring bycatch occurs in the Bering Sea pollock fishery.
New methods to assess impacts:	• No new methods have been developed for evaluating the impacts of the groundfish fisheries on herring.

Forage fish

Management changes:	• No, although forage fish are now listed as part of the "ecosystem component" in the FMP.
Status changes:	• There continues to be very little information on the status of forage fishes, including no reliable estimates of forage fish abundance.
New information on impacts:	• More information is provided on a biennial basis as an appendix to the SAFE reports, including information on state-waters removals, and species' vulnerability in the Pacific Northwest. • Available evidence suggests that forage fish abundance fluctuates independent of fishery activities.
New methods to assess impacts:	• None.

Grenadiers

Management changes:	• Unofficial assessment reports have been prepared for grenadiers since 2006, and the FMPs were amended in 2014 to include grenadiers as an ecosystem component, which prompted increased data collection on grenadier catch in the groundfish fisheries.
Status changes:	• The status of non-specified species was unknown in the 2004 PSEIS; grenadier assessment reports now track indices of abundance, which indicate that population trends are stable.
New information on impacts:	• There is a disproportionate catch of females in surveys and the fishery; however, all data indicate that catch of grenadier has not affected the stock status. • Impacts of groundfish fisheries have decreased in recent years, since grenadiers are primarily caught in the sablefish longline fishery, and ABCs and TACs for sablefish have decreased. • New catch information is available from smaller vessels fishing for halibut, under the restructured observer program.
New methods to assess impacts:	• In the assessment reports, catch, biomass, fishery and survey length frequencies, and indices of abundance are now tracked.

6.3 Marine Mammals and Seabirds

Table 17 provides a short summary of the reviews for marine mammals and seabirds. Additional points of rationale are captured in bullets following the summary table. The complete reviews for each resource component are included in Appendix 4.

Table 17 Summary of expert review of marine mammals and seabirds

Species	Would a new analysis reach a significantly different conclusion?	Comments / rationale
Steller sea lions	No	Extensive new analysis of the impacts of the groundfish fisheries on SSLs was undertaken in the 2014 Biological Opinions (NMFS 2014a), and the 2014 SSL EIS (NMFS 2014b). These analyses, and the subsequent regulatory changes, result in fisheries that continue to avoid jeopardy and adverse modification of critical habitat, which is consistent with the conclusions in the PSEIS.
Northern fur seals	No	Ongoing research is evaluating whether there is evidence of a strong link between commercial fisheries and the decline of northern fur seals, but currently, the cause of the ongoing decline remains unknown.
Harbor seals	No	Continued paucity of information about the foraging ecology of this species, especially in the Aleutian Islands.
Ice-associated seals	No	An evaluation of newly available food habits data might identify further impacts from commercial fisheries, but firm conclusions would be difficult to develop with the limited information.
Northern elephant seals	No	The California breeding population appears to be continuing to grow.
Pacific walrus	No	The latest available estimate of Pacific walrus take is within the range analyzed in the PSEIS, and is considered insignificant.
Whales	Possibly	The ESA listing of Cook Inlet beluga whales and designation of critical habitat caused a new analysis of the impacts of the groundfish fisheries, but the conclusion was similar to that in the PSEIS. Also, fishery interactions with Bering Sea harbor porpoise, western North Pacific stock of humpback whales, western gray whales, and killer whales may have increased.
Sea otters	No	NMFS conducted a new analysis for the Biological Assessment (NMFS 2013) and arrived at a similar conclusion as the PSEIS.
Seabirds	No	Neither new information nor new approach to estimation will change the conclusions of the PSEIS that impacts are insignificant.

Marine mammals – Steller sea lions

Management changes:
- Closures and restrictions on Atka mackerel. Pacific cod, and pollock fisheries in the Aleutian Islands, resulting from the 2014 Biological Opinion (NMFS 2014a) and 2014 SSL EIS (NMFS 2014b).

Status changes:
- Abundance of SSLs has increased, and regionally, trends in population have changed.
- New information available on food habits, abundance, foraging behavior, contaminants, and vital rates.
- The eastern distinct population segment of SSL has been delisted.

New information on impacts:
- 2014 Biological Opinion and 2014 EIS update changes in the impacts of groundfish fisheries on SSLs, especially in the AI.

New methods to assess impacts:
- No, but more recent analyses using conventional methods have been undertaken.

Marine mammals – Northern fur seals

Management changes:	• None
Status changes:	• Significant declines on both Pribilof Islands in the last 15 years, at just under 5 percent annually; partially offset by an increase in abundance on Bogoslof Island, where the population of pups now exceeds St George Island.
New information on impacts:	• It is unknown if the fisheries are affecting northern fur seals, but there is additional published literature available indicating similar habitat and prey use by both consumers.
New methods to assess impacts:	• No, but more recent analyses using conventional methods have been undertaken.

Marine mammals – Harbor seals

Management changes:	• None
Status changes:	• Three previously-recognized stocks of harbor seals were subdivided into 12 stocks. • Harbor seals in Lake Iliamna have been petitioned for listing under the ESA. • Harbor seals in the Aleutian Islands have declined substantially since the early 1980s, especially in the western Aleutians; similar geographic pattern as SSLs.
New information on impacts:	• Splitting into 12 stocks has led to individual stocks with lower abundance and the potential for groundfish fisheries to have significant impacts on individual stocks, but there is no new information.
New methods to assess impacts:	• None

Marine mammals – Ice-associated seals

Management changes:	• None
Status changes:	• In response to a petition for listing all four species under the ESA, NMFS listed ringed and bearded seals as threatened. NMFS is currently considering critical habitat designations.
New information on impacts:	• The ESA status reviews identified food habits studies indicating that various species of groundfish are important to ribbon and bearded seals, in some areas, seasons, and/or years.
New methods to assess impacts:	• None

Marine mammals – Northern elephant seals

Management changes:	• None
Status changes:	• The California breeding population appears to be continuing to grow.
New information on impacts:	• Unchanged since 2004; no recent reports of takes in Alaska fisheries.
New methods to assess impacts:	• None

Marine mammals – Pacific walrus

Management changes:	• No adverse changes. New protection areas at Round Island and Cape Pierce have been implemented to minimize levels of disturbance from Federal vessels.
Status changes:	• Walrus remains a candidate species for listing under the ESA. Uncertainty about current population estimates is very high.
New information on impacts:	• Unchanged since 2004. Estimated take of walrus in the Alaskan fisheries is considered insignificant.
New methods to assess impacts:	• None

Marine mammals – killer whale (transients), other toothed whales, baleen whales

Management changes:	• None
Status changes:	• Killer whales: new information on transient killer whale counts. Resident stock continues to increase in population size, with exception of a few pods. • Toothed whales: Cook Inlet belugas have continued to decline, are now listed under the ESA, and have critical habitat designated through much of Cook Inlet. Bristol Bay belugas continue to increase in size. No new information on other toothed whales. • Baleen whales: North Pacific right whales are now relisted under the ESA, and critical habitat has been designated. Western Arctic bowhead population has been increasing. A large-scale study of humpback whales is being evaluated. The eastern N Pacific gray whale status remains the same; however, the western North Pacific population, once thought extinct, has been rediscovered. No new information on other baleen whales.
New information on impacts:	• More specific information is now available on which target fishery is impacting which killer whale stocks. • One observed mortality of a harbor porpoise and one injury of a sperm whale, occurred in recent years due to groundfish fishery interactions. Also, the estimate of fisheries-related mortality to humpback whales is not significant. No other serious injuries or mortalities reported for other toothed or baleen whales, although information is lacking for belugas and western gray whales.
New methods to assess impacts:	• None

Marine mammals – sea otters

Management changes:	• Yes – the southwest distinct population segment of the northern sea otter were listed as threatened under the ESA in 2005. Critical habitat was designated in nearshore marine waters.
Status changes:	• Despite the listing of sea otters under the ESA, population abundance and trends have generally not notably changed since the early 2000s.
New information on impacts:	• A 2006 ESA consultation concluded that groundfish fisheries are not likely to adversely affect sea otters. The consultation was reinitiated, with the same conclusion pronounced in 2013 (NMFS 2013).
New methods to assess impacts:	• None

Seabirds

Management changes:	• Measures to manage seabird interactions with the fisheries are unchanged. • The 2013 implementation of restructured observer program will provide for better evaluation of total fishery impacts in the future.
Status changes:	• Status of various seabird species groups remains unchanged.
New information on impacts:	• Impacts reduced in the demersal longline fisheries. • Bycatch from trawl vessels higher than reported (estimates under evaluation), but still far less than the reduced impact in the longline fisheries. • Impact from vessels under 60 ft LOA are being evaluated with observer data beginning with 2013.
New methods to assess impacts:	• Annual estimates of seabird bycatch from observer species composition now generated through the Catch Accounting System for longline vessels, and estimates being developed for similar procedure for trawl vessels

6.4 Habitat, Socioeconomics, Ecosystem

Table 18 provides a short summary of the reviews for habitat, socioeconomics, and the ecosystem. Additional points of rationale are captured in bullets following the summary table. The complete reviews for each resource component are included in Appendix 4.

Table 18 Summary of expert review of habitat, socioeconomics, and ecosystem components

Species	Would a new analysis reach a significantly different conclusion?	Comments / rationale
Habitat	No	Analyses and research subsequent to the 2004 PSEIS have largely confirmed its general conclusions. A new analysis would provide more specific estimates with less uncertainty, but is not likely to reach seriously different conclusions.
Socioeconomics	No	The fundamental impacts of rationalizing fisheries (e.g., on overcapacity, efficiency, and the nature of the jobs) or closing areas to fishing is correct in the 2004 PSEIS. The 2004 PSEIS relies on predicting the results of rationalization programs, and a new analysis could provide actual results, likely with a smaller magnitude of benefits. But the basic understanding of effects is correct.
Ecosystem	No	The new research and information will enable improved monitoring of the ecosystem research, but to date does not suggest that the conclusions of the 2004 PSEIS would differ substantially.

Habitat

Management changes:

- Substantial changes to management have included implementation of regulations to protect habitat that provides structural relief, and gear modifications to limit adverse impacts of trawling on the seafloor.

Status changes:

- The current status of habitat is the same as in the PSEIS because long-lived, slow-growing species have likely not recovered from the impacts of historical fishing, and impacts continue in areas that are open to bottom trawling.
- In 2012, NMFS received a petition to list 44 species of cold water corals off Alaska as threatened or endangered in response to changing environmental conditions, the presence of commercial fisheries, and other factors. Based on the scientific information available, NMFS determined that such a designation was not warranted. NMFS analyzed whether threats are impeding the survival and recovery of coral species and warrant their protection under the ESA, including ocean warming, ocean acidification, commercial fishing, and oil spills (78 FR 10601, February 14, 2013). Coral species in Alaska are non-reef building and are less susceptible to the effects of ocean acidification as other organisms, and scientists noted that fishing closures in certain areas in the BSAI and GOA provide substantial protection for corals and cold water coral habitat.

New information on impacts:

- There has been additional research on the habitat requirements of different species, on trawl gear modifications to reduce habitat effects, and some limited research on the recovery of habitat in the eastern GOA that was damaged with trawl gear. There is improved resolution of data on the distribution of fishing effort due to broader implementation of VMS. There is also additional information on the distribution of habitat types and features, through better technology and habitat mapping.

New methods to assess impacts:

- The EFH EIS (NMFS 2005) used a different methodology than the PSEIS to assess the effects of fishing on habitat from the perspective of managed species that are dependent on habitat features. The 2005 EFH EIS fishing effects methodology is also being updated for the 2015 EFH 5-year review, which is currently under development.

Ecosystem

Management changes:	• Management changes to protect ecosystem components are referenced in the sections above. The Council has adopted an ecosystem vision statement as a Council policy, and has established guidelines for including ecosystem considerations in stock assessment reports and analytical documents.
Status changes:	• While there have been short-term changes in some ecosystem indicators, there is no evidence that these variations are outside short- or medium-term (3 to 5 year) range of natural variability, as measured over the last 30 years.
New information on impacts:	• There has been substantial new world-wide research on energy flow within ecosystems; however, this information does not suggest that impacts of the groundfish fisheries on Alaska ecosystems have significantly changed.
New methods to assess impacts:	• Significant improvements have been made in monitoring critical aspects of the ecosystem, through the development of annual Ecosystem Assessments and Report Cards, and management strategy evaluations on different ecosystem aspects. Ecosystems research at the AFSC is being developed as an Integrated Ecosystem Assessment program, which provides a formal method for evaluating climate impacts on Alaska's large marine ecosystems.

Socioeconomics

Management changes:	• The PSEIS refers to several fisheries that have since been rationalized, and there have also been management changes resulting from Chinook salmon bycatch avoidance and Steller sea lion protection measures.
Status changes:	• The PSEIS projects many then-recent trends in species biomass, and the impacts of climate change, which have since changed.
New information on impacts:	• Information is available on impacts in fisheries that have rationalized since the PSEIS, or been subject to other management changes (e.g., salmon or SSL closures). There are some impacts that the PSEIS does not address, but which have become issues of concern for the public and the Council, for example, the impacts of rationalization on crew members.
New methods to assess impacts:	• A new economic impact model has been developed as part of the analysis of Steller sea lion closures, and several papers have been written on the impacts of rationalization programs.

7 Public Comments

This SIR was first released as a draft in April 2014 for public and Council review. The review process was to ensure that all the relevant facts and information are compiled in the SIR, as a basis for decision makers to reach a conclusion as to whether a supplemental PEIS is required. In response to public testimony at the April 2014 Council meeting, NMFS noted that the agency would consider public comments on the SIR before making their final determination. NMFS received public comment letters from the Center for Biological Diversity, The Boat Company, and Oceana. The comments from each have been paraphrased and similar comments have been grouped to avoid redundancy in the responses.

Comment 1: The individual NEPA analyses that have accompanied the numerous changes in management since 2004 are not an adequate substitute for a programmatic update. The SIR incorrectly characterizes these management changes as not substantial relative to environmental concerns and incorrectly concludes that the management changes are consistent with the 2004 PSEIS. The 2004 PSEIS should be updated to be consistent with the current management regime.

> **Response:** Section 3 of the SIR recognizes that there have been a number of changes to the management program since issuance of the 2004 PSEIS and states, "All management changes since 2004 have been subject to NEPA analysis." However, the Council and the agency did not simply rely on these NEPA analyses to conclude that a supplement to the 2004 PSEIS is not required at this time. The SIR clearly demonstrates that the Council and the agency comprehensively evaluated whether the management changes that have occurred since 2004 have resulted in a substantial change in the proposed action that is relevant to environmental concerns, as required by NEPA.
>
> Section 5 of the SIR identifies the management changes that have occurred since 2004 and compares these changes with the proposed action of the 2004 PSEIS (i.e., the management of the Federal groundfish fisheries) and the preferred alternative for that action – adopt a conservative, precautionary approach to ecosystem-based fisheries management. Based on this information, the SSC, Council, and NMFS concluded that considerable progress has been made toward achieving the goals and objectives of the preferred alternative, and determined that the management measures implemented since 2004 are consistent with the preferred alternative. This information and analysis led the Council and NMFS to conclude that neither the management changes individually nor all of the management changes cumulatively since 2004 represent a substantial change in the proposed action.
>
> As explained in Section 2.3 of this SIR, not every change requires the preparation of a supplement; only those changes that cause effects which are significantly different from those already studied require supplementary consideration. Therefore, in addition to determining whether a substantial change in the proposed action occurred, the SIR also examines whether any of the changes made since 2004 have caused effects that are significantly different than those analyzed and predicted in the 2004 PSEIS. This information is presented in Section 6 of the SIR and demonstrates that none of the management changes since 2004 have caused effects significantly different from those identified in the 2004 PSEIS.

Comment 2: Given the significant new information from recent scientific literature on ocean acidification and climate change, NMFS must supplement the 2004 PSEIS to consider the impacts of these changes on Alaska's groundfish fisheries.

> **Response:** EISs do not need to be supplemented because information has accumulated. Rather, a PSEIS should be supplemented if the information brings new bearing on the management of the groundfish fisheries or the impacts of the groundfish fisheries on the human environment. In the 2004 PSEIS, the expected direct, indirect, and cumulative impacts of the groundfish fisheries on the environment were assessed within a broad range of historical and future environmental conditions.

The 2004 PSEIS evaluates a groundfish management program that is both comprehensive and adaptive. The management program builds in the flexibility to adapt to changing environmental circumstances through a harvest specifications process that is based on the best available scientific information and responds to environmental variability. The groundfish policy objectives oblige the Council and NMFS to implement appropriate protection measures when resource components are adversely affected as a result of the groundfish fisheries.

This SIR considers whether recent information, about climate change or other topics, would cause analysts to reach significantly different conclusions about the impacts of the groundfish fisheries on the environment. The SIR finds that the conclusions characterized in the 2004 PSEIS are still appropriate, and that the trigger requiring a supplement to the 2004 PSEIS has not been met.

NOAA is a world leader in ocean acidification and climate change research and this scientific work in Alaska is available on the AFSC Web site at *http://www.afsc.noaa.gov/*.

Comment 3: The growing scientific understanding of cold water coral's important ecosystem role, the devastating impacts of bottom contact fisheries, and the resulting loss of important groundfish habitat, may support different conclusions about the impacts of bottom trawling and climate change than were considered in the 2004 PSEIS, and should be examined in a supplemental EIS.

Response: The 2004 PSEIS established the policy goal statement to reduce and avoid impacts to habitat. As a direct result, the Council and NMFS have implemented FMP amendments to identify and protect concentrations of deep sea coral and other living substrate from fishery impacts. The management policy will continue to guide the Council as it actively assesses any further protections needed for minimizing the impacts of fishing activities on deep sea coral. The habitat protection actions implemented under the management policy include establishing gear mitigation and coral protection areas in the Aleutian Islands and the GOA (BSAI/GOA Amendments 78/73; NMFS 2005), implementing habitat conservation areas in the BSAI (BSAI Amendment 89; NMFS 2007b), and requiring trawl gear modifications to reduce bottom contact (BSAI/GOA Amendments 94/89; NMFS 2009b/NMFS 2010). This SIR examined these changes in fishery management and concluded that these actions maintain and support the 2004 PSEIS's conclusions that the groundfish fishery has an insignificant impact on habitat, including corals.

The 2004 PSEIS also evaluated a more conservative policy alternative which, although not ultimately selected, took a more precautionary approach to uncertainty about the potential impact of the fisheries on bottom habitat. The conclusions of the 2004 PSEIS with respect to both the Preferred Alternative and other alternatives remain apposite with respect to the impacts of the groundfish fisheries on corals and groundfish habitat.

The 2004 PSEIS acknowledges the importance of coral and other living substrate, and assesses the impacts of bottom contact fisheries on habitat. New information exists regarding the impacts of the groundfish fisheries on habitat, including corals. The EFH EIS further analyzes the impacts of all groundfish fisheries, including bottom contact fisheries, on habitat, including cold water coral (NMFS 2005). NMFS analyzed whether threats are impeding the survival and recovery of coral species and warrant their protection under the ESA, including ocean warming, ocean acidification, commercial fishing, and oil spills (78 FR 10601, February 14, 2013). NMFS found that scientific or commercial information does not warrant protection under the ESA.

The Council has also initiated scientific research fieldwork and analysis of coral concentrations in the Bering Sea canyons (NMFS 2015). The management actions taken to protect cold water coral and

habitat are informed by ongoing scientific research conducted by the AFSC. For additional information, please see AFSC Web site at
http://www.afsc.noaa.gov/News/Aleutian_corals.htm.

This SIR examined this new information and whether the groundfish fisheries are affecting habitat and corals differently than described in the 2004 PSEIS. Section 6 of this SIR summarizes the results of that analysis. No information indicates that the new analysis would conclude that there is now a significant impact where the 2004 PSEIS concludes that the impact was insignificant. Additionally, most of this new information has been analyzed in a subsequent NEPA or ESA analysis. Based on this work, the available new scientific information and research does not suggest a substantial change in our understanding of the impacts of the groundfish fisheries on the habitat in the BSAI and GOA.

Comment 4: New adverse effects to threatened or endangered species or new information about adverse effects require NMFS to supplement an EIS. NMFS must explore these adverse effects through a full SEIS at the programmatic level, to ensure that cumulative impacts to endangered or threatened species are properly taken into account.

Response: Avoiding impacts to seabirds and marine mammals is a specific policy goal identified in the PSEIS, as described in Section 5.2 of this SIR. That goal, as well as obligations under the ESA and Marine Mammal Protection Act, continue to be fulfilled in the Council and NMFS's consideration of information regarding the status of threatened and endangered species and both the proximal and cumulative impacts of groundfish fishery actions on those species. As appropriate, the Council and NMFS have comprehensively evaluated the effects of the groundfish fisheries on threatened and endangered species that have changed their listing status since the issuance of the 2004 PSEIS, including cumulative impacts, as described in Section 6.3 of this SIR. Where warranted the Council and NMFS have taken action to further reduce fishery interactions with endangered or threatened species and their critical habitat. This SIR examined these changes in fishery management and concluded that these actions maintain and support the 2004 PSEIS's conclusions that the groundfish fishery has an insignificant impact on endangered or threatened species.

This SIR examined new information and whether the groundfish fisheries are affecting threatened or endangered species differently than described in the 2004 PSEIS. Section 6 of this SIR summarizes the results of that analysis. No information indicates that the new analysis would conclude that there is now a significant impact where the 2004 PSEIS concludes that the impact was insignificant. Additionally, most of this new information has been analyzed in a subsequent NEPA or ESA analysis. Based on this work, the available new scientific information and research does not suggest a substantial change in our understanding of the impacts of the groundfish fisheries on threatened or endangered species in the BSAI and GOA.

Comment 5: Significant declines in PSC species have changed the human environment in a substantial way compared to the 2004 analysis and necessitate re-examination in an SEIS of the biological and socio-economic impacts, including cumulative impacts, of the groundfish fisheries.

Response: The 2004 PSEIS established the policy goal to manage incidental catch and reduce bycatch and waste, as described in Section 5.2 of this SIR. This policy goal continues to guide the decision making with regard to ongoing management of the groundfish fisheries. As described under Comment 1, the 2004 PSEIS analyzed an adaptive management program with the ability to react to change in environmental circumstances. Changes include consideration of any changes in the status of those resources as well as cumulative impacts of past, present, and reasonably foreseeable future actions. Consistent with the Council's policy, the Council and NMFS have conducted comprehensive analyses and implemented actions to further reduce Chinook salmon, chum salmon, and halibut PSC and thereby reduce the impacts of the groundfish fisheries to these species, as described in Section 6.2

of this SIR. This SIR examined these changes in fishery management and concluded that these actions maintain and support the 2004 PSEIS's conclusions that the groundfish fishery has an insignificant impact on endangered or threatened species.

This SIR examined this new information and whether the groundfish fisheries are affecting PSC species differently than described in the 2004 PSEIS. Section 6 of this SIR summarizes the results of that analysis. No information indicates that the new analysis would conclude that there is now a significant impact where the 2004 PSEIS concludes that the impact was insignificant. Additionally, most of this new information has been analyzed in a subsequent NEPA analysis. Based on this work, the available new scientific information and research does not suggest a substantial change in our understanding of the impacts of the groundfish fisheries on PSC species in the BSAI and GOA.

Comment 6: Important changes in our understanding of climate change, ocean acidification, and the status of several protected or non-target species (Steller sea lions, northern fur seals, Chinook salmon, halibut) have implications on the "significance" determination. The SIR determination that none of the new circumstances and information is "significant" within the meaning of NEPA is based on an incorrect approach to determining significance. The SIR incorrectly examines whether a "seriously different conclusion" is expected from the new information rather than whether the new information may "raise substantial questions" about the potential for significant effects.

Response: The SIR examines information and circumstances that have occurred since 2004 that are relevant to environmental concerns and bearing on the management of the groundfish fisheries or their impacts, and evaluates whether the new information and circumstances show that the groundfish fisheries will affect the quality of the human environment in a significant manner or to a significant extent not already considered, as required under NEPA. As explained in Section 3, the SIR approaches the "significance" determination by posing two overarching questions: "Are the impacts predicted in the 2004 PSEIS for the preferred alternative still valid, given any changes since 2004" and "Does the new information present a seriously different picture of the likely impacts of the groundfish fisheries on a particular resource, compared to what was considered in the 2004 PSEIS." New information and circumstances with regard to target groundfish species, non-target groundfish species (including Chinook salmon and Pacific halibut), marine mammals (including Steller sea lions and northern fur seals) and seabirds, habitats, socioeconomics, and ecosystems (including climate change and ocean acidification) were examined and evaluated in light of these two overarching questions (see Section 6 and Appendices 2 and 4 of the SIR). Based on this examination and evaluation, the Council and NMFS determined that that none of the new circumstances and information is "significant" under NEPA.

The SIR's use of "seriously different conclusion" as the standard for determining significance is consistent with NEPA and case law. Furthermore, this standard encompasses and does not preclude or prevent a determination that new information may raise substantial questions about the potential for significant effects. Evidence of this is seen in Appendix 2 of the SIR. In answering the question "Would a new analysis using the latest methods and information reach a seriously different conclusion," analysts were specifically asked to provide some discussion if the analyst thought the issue needed further investigation. This clearly supports the ability of an analyst to conclude that the new information raises substantial questions about the potential for significant effects.

Comment 7: A new SEIS should be prepared as the supporting analysis to help facilitate the transition to ecosystem-based fishery management in Alaska.

Response: The 2004 PSEIS characterized what is today called ecosystem-based fishery management, and served as the vehicle for refining the groundfish management program to address ecosystem considerations in management decisions. The 2004 PSEIS established policy goals that advance ecosystem-based fishery management, as described in Section 5.2 of this SIR. These policy goals continue to guide the decision making with regard to ongoing management of the groundfish fisheries. Consistent with the Council's policy, the Council and NMFS have taken a number of actions that improve ecosystem-based management in Alaska by minimizing the groundfish fisheries' impacts on ecosystem components, and incorporating ecosystem information into decision-making, as described in Section 6.4 of this SIR.

Additionally, reflective of the Council's ongoing efforts to continue the transition to ecosystem-based fishery management, the Council has adopted an Aleutian Islands Fishery Ecosystem Plan (NPFMC 2007) and is developing a Bering Sea Fishery Ecosystem Plan. Both the AI FEP and the developing BS FEP are action-informing mechanisms that provide a framework for addressing ecosystem considerations in future management decisions. The summary of the preferred alternative from the 2004 PSEIS to the transition to ecosystem-based fishery management can be found in Table 1 of this SIR.

8 Conclusions

The objective of this SIR is to synthesize relevant information for the Council and NMFS to determine whether there is a need to supplement the 2004 PSEIS for the Alaska groundfish fisheries. Note, the Council and NMFS may choose to supplement the 2004 PSEIS at any time for a variety of reasons; this SIR simply focuses on whether the triggers have been met that would require the Council and NMFS to supplement the 2004 PSEIS.

As described in Chapter 3, there are two conditions that would require supplementing an EIS:

1. if NMFS and the Council have made a substantial change in the proposed action (i.e., the management of the Federal groundfish fisheries) that is relevant to environmental concerns, or
2. if there are significant new circumstances or information relevant to environmental concerns and bearing on the management of the groundfish fisheries or their impacts.

With respect to the first condition, Section 5 of this SIR identifies the changes to the management program since 2004. All management changes since 2004 have been subject to NEPA analysis. The Council considered these changes in their discussions of this issue in 2012. The SSC discussed the management changes at the March 2012 meeting, and determined that they are all consistent with the preferred alternative evaluated in the 204 PSEIS. As a result, these changes do not represent a substantial change to the management of the Federal groundfish fisheries that is relevant to environmental concerns.

With respect to the second condition, the SIR includes a comprehensive overview of new circumstances and information relevant to environmental concerns, and bearing on the management of the groundfish fisheries or their impacts. Section 6 summarizes the review process undertaken for each of the resource components analyzed in the 2004 PSEIS, which were considered to be impacted by the management of the groundfish fisheries. These include target and non-target fish species, marine mammals and seabirds, habitat, socioeconomic components, and the ecosystem. For each of these components, experts considered whether the status of the component has changed, and whether new information or methods are available to better understand the impacts of the fisheries on that component. Based on this review, experts were asked to identify whether a new analysis, using the latest methods and information, would reach a significantly different conclusion regarding the impact of the groundfish fisheries. A brief summary of their findings is included in Table 19.

Table 19 Summary of changes to the PSEIS impacts resulting from the SIR review

Resource component	Would a new analysis using the latest methods and information reach a significantly different conclusion	Which components have a "possibly" response
BSAI and GOA target groundfish species	No/possibly	• GOA pollock • GOA blackspotted/rougheye rockfish, dusky rockfish, thornyhead rockfish
Prohibited species	No/possibly	• Pacific salmon
Other fish species	No	
Marine Mammals	No/possibly	• Whales
Seabirds	No	
Habitat	No	
Socioeconomics	No	
Ecosystem	No	

For most resource components, the new information reported in this SIR does not suggest that a new analysis would result in a significantly different conclusion for impacted resource components. There are some responses that indicate that there is now more information available that might further refine the conclusions in the 2004 PSEIS for their resource component (GOA blackspotted/rougheye rockfish, GOA dusky rockfish, and Pacific salmon). For the two GOA rockfish species, an age-structured model is now available which changes some "unknown" conclusions to "insignificant." For Pacific salmon, stock of origin information is now available to differentiate bycatch impacts from Bering Sea versus GOA trawl fishing, however new information does not suggest that there is any increase in adverse environmental impact than previously understood, and groundfish fishery impacts have been minimized, to the extent practicable, through management measures.

There are three other responses that indicated the possibility that a new analysis might reach a different conclusion. The first of these is GOA thornyhead rockfish; in this case, uncertainty has developed about the validity of data allowing an age-structured model, so the expert suggests that the "insignificant" conclusion should be changed to "unknown." The expert does not consider the impacts of the groundfish fishery to be a conservation concern, however. Secondly, with respect to whales, there has been a documented instance of interaction of a groundfish fishery with a harbor porpoise and a sperm whale in recent years, which was not considered at the time of the 2004 PSEIS. There has also been an increase in fisheries-related mortality to humpback whales. These changes indicated some uncertainty for the expert in evaluating the conclusions of the 2004 PSEIS with respect to whales. And finally, the rationale for GOA pollock includes signs of ecosystem change in the GOA as a source of uncertainty about a new conclusion, especially the resurgence of large whales (particularly the humpback whale), and an increase in abundance of arrowtooth flounder.

While the expert reviewers have considered new information specifically from the perspective of each of their resource components, **the decision as to whether to supplement the PSEIS must be based on a consideration of the proposed action as a whole**, that is, the perspective of the overall groundfish management program. As a result, it is incumbent on the Council and NMFS to consider the individual expert reviews, and consolidate them to the level of the overall groundfish management program. From a programmatic perspective, has there been a substantial change in the management of the groundfish fisheries, relevant to environmental concerns? Is the new information on the impact of the groundfish fisheries, relevant to environmental concerns, significant? These are the questions that the Council and NMFS considered.

In April 2014, the Council evaluated the information in the draft SIR, and concluded that a supplemental EIS was not required and that they would not reinitiate a new PSEIS. The Council first evaluated the management program in 2012, to see whether there had been substantial changes, and concluded that the management program is still consistent with the 2004 PSEIS's PA. The PA is described in Section 4.2 of this SIR, and the management changes are documented in Sections 5.1 and 5.2 of this SIR. In the Council's view, the updated information is still consistent with the Council's initial conclusion.

Regarding new information on the impact of the groundfish fisheries relevant to environmental concerns, the SIR synthesizes new information for each of the resource components. Based on this evaluation, the Council concluded that there has not been significantly new information to trigger the need for supplementing the PSEIS at this time. The Council acknowledged the SIR's comprehensive review of the resource components that were evaluated in the 2004 PSEIS, and noted that for almost all resource components the new information does not suggest a new analysis would result in significantly different conclusions. For a few components there may be a new conclusion, but the experts mostly noted that it is not a conclusion that the groundfish fisheries are having a significant impact on that component. Taking the SIR review as a whole, then, to evaluate the overall groundfish program, the Council concluded that the new information documented in the SIR would not result in a significantly different conclusion regarding the environmental impact of the fisheries.

In preparation for the final SIR, some additional information has been included in the report in response to Council and public comment, and staff has worked with the expert reviewers, in some instances, to ensure that the reviewers have consistently evaluated the 2004 PSEIS conclusions in the light of new information. In the draft SIR, there were several instances where an expert had identified uncertainty as to the outcome of a new programmatic analysis based on a discussion of future work, or ongoing but not yet concluded research, which may have bearing on the resource component. The SIR approach is to consider each resource component based on information that is available at present. To finalize the draft SIR, staff worked with the expert reviewers to ascertain that the reviewers understood the SIR approach, and to update the review to capture work that has been completed to date and to clarify the expert's conclusion, if appropriate.

9 Determination

The 2004 PSEIS continues to provide NEPA compliance for the groundfish FMPs and a supplemental NEPA document is not necessary. After reviewing the information presented in the SIR, I determine that—

(1) The management changes since 2004 do not constitute a substantial change in the action analyzed in the 2004 PSEIS. In analyzing the preferred alternative in the PSEIS, the Council and NMFS recognized that fishery management is dynamic and adaptive. Largely, every management change is related to and advances one or more of the Council's policy goals and objectives and all changes are consistent with the preferred alternative evaluated in the PSEIS.

(2) The current status of the resources can be considered within the range of variability analyzed in the 2004 PSEIS. For species where there has been a change of status, such as for some marine mammals, NMFS and the Council have responded with the appropriate analysis and action that maintain and support the 2004 PSEIS's conclusions that the groundfish fishery has an insignificant impact on these species with a change in status.

(3) New information exists regarding the impacts of the groundfish fisheries on resources. Analysts looked at whether the groundfish fisheries are affecting each resource differently than described in the 2004 PSEIS. Section 6 of this SIR summarizes the results of that analysis. According to this analysis, there are a few areas where a new analysis may lead to a different conclusion. However, no information indicates that the new analysis would conclude that there is now a significant impact where the 2004 PSEIS concludes that the impact was insignificant. Additionally, most of this new information has been analyzed in a subsequent NEPA or ESA analysis. Based on this work, the available new scientific information and research does not suggest a substantial change in our understanding of the impacts of the groundfish fisheries on the resources in the BSAI and GOA and does not present significant new circumstances or information relevant to environmental concerns and bearing on the management of the groundfish fisheries or their impacts.

Robert D Mecum (signature) — 11/19/15

fr Administrator, Alaska Region — Date

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APPENDICES

Appendix 1 BSAI and GOA groundfish management policy

The Council's management policy is in the BSAI and GOA groundfish FMPs. The policy is excerpted below.

2.2 Management Approach for the BSAI [GOA] Groundfish Fisheries

The Council's policy is to apply judicious and responsible fisheries management practices, based on sound scientific research and analysis, proactively rather than reactively, to ensure the sustainability of fishery resources and associated ecosystems for the benefit of future, as well as current generations. The productivity of the North Pacific ecosystem is acknowledged to be among the highest in the world. For the past 25 years, the Council management approach has incorporated forward looking conservation measures that address differing levels of uncertainty. This management approach has in recent years been labeled the precautionary approach. Recognizing that potential changes in productivity may be caused by fluctuations in natural oceanographic conditions, fisheries, and other, non-fishing activities, the Council intends to continue to take appropriate measures to insure the continued sustainability of the managed species. It will carry out this objective by considering reasonable, adaptive management measures, as described in the Magnuson-Stevens Act and in conformance with the National Standards, the Endangered Species Act (ESA), the National Environmental Policy Act, and other applicable law. This management approach takes into account the National Academy of Science's recommendations on Sustainable Fisheries Policy.

As part of its policy, the Council intends to consider and adopt, as appropriate, measures that accelerate the Council's precautionary, adaptive management approach through community-based or rights-based management, ecosystem-based management principles that protect managed species from overfishing, and where appropriate and practicable, increase habitat protection and bycatch constraints. All management measures will be based on the best scientific information available. Given this intent, the fishery management goal is to provide sound conservation of the living marine resources; provide socially and economically viable fisheries for the well-being of fishing communities; minimize human-caused threats to protected species; maintain a healthy marine resource habitat; and incorporate ecosystem-based considerations into management decisions.

This management approach recognizes the need to balance many competing uses of marine resources and different social and economic goals for sustainable fishery management, including protection of the long-term health of the resource and the optimization of yield. This policy will use and improve upon the Council's existing open and transparent process of public involvement in decision-making.

2.2.1 Management Objectives

Adaptive management requires regular and periodic review. Objectives identified in this policy statement will be reviewed annually by the Council. The Council will also review, modify, eliminate, or consider new issues, as appropriate, to best carry out the goals and objectives of this management policy.

To meet the goals of this overall management approach, the Council and NMFS will use the Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement (PSEIS) (NMFS 2004) as a planning document. To help focus consideration of potential management measures, the Council and NMFS will use the following objectives as guideposts, to be re-evaluated, as amendments to the FMP are considered over the life of the PSEIS.

Prevent Overfishing:

1. Adopt conservative harvest levels for multi-species and single species fisheries and specify optimum yield.
2. Continue to use the 2 million mt optimum yield cap for the BSAI groundfish fisheries. [Continue to use the existing optimum yield cap for the GOA groundfish fisheries.]
3. Provide for adaptive management by continuing to specify optimum yield as a range.
4. Provide for periodic reviews of the adequacy of F_{40} and adopt improvements, as appropriate.
5. Continue to improve the management of species through species categories.

Promote Sustainable Fisheries and Communities:

6. Promote conservation while providing for optimum yield in terms of the greatest overall benefit to the nation with particular reference to food production, and sustainable opportunities for recreational, subsistence, and commercial fishing participants and fishing communities.
7. Promote management measures that, while meeting conservation objectives, are also designed to avoid significant disruption of existing social and economic structures.
8. Promote fair and equitable allocation of identified available resources in a manner such that no particular sector, group or entity acquires an excessive share of the privileges.
9. Promote increased safety at sea.

Preserve Food Web:

10. Develop indices of ecosystem health as targets for management.
11. Improve the procedure to adjust acceptable biological catch levels as necessary to account for uncertainty and ecosystem factors.
12. Continue to protect the integrity of the food web through limits on harvest of forage species.
13. Incorporate ecosystem-based considerations into fishery management decisions, as appropriate.

Manage Incidental Catch and Reduce Bycatch and Waste:

14. Continue and improve current incidental catch and bycatch management program.
15. Develop incentive programs for bycatch reduction including the development of mechanisms to facilitate the formation of bycatch pools, vessel bycatch allowances, or other bycatch incentive systems.
16. Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits, as information becomes available.
17. Continue program to reduce discards by developing management measures that encourage the use of gear and fishing techniques that reduce bycatch which includes economic discards.
18. Continue to manage incidental catch and bycatch through seasonal distribution of total allowable catch and geographical gear restrictions.

19. Continue to account for bycatch mortality in total allowable catch accounting and improve the accuracy of mortality assessments for target, prohibited species catch, and non-commercial species.
20. Control the bycatch of prohibited species through prohibited species catch limits or other appropriate measures.
21. Reduce waste to biologically and socially acceptable levels.

Avoid Impacts to Seabirds and Marine Mammals:

22. Continue to cooperate with U.S. Fish and Wildlife Service (USFWS) to protect ESA-listed species, and if appropriate and practicable, other seabird species.
23. Maintain or adjust current protection measures as appropriate to avoid jeopardy of extinction or adverse modification to critical habitat for ESA-listed Steller sea lions.
24. Encourage programs to review status of endangered or threatened marine mammal stocks and fishing interactions and develop fishery management measures as appropriate.
25. Continue to cooperate with NMFS and USFWS to protect ESA-listed marine mammal species, and if appropriate and practicable, other marine mammal species.

Reduce and Avoid Impacts to Habitat:

26. Review and evaluate efficacy of existing habitat protection measures for managed species.
27. Identify and designate essential fish habitat and habitat areas of particular concern pursuant to Magnuson-Stevens Act rules, and mitigate fishery impacts as necessary and practicable to continue the sustainability of managed species.
28. Develop a Marine Protected Area policy in coordination with national and state policies.
29. Encourage development of a research program to identify regional baseline habitat information and mapping, subject to funding and staff availability.
30. Develop goals, objectives and criteria to evaluate the efficacy and suitable design of marine protected areas and no-take marine reserves as tools to maintain abundance, diversity, and productivity. Implement marine protected areas if and where appropriate.

Promote Equitable and Efficient Use of Fishery Resources:

31. Provide economic and community stability to harvesting and processing sectors through fair allocation of fishery resources.
32. Maintain the license limitation program, modified as necessary, and further decrease excess fishing capacity and overcapitalization by eliminating latent licences and extending programs such as community or rights-based management to some or all groundfish fisheries.
33. Provide for adaptive management by periodically evaluating the effectiveness of rationalization programs and the allocation of access rights based on performance.
34. Develop management measures that, when practicable, consider the efficient use of fishery resources taking into account the interest of harvesters, processors, and communities.

Increase Alaska Native Consultation:

35. Continue to incorporate local and traditional knowledge in fishery management.
36. Consider ways to enhance collection of local and traditional knowledge from communities, and incorporate such knowledge in fishery management where appropriate.
37. Increase Alaska Native participation and consultation in fishery management.

Improve Data Quality, Monitoring and Enforcement:

38. Increase the utility of groundfish fishery observer data for the conservation and management of living marine resources.
39. Develop funding mechanisms that achieve equitable costs to the industry for implementation of the North Pacific Groundfish Observer Program.
40. Improve community and regional economic impact costs and benefits through increased data reporting requirements.
41. Increase the quality of monitoring and enforcement data through improved technology.
42. Encourage a coordinated, long-term ecosystem monitoring program to collect baseline information and compile existing information from a variety of ongoing research initiatives, subject to funding and staff availability.
43. Cooperate with research institutions such as the North Pacific Research Board in identifying research needs to address pressing fishery issues.
44. Promote enhanced enforceability.
45. Continue to cooperate and coordinate management and enforcement programs with the Alaska Board of Fish, Alaska Department of Fish and Game, and Alaska Fish and Wildlife Protection, the U.S. Coast Guard, NMFS Enforcement, International Pacific Halibut Commission, Federal agencies, and other organizations to meet conservation requirements; promote economically healthy and sustainable fisheries and fishing communities; and maximize efficiencies in management and enforcement programs through continued consultation, coordination, and cooperation.

Appendix 2 Template for PSEIS SIR – review of conclusions in 2004 PSEIS

What resource component is this review for? ___________________
What sections of the PSEIS were reviewed? ___________________

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Have there been substantial changes in the management program that have affected the resource, since the 2004 PSEIS (e.g., species is now managed independently, rather than as part of a complex; implementation of catch share privileges or closure areas affecting fisheries targeting resource)?

2 Has the status of the resource changed?

Is the status of the resource different than described in the 2004 PSEIS, and if so, how? What has affected the change in status? Is the current status within the range of variability analyzed in the 2004 PSEIS?

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Are the fisheries affecting the resource differently than described in the 2004 PSEIS? Is this difference within the range of variability analyzed in the 2004 PSEIS? Has the difference been analyzed in a subsequent NEPA analysis (e.g., the difference in impact is the result of a management change for which an EA or EIS was written)? Is there new scientific information or research indicating or suggesting a change in our understanding of the impact of the fisheries on the resource?

4 Are there new methods of analysis or protocols for evaluating impacts?

Has a new methodology been developed for better understanding or evaluating impacts of the fisheries on the resource? Has that methodology been used in NEPA analyses of management actions affecting the resource, since the 2004 PSEIS?

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

If new information is available, consider whether taking that information into account would cause you to reach a different conclusion about the effect of the groundfish fisheries on the resource. Provide a rationale if you conclude that it would not, or some discussion if you think this issue needs further investigation. We are not asking for the new analysis to be undertaken, only for you to provide a discussion of whether it is merited.

Appendix 3 Changes in target species and species complexes between 2004 and present

The tables below list the species and species complexes that are currently identified in the BSAI and GOA Groundfish FMPs, and compare them to the species or species complexes that were assessed in the 2004 PSEIS. In a few cases, there are discrepancies. For example, shortraker and rougheye rockfish were managed as a complex in 2004, but are now managed separately (in fact, rougheye rockfish is managed as a complex with blackspotted rockfish).

Table 20 Species or species complexes that are currently identified in the BSAI SAFE report, compared to species or species complexes that were assessed in the 2004 PSEIS

Species or complexes that were assessed in the 2004 PSEIS		Species or complexes that are now identified in the BSAI SAFE report	
Target species	pollock	**Target species**	pollock (EBS, AI, Bogoslof)
	pacific cod		pacific cod
	sablefish		sablefish
	yellowfin sole		yellowfin sole
	greenland turbot		greenland turbot
	arrowtooth flounder		arrowtooth flounder
			Kamchatka flounder
	rock sole		Northern rock sole
	flathead sole		flathead sole
	alaska plaice		alaska plaice
	rex sole		other flatfish
	dover sole		
	Pacific ocean perch		Pacific ocean perch
	northern rockfish		northern rockfish
	shortraker/ rougheye rockfish		shortraker rockfish
			blackspotted/ rougheye rockfish
	yelloweye rockfish		other rockfish
	dusky rockfish		
	thornyhead rockfish		
	atka mackerel		atka mackerel
	squid		squid
Other species	octopus		octopus
	sharks		sharks
	sculpins		sculpins
	skates		skates
Forage fish	forage fish complex	**Ecosystem Component**	forage fish complex
Non-specified species	(specific species not listed)		grenadiers[38]

[38] The Council has approved, and NMFS has implemented, an FMP amendment to include grenadiers in the ecosystem component of the BSAI FMP and GOA FMP.

Table 21 Species or species complexes that are currently identified in the GOA SAFE report, compared to species or species complexes that were assessed in the 2004 PSEIS

Species or complexes that were assessed in the 2004 PSEIS		Species or complexes that are identified in the GOA SAFE report	
Target Species	pollock	**Target species**	pollock
	pacific cod		pacific cod
	sablefish		sablefish
	yellowfin sole		shallow water flatfish
	rock sole		
	Alaska plaice		
	dover sole		deep water flatfish
	greenland turbot		
	rex sole		rex sole
	arrowtooth flounder		arrowtooth flounder
	flathead sole		flathead sole
	Pacific ocean perch		Pacific ocean perch
	northern rockfish		northern rockfish
	shortraker/ rougheye rockfish		shortraker/ other slope rockfish
			dusky rockfish
			blackspotted and rougheye rockfish
	dusky rockfish		pelagic shelf rockfish
	yelloweye rockfish		demersal shelf rockfish
	thornyhead rockfish		thornyhead rockfish
	atka mackerel		atka mackerel
	skates		big skate
			longnose skate
			other skates
Other species	squids		squids
	octopuses		octopuses
	sharks		sharks
	sculpins		sculpins
Forage fish	forage fish complex	**Ecosystem Component**	forage fish complex
Non-specified species	(species not listed in FMP)		grenadiers[39]

[39] The Council has approved, and NMFS has implemented, an FMP amendment to include grenadiers in the ecosystem component of the BSAI FMP and GOA FMP.

Appendix 4 Worksheets from resource component expert reviews

Note, this appendix is available online, as a separate file. Please go to the following webpage to retrieve: www.npfmc.org.

Target Groundfish Species

Ecosystem component (prohibited and forage fish) and non-specified fish species

Marine mammals and seabirds

Habitat, Socioeconomics, Ecosystem

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/19/13

What resource component is this review for? EBS Pollock
What sections of the PSEIS were reviewed? 4.9.1.1

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The control rules governing the over-arching management regulations are unchanged relative to those analyzed in 2004. The principal factors affecting pollock fishery management include: seasonal apportionments (40% during the winter, 60% from June 10-October 31st), bycatch of pollock in other fisheries (count against the TAC), the sector-specific TAC allocations (i.e., CDQ, mother-ship, catcher-processors, and shore-based catcher boats), the 2-million t OY cap (which limits pollock TAC to about 1.5 million t), the "Tier 1" ABC/OFL control rules (amendment 56) from the single species assessment, and salmon bycatch avoidance. The control rule (which explicitly takes into account uncertainty in estimation of F_{MSY}) constrained the TAC for a couple of years (2009 and 2010) during a period when the stock dropped below the target level (and the upper limit of the harvest rate was required to be adjusted downwards). Specific management actions affect the EBS pollock fishery includes Amendment 91 (implemented in 2011) which set a cap for the number of Chinook salmon that can be taken incidentally. The indirect effect of this measure has amounted to shifts to fishing earlier in the B-season since bycatch rates (in terms of numbers of Chinook salmon per ton of pollock) increases in late September through October. Also, within-industry measures to close salmon bycatch "hot-spots" have affected the areas where pollock fishing can occur.

2 Has the status of the resource changed?

The status of the pollock stocks have fluctuated over time since the 2004 PSEIS but remains within the expected range of stock variability estimated at that time. As noted above, the stock has dropped below the target level in the past 10 years but this is as expected.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

The observer coverage for the entire fleet switched to 100% in 2011 as part of the salmon bycatch measures. Previously the shore-based catcher vessels smaller than 125 feet had about 50% of their operations covered by scientific observers (even though the legal mandate was to have only 30% coverage in each quarter of the year).

In addition to the annual bottom-trawl surveys that cover the period 1982-2012, the supplemental dedicated acoustic-trawl surveys ran each summer 2006-2010 as part of a large-scale Bering Sea Integrated Ecosystem Research Program (BSIERP) funded by the North Pacific Research Board (NPRB). Prior to 2006 this acoustic survey ran (typically) every other year. This survey provides valuable direct observations on pre-recruit pollock and improves the information available to make near-term projections of fishing conditions and stock status (for spawning biomass conservation measures). Additionally, these added survey years allowed the development of valuable opportunistic data collection programs. These opportunistic acoustic data are presently collected on the chartered bottom-trawl survey vessels to provide an alternative index in years that the dedicated research vessel is unavailable. Also, acoustic data are collected from commercial vessels and have proven valuable for evaluating the turnover-rate of pollock abundance during the winter season. This study is of particular importance to help provide information on the forage available to Steller sea lions during their over-wintering period within their critical habitat. This information improves NMFS ability to evaluate fishery impacts and to provide better more-timely advice on stock status and catch limit recommendations.

4 Are there new methods of analysis or protocols for evaluating impacts?

The main assessment methodology is similar to that done for the 2004 PSEIS. However, the data collection and evaluations have improved on comprise new methods (e.g., developing an index from opportunistically collected acoustic data). Techniques to test assessment-management approaches which involve the development of operating models is underway and have been applied (e.g., decision tables, climate change effects etc.). The technical interactions model used for the PSEIS remains unchanged but presently research is underway to improve that approach and update the data streams used for that model.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

Results from new analyses using an updated technical interaction model would likely be provide a similar conclusions. Anticipated differences would include added complexity to the management (e.g., due to salmon bycatch regulation changes). Difficulties in appropriately mimicking the TAC setting process may also be greater than in the past due to the larger number of constraints and having information that would predict recent trends (e.g., using different gear configurations to avoid salmon and/or crab and halibut.

PSEIS SIR – review of conclusions in 2004 PSEIS

Draft ~6/19/13

What resource component is this review for? BSAI Pacific cod
What sections of the PSEIS were reviewed? 4.9.1.2

1 Has management of the resource changed?

The only two FMP amendments since 2004 (inclusive) that reference Pacific cod explicitly are Amendments 77 and 85.

Amendment 77 was implemented January 1, 2004. This amendment revised Amendment 64. It implemented a Pacific cod fixed gear allocation between hook and line catcher processors (80 percent), hook and line catcher vessels (0.3 percent), pot catcher processors (3.3 percent), pot catcher vessels (15 percent), and catcher vessels (pot or hook and line) less than 60 feet (1.4 percent).

Amendment 85 was partially implemented on March 5, 2007. This amendment superseded Amendments 46 and 77. It implemented a gear allocation among all non-CDQ fishery sectors participating in the directed fishery for Pacific cod. After deduction of the CDQ allocation, the Pacific cod TAC is apportioned to vessels using jig gear (1.4 percent); catcher processors using trawl gear listed in Section 208(e)(1)-(20) of the AFA (2.3 percent); catcher processors using trawl gear as defined in Section 219(a)(7) of the Consolidated Appropriations Act, 2005 (Public Law 108-447) (13.4 percent); catcher vessels using trawl gear (22.1 percent); catcher processors using hook-and-line gear (48.7 percent); catcher vessels ≥60’ LOA using hook-and-line gear (0.2 percent); catcher processors using pot gear (1.5 percent); catcher vessels ≥60’ LOA using pot gear (8.4 percent); and catcher vessels <60’ LOA that use either hook-and-line gear or pot gear (2.0 percent).

Attachment 2.3 to the 2012 BSAI Pacific cod assessment describes regulations specific to the BSAI Pacific cod fisheries.

2 Has the status of the resource changed?

Relative to MSST, the status of BSAI Pacific cod remains the same, qualitatively speaking. Based on the 2012 stock assessment, projections for the 2013-2017 time period are fairly similar to the projections for 2007 contained in the 2004 PSEIS. For example, projected total biomass is within 10-19% of the value projected previously under PA.1 and within 12-21% of the value projected previously under PA.2, projected spawning biomass is within 5-11% of the value projected previously under PA.1 and within 7-9% of the value projected previously under PA.2, projected fishing mortality is within 8% of the value projected previously under PA.1 and within 14% of the value projected previously under PA.2, and projected average age (exlusive of age zero) is within 2-11% of the value projected previously under PA.1 and within 3-10% of the value projected previously under PA.2.

A related issue is how “the resource” should be defined in the case of BSAI Pacific cod. Although BSAI Pacific cod has, and continues to be, managed as a unit stock, recent research suggests that AI Pacific cod would be more appropriately managed as a separate stock, and it is likely that management will be split into separate EBS and AI units in the very near future. However, no age-structured model of the AI stock has been accepted by the SSC, and stock status continues to be determined on a BSAI-wide basis at the present time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

New information regarding impacts of the groundfish fishery on the resource is incorporated annually in the stock assessment. This new information consists primarily of total catch weight (including discards), stratified by year, season, and gear; and catch length composition, stratified by the same three factors. In addition, research by Ingrid Spies (PhD dissertation, in prep.) is evaluating potential impacts of differential fishing mortality rates on Pacific cod in the EBS and AI.

4 Are there new methods of analysis or protocols for evaluating impacts?

The model used in the stock assessment has changed considerably since 2002. These changes are documented in the 2012 stock assessment, beginning on page 254.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

I doubt it. Of course, it is not possible to predict the results of a future analysis based on a yet-to-be-developed age-structured model for the AI stock.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 5/30/2013

What resource component is this review for? ____Sablefish
What sections of the PSEIS were reviewed? ___4.9.1.3

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

A minor change in gear restrictions occurred in 2008, when the pot fishing ban was repealed for the Bering Sea during June 1-30 (74 FR 28733). This should have no significant impact on the resource.

2 Has the status of the resource changed?

The status of the sablefish stock is similar to the status during the 2004 PSEIS and within the range of variability of the estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There was an increase in the BSAI fisheries in the use of pot gear to catch sablefish during 2004-2008, which has recently decreased again. The catch from pot gear was analyzed and shown to have minimal differences from longline gear and size of fish harvested (Sablefish SAFE, Hanselman et al. 2009).

4 Are there new methods of analysis or protocols for evaluating impacts?

The methodology is similar to the 2004 PSEIS.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The current analysis uses modern methods and the sablefish assessment model is relatively robust to the assumptions of the analysis.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/5/2013

What resource component is this review for? **BSAI Atka mackerel**
What sections of the PSEIS were reviewed? **Section 4.9.1.4 Atka Mackerel**

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management of the BSAI Atka mackerel fishery changed significantly in 2011 due to the implementation of Reasonable and Prudent Alternatives included in the 2010 Biological Opinion which required changes in groundfish fishery management in Management Sub-areas 543, 542, and 541 in the Aleutian Islands Management Area. In area 543, retention of Atka mackerel and Pacific cod is prohibited. In area 542, the TAC for Atka mackerel is set to no more than 47 percent of the Area 542 acceptable biological catch (ABC). Additionally, there are year round closures to directed fishing for Atka mackerel in defined areas of critical habitat and limits within defined areas of critical habitat for vessels participating in harvest cooperatives or CDQ fisheries. In area 541 the Bering Sea subarea is closed to year round fishing for the directed Atka mackerel fishery.

Amendment 80 to the BSAI Groundfish FMP was adopted by the Council in June 2006 and implemented for the 2008 fishing year. This action allocated several BSAI non-pollock trawl groundfish species among trawl fishery sectors, and facilitated the formation of harvesting cooperatives in the non-American Fisheries Act (non-AFA) trawl catcher/processor sector. Bering Sea/Aleutian Islands Atka mackerel is one of the groundfish species directly affected by Amendment 80.

2 Has the status of the resource changed?

The status of the BSAI Atka mackerel stock is higher than the status described in the 2004 PSEIS due to the impact of strong year classes, most notably the 1999, 2000, 2001, and 2006 year classes. Also, due to changes in the stock assessment model configuration since 2004, our knowledge and perception of the stock status has improved. The status of the BSAI Atka mackerel stock is within the range of variability estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

The BSAI Atka mackerel fishery changed significantly since 2004 due to the implementation of Reasonable and Prudent Alternatives included in the 2010 Biological Opinion which required changes in groundfish fishery management in Management Sub-areas 543, 542, and 541 in the Aleutian Islands Management Area. The fishery and the impacts of the fishery were analyzed in the 2010 Biological Opinion and in the Draft Stellar Sea Lion Protection Measures Environmental Impact Statement (SSL EIS). Changes to the fishery have been described and modeled in the BSAI stock assessment on an annual basis.

4 Are there new methods of analysis or protocols for evaluating impacts?

The basic methodology for evaluating impacts (age-structured model) is similar to the 2004 PSEIS.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

New and updated fishery information and improvements to the age structured model are incorporated into the stock assessment, but has not resulted in a different conclusion about the effect of the groundfish fisheries on the resource.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/13/13

What resource component is this review for? ____Gulf of Alaska walleye pollock
What sections of the PSEIS were reviewed? ___ 4.9.1.1

1 Has management of the resource changed?

There have been no changes to the harvest control rules specifying the OFL harvest rate, the maximum acceptable ABC, and the author's recommended ABC since the 2002 stock assessment for GOA pollock. Other features of the management system, such as the B20% limit for the target fishery, and the procedure for spatially and temporally allocating the ABC are also unchanged. Additional survey information is available for allocating the ABC between areas during the winter fishery (A and B seasons). Since the harvest control rule depends on estimated quantities from the stock assessment (such as mean recruitment, weight at age, and fishery selectivity), the values used to specify the harvest control rule, such as B35%, F40%, have changed. However the process used to calculate them has not.

With respect to in-season management of the pollock fishery, the trip limit regulation for the pollock target fishery in the GOA was fine-tuned to better achieve its original intent. Also Chinook salmon bycatch limits were established for the GOA pollock fishery by FMP Amendment.

2 Has the status of the resource changed?

The current status of the Gulf of Alaska walleye pollock stock is similar to the status during the 2004 PSEIS, and is within the range of variability of the estimates at that time. In the 2002 assessment, pollock was estimated to be at 28% of unfished spawning biomass in 2003. In the 2012 assessment, GOA pollock was estimated to be at 35.1% of unfished spawning biomass. Pollock biomass has been relatively stable during the last decade, but in the last couple of years has shown an increasing trend.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Ongoing fishing impacts on groundfish EFH were evaluated during the 5-year EFH review. Results of this analysis may be useful in future EIS evaluations.

4 Are there new methods of analysis or protocols for evaluating impacts?

Methods are being developed at AFSC to explore the implications of incorporating stock-specific uncertainty buffers to establish ABCs.

Teresa A'mar completed her dissertation in 2009 on a Management Strategy Evaluation of GOA pollock . Her work evaluated the performance of the current stock assessment methodology and management system (references below) .

No new methods of analysis have been used in NEPA analyses of management actions.

References for the management strategy evaluation for GOA pollock

A'mar, Z.T., A.E. Punt, and M.W. Dorn. 2008. The Management Strategy Evaluation Approach and the Fishery for Walleye Pollock in the Gulf of Alaska. Pages 317-346. In: Kruse, G.H., Drinkwater, K., Ianelli, J.N., Link, J.S., Stram, D.L., Wespestad, V., and Woodby, D. [Eds.] Proceedings of 24th Lowell Wakefield Fisheries Symposium: Resiliency of Gadid Stocks to Fishing and Climate Change. Alaska Sea Grant College Program, University of Alaska Fairbanks, AK.

A'mar, Z.T., A.E. Punt, and M.W. Dorn. 2009. The evaluation of two management strategies for the Gulf of Alaska walleye pollock fishery under climate change. ICES Journal of Marine Science, 66: 1614-1632.

A'mar, Z.T., A.E. Punt, and M.W. Dorn. 2009. The impact of regime shifts on the performance of management strategies for the Gulf of Alaska walleye pollock fishery. Canadian Journal of Fisheries and Aquatic Sciences, 66(12): 2222-2242.

A'mar, Z.T., A.E. Punt, and M.W. Dorn. 2010. Incorporating ecosystem forcing through predation into a Management Strategy Evaluation for the Gulf of Alaska walleye pollock (Theragra chalcogramma) fishery. Fisheries Research, 102(1-2): 98-114.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

It is difficult to say what the outcome of a new analysis would be. The GOA pollock MSE mentioned above did not find any serious failings of the current assessment and management system. In general, groundfish fisheries in the Gulf of Alaska have been fairly stable since 2002, and the changes that have been implemented were contemplated by two bookend alternatives in the PSEIS. Therefore it might be reasonable to expect that a new analysis would reach similar conclusions to the 2004 PSEIS.

There two changes in the GOA ecosystem that may merit further evaluation. The first is the continued increase in abundance of arrowtooth flounder, a major predator of pollock in the GOA. The second is the resurgence of large whales in the GOA ecosystem, in particular, humpback whales (*Megaptera novaeangliae*).

PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/13/13

What resource component is this review for? ____GOA Pacific cod
What sections of the PSEIS were reviewed? ___4.9.1.2

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

An adjustment among gear and operational sectors occurred in 2012, when Amendment 83 of the GOA Groundfish FMP was enacted. This should have no significant impact on the resource.

2 Has the status of the resource changed?

The status of the GOA Pacific cod stock is similar to the status during the 2004 PSEIS and within the range of variability of the estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

The fisheries observer program was restructured in 2013. This change will result in differences in the fishery data collected, and the significance of these changes for the GOA Pacific cod stock will not be determined for several years.

4 Are there new methods of analysis or protocols for evaluating impacts?

The methodology is similar to the 2004 PSEIS.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The current analysis uses modern methods and the GOA Pacific cod assessment model is relatively robust to the assumptions of the analysis.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/5/13

What resource component is this review for? **GOA Atka mackerel**
What sections of the PSEIS were reviewed? **Section 4.9.1.4 Atka Mackerel**

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

No, Gulf of Alaska (GOA) Atka mackerel has been managed under Tier 6 specifications since 1996 due to the lack of reliable estimates of current biomass. Gulf of Alaska Atka mackerel are managed as a bycatch species. The total allowable catch (TAC) for GOA Atka mackerel is intended to provide for anticipated bycatch needs of other fisheries, principally for Pacific cod, rockfish and pollock, and to only allow for minimal targeting. The TACs for 2004-2005 were 600 t, 1,500 t for 2006-2008, and have been set at 2,000 t for 2009 to 2013.

Gulf of Alaska Atka mackerel has been moved to a biennial stock assessment schedule to coincide with the availability of new survey data from the biennial trawl survey. A full assessment is presented in odd years. On alternate (even) years an executive summary is presented with updated catch, the previous year's key assessment parameters, any significant new information available in the interim, and projections for the upcoming year.

2 Has the status of the resource changed?

Information for GOA Atka mackerel is very limited and consists of catch information and small samples of age data. The data show fluctuations in the catches and distribution of GOA Atka mackerel coinciding with strong year classes observed in the Aleutian Islands. The strong year classes observed in the Aleutian Islands dominate the limited age compositions of GOA Atka mackerel.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

No, there has not been a directed fishery for Atka mackerel since 1996. Annual changes in the GOA Atka mackerel catches reflect shift in catches of other species which catch Atka mackerel as bycatch.

4 Are there new methods of analysis or protocols for evaluating impacts?

No, there have been no changes to the assessment methodology. Gulf of Alaska Atka mackerel have been assessed and managed under Tier 6 specifications since 1996 due to lack of reliable estimates of current biomass.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No, limited new and updated fishery information are discussed in the stock assessment, but has not resulted in a different conclusion about the effect of the groundfish fisheries on the resource.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/3/2013

What resource component is this review for? **BSAI yellowfin sole**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.5***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management of the yellowfin sole fishery changed significantly in 2008 with the implementation of Amendment 80 to the BSAI Fisheries Management Plan. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. In addition, Amendment 80 also mandated additional monitoring requirements which included observer coverage on all hauls, motion-compensating scales for weighing samples, flow scales to obtain accurate catch weight estimates for the entire catch, no mixing of hauls and no on-deck sorting. The partitioning of TAC and PSC (prohibited species catch) among cooperatives has significantly changed the way the annual catch has accumulated (slower and more evenly) and the rate of target catch per bycatch ton (less).

2 Has the status of the resource changed?

The status of the BSAI yellowfin sole stock is similar to the status during the 2004 PSEIS, well above the target reference points and within the range of variability of the estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2011, a trawl sweep modification requirement was implemented for vessels participating in the Bering Sea flatfish fishery resulting is less impact of the fishery on the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps, to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor. Research has demonstrated that this gear modification reduces unobserved mortality of red king crab, Tanner crab, and snow crab.

4 Are there new methods of analysis or protocols for evaluating impacts?

Since 2004 the yellowfin sole stock assessment analysis has changed from Tier 3 methodology to Tier 1 resulting in differences in the way the productivity of the stock and risk is incorporated into the ABC calculation.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

Some new information regarding temperature-dependent growth has become available and is incorporated into the stock assessment but it has not resulted in a different conclusion about the effect of the groundfish fisheries on the resource.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/10/2013

What resource component is this review for? ____BSAI Greenland turbot
What sections of the PSEIS were reviewed? ___4.9.1.9

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

There have been no changes to management of the BSAI Greenland turbot stock since 2004.

2 Has the status of the resource changed?

Although the stock spawning biomass has declined the status of the BSAI Greenland turbot is similar to the status during the 2004 PSEIS and within the range of variability of the estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There has been no new information regarding the impacts of the groundfish fisheries on this stock.

4 Are there new methods of analysis or protocols for evaluating impacts?

The methodology is similar to the 2004 PSEIS.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The current analysis uses modern methods and the BSAI Greenland turbot assessment model is relatively robust to the assumptions of the analysis.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/10/2013

What resource component is this review for? **BSAI arrowtooth flounder**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.8***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

No, BSAI arrowtooth flounder were assessed and managed under Tier 3a in 2002 and continue to be managed with this methodology. The same model has been used since 2002.

2 Has the status of the resource changed?

The status of the resource has been consistently increasing since 2002. The spawning biomass of female BSAI arrowtooth flounder was estimated to be 475,900 mt at the beginning of 2002. At the beginning of 2013, female spawning biomass was estimated at 638,377 mt.

2 Is there new information regarding the impacts of the groundfish fisheries on the resource?

The model estimates the fishing mortality rate on arrowtooth flounder by the fishery, both as a targeted fishery and as bycatch. The estimated fishing mortality rate was 0.015 in 2002 and 0.014 in 2013, and remained stable during the intervening period. Only a fraction of the recommended ABC is taken in the fishery; the estimated catch from 2002 – 2013 has been less than 20,000 mt even though the ABC has been over 100,000 mt for each of those years.

New information from NMFS research surveys and fishery length data are used in the assessment; EBS slope survey was conducted in 2002 2004 2008 2010 2012, the Aleutian Islands survey was conducted in 2002 2004 2006 2010 2012, and the EBS shelf survey was conducted every year since 2002. New fishery length data is incorporated from each year since 2002.

3 Are there new methods of analysis or protocols for evaluating impacts?

No significant new analyses have been implemented to assess the effect of the groundfish fishery on arrowtooth flounder.

4 Would a new analysis using the latest methods and information reach a seriously different conclusion?

Recently, a new maturity ogive was published for female arrowtooth flounder (Stark, J. 2008. Age- and length-at-maturity of female arrowtooth flounder (*Atheresthes stomias)* in the Gulf of Alaska. Fish. Bull. 106: 328–333). This work motivated a re-analysis of the estimated arrowtooth flounder biomass using the current model with several different maturity ogives. Although maturity ogives have a significant effect on the estimate of female spawning biomass, all estimates were well above $B_{40\%}$ and all showed in increasing trend in arrowtooth female spawning biomass since 2002.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/3/2013

What resource component is this review for? **BSAI Kamchatka flounder**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.8***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management of the Kamchatka flounder fishery has changed significantly since 2004. In the eastern part of their range, Kamchatka flounder overlap with arrowtooth flounder (*Atheresthes stomias*) which are very similar in appearance and were not routinely distinguished in the commercial catches until 2007. Until about 1992, these species were also not consistently separated in trawl survey catches and were combined in the arrowtooth flounder stock assessment (Wilderbuer et al. 2009). However, managing the two species as a complex became undesirable in 2010 due to the emergence of a directed fishery for Kamchatka flounder in the BSAI management area. Since the ABC was determined by the large amount of arrowtooth flounder relative to Kamchatka flounder (complex is about 93% arrowtooth flounder) the possibility arose of an overharvest of Kamchatka flounder as the *Atheresthes sp*. ABC exceeded the Kamchatka flounder biomass. Arrowtooth and Kamchatka flounder have been managed separately since 2011.

2 Has the status of the resource changed?

The status of the BSAI Kamchatka flounder stock is similar to the status during the 2004 PSEIS as indicated by the results of the Bering Sea shelf, slope and Aleutian Islands surveys. The stock biomass is estimated to have increased or remained at the same level in all three areas and remains within the range of variability of the estimates from 2004.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2011, a trawl sweep modification requirement was implemented for vessels participating in the Bering Sea flatfish fisheries resulting is less impact to the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps, to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor. Research has demonstrated that this gear modification reduces unobserved mortality of red king crab, Tanner crab, and snow crab.

4 Are there new methods of analysis or protocols for evaluating impacts?

The Kamchatka flounder assessment is presently a Tier 5 assessment reliant upon survey biomass estimates and an estimate of natural mortality to set the annual ABC and OFL levels. Work is progressing to elevate the assessment to a Tier 3 level for the 2014 fishing season by utilizing age, size, growth, maturity and improved natural mortality information as well as survey abundance and fishery catch.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

Although new information and modeling techniques will improve the stock assessment it is not expected that a seriously different conclusion regarding stock condition will result since the fishery-independent information is on the same order as before and the fisheries mortality remains at a moderate level.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/3/2013

What resource component is this review for? **BSAI northern rock sole**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.6***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management of the northern rock sole fishery changed significantly in 2008 with the implementation of Amendment 80 to the BSAI Fisheries Management Plan. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. In addition, Amendment 80 also mandated additional monitoring requirements which included observer coverage on all hauls, motion-compensating scales for weighing samples, flow scales to obtain accurate catch weight estimates for the entire catch, no mixing of hauls and no on-deck sorting. The partitioning of TAC and PSC (prohibited species catch) among cooperatives has significantly changed the way the annual catch has accumulated (slower and more evenly) and the rate of target catch per bycatch ton (less).

2 Has the status of the resource changed?

The status of the BSAI northern rock sole stock is similar to the status during the 2004 PSEIS, well above the target reference points and within the range of variability of the estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2011, a trawl sweep modification requirement was implemented for vessels participating in the Bering Sea flatfish fishery resulting is less impact of the fishery on the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps, to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor. Research has demonstrated that this gear modification reduces unobserved mortality of red king crab, Tanner crab, and snow crab.

4 Are there new methods of analysis or protocols for evaluating impacts?

Since 2004 the northern rock sole stock assessment analysis has changed from a Tier 3 methodology to a Tier 1 approach resulting in differences in the way the productivity of the stock and risk is incorporated into the ABC calculation (northern rock sole SAFE, Wilderbuer et al. 2012).

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

Some new information regarding temperature-dependent growth has become available for northern rock sole and is planned be incorporated into the stock assessment but it is unlikely that it will result in a different conclusion about the effect of the groundfish fisheries on the resource.

Review of Conclusions in 2004 PSEIS

draft 6/19/2013

What resource component is this review for? **BSAI flathead sole**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.7***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management of the flathead sole fishery changed significantly in 2008 with the implementation of Amendment 80 to the BSAI Fisheries Management Plan. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. In addition, Amendment 80 also mandated additional monitoring requirements which included observer coverage on all hauls, motion-compensating scales for weighing samples, flow scales to obtain accurate catch weight estimates for the entire catch, no mixing of hauls and no on-deck sorting. The partitioning of TAC and PSC (prohibited species catch) among cooperatives has significantly changed the way the annual catch has accumulated (slower and more evenly) and the rate of bycatch per target catch ton (less).

2 Has the status of the resource changed?

Total biomass of the BSAI flathead sole stock at the beginning of 2013 (Stockhausen and Nichol, 2012) was projected in 2012 to be ~750,000 t, almost 50% larger than that considered in the 2004 PSEIS (513,000 t). Female spawning biomass in 2013 was projected in 2012 (Stockhausen and Nichol, 2012) to be almost 250,000 t, whereas the spawning biomass considered in the 2004 PSEIS was approximately 230,000 t. Thus, both spawning biomass and total biomass are currently larger than that considered in the 2004 PSEIS. In addition, spawning biomass is substantially larger than $B_{35\%}$ for this stock. Qualitatively, then, the status of the resource has not changed since the 2004 PSEIS.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2011, a trawl sweep modification requirement was implemented for vessels participating in the Bering Sea flatfish fishery resulting in less impact of the fishery on the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor. Research has demonstrated that this gear modification reduces unobserved mortality of red king crab, Tanner crab, and snow crab.

4 Are there new methods of analysis or protocols for evaluating impacts?

Yes. For the purposes of the 2004 PSEIS, BSAI flathead sole was evaluated as a Tier 4 stock. Beginning in 2004, and in subsequent years, flathead sole was evaluated as a Tier 3 stock (e.g., Stockhausen and Nichol, 2012). As such, reliable estimates of $B_{35\%}$ (i.e., a proxy for B_{msy}) are now available that were not at the time of the 2004 PSEIS. However, similar conclusions would be reached with these (Tier 3) methods as were reached in the 2004 PSEIS.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No.

Citations

Stockhausen, W. and D. Nichol. 2012. Chapter 9: Assessment of the Flathead Sole Stock in the Bering Sea and Aleutian Islands. *In:* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Region. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, Alaska 99510. http://www.afsc.noaa.gov/REFM/Docs/2012/BSAIflathead.pdf

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/3/2013

What resource component is this review for? **BSAI Alaska plaice**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.10***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management of the Alaska plaice fishery changed significantly in 2008 with the implementation of Amendment 80 to the BSAI Fisheries Management Plan. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. In addition, Amendment 80 also mandated additional monitoring requirements which included observer coverage on all hauls, motion-compensating scales for weighing samples, flow scales to obtain accurate catch weight estimates for the entire catch, no mixing of hauls and no on-deck sorting. The partitioning of TAC and PSC (prohibited species catch) among cooperatives has significantly changed the way the annual catch has accumulated (slower and more evenly) and the rate of target catch per bycatch ton (less).

2 Has the status of the resource changed?

The status of the BSAI Alaska plaice stock is similar to the status during the 2004 PSEIS, well above the target reference points and within the range of variability of the estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2011, a trawl sweep modification requirement was implemented for vessels participating in the Bering Sea flatfish fishery resulting is less impact of the fishery on the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps, to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor. Research has demonstrated that this gear modification reduces unobserved mortality of red king crab, Tanner crab, and snow crab.

4 Are there new methods of analysis or protocols for evaluating impacts?

The stock assessment methods and protocols in the latest assessment do not differ substantially from those used in 2004. The annual trawl survey was extended into the northern Bering Sea in 2010 and indicated about 38% of the Bering Sea resource inhabit the northern waters which are currently unavailable to the fishery.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The current analysis uses modern methods to assess the Alaska plaice resource which is high in abundance and lightly harvested.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/3/2013

What resource component is this review for? **BSAI Other flatfish**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.10***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management of the Alaska plaice fishery changed significantly in 2008 with the implementation of Amendment 80 to the BSAI Fisheries Management Plan. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. In addition, Amendment 80 also mandated additional monitoring requirements which included observer coverage on all hauls, motion-compensating scales for weighing samples, flow scales to obtain accurate catch weight estimates for the entire catch, no mixing of hauls and no on-deck sorting. The partitioning of TAC and PSC (prohibited species catch) among cooperatives has significantly changed the way the annual catch has accumulated (slower and more evenly) and the rate of target catch per bycatch ton (less). Although the species of this complex are not directly targeted, the increased observer information should guard against the unintended consequences of managing a complex of species where disproportionate harvest can occur.

2 Has the status of the resource changed?

The status of the BSAI Other flatfish complex is similar to the status during the 2004 PSEIS, both in terms of biomass and catch levels.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2011, a trawl sweep modification requirement was implemented for vessels participating in the Bering Sea flatfish fishery resulting is less impact of the fishery on the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps, to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor. Research has demonstrated that this gear modification reduces unobserved mortality of red king crab, Tanner crab, and snow crab.

4 Are there new methods of analysis or protocols for evaluating impacts?

The stock assessment methods and protocols in the latest assessment do not differ substantially from those used in 2004. The present assessment using survey averaging of the past 7 years to calculate the ABC compared to using just the present year as was done in 2004.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The current analysis uses annual survey methods to assess the BSAI Other flatfish resource which is lightly harvested, primarily as bycatch in pursuit of other targeted species.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/10/2013

What resource component is this review for? **GOA arrowtooth flounder**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.8***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

GOA arrowtooth flounder were assessed and managed under Tier 3a in 2002 and continues to be managed with this methodology. The same model has been used since 2002. In 2006, the Gulf of Alaska arrowtooth flounder (*Atheresthes stomias)* stock was moved to a biennial stock assessment schedule to coincide with new survey data.

2 Has the status of the resource changed?

The status of the resource has been consistently increasing since 2002. The estimated total biomass of GOA arrowtooth flounder was estimated to be 1,816,000 mt at the beginning of 2002. Total biomass has been consistently increasing since that time and was estimated to be 2,055,560 mt at the beginning of 2013.

2 Is there new information regarding the impacts of the groundfish fisheries on the resource?

The Gulf of Alaska NMFS research survey takes place on a biennial basis; therefore, new survey information is available in even years. These surveys are expected to reflect the impact of groundfish fisheries on the resource. New fishery length data has been incorporated each year since 2002.

3 Are there new methods of analysis or protocols for evaluating impacts?

No significant new analyses have been implemented to assess the effect of the groundfish fishery on arrowtooth flounder.

4 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/13/13

What resource component is this review for? ____GOA northern and southern rock sole
What sections of the PSEIS were reviewed? ___4.9.1.6

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The GOA northern and southern rock sole stocks were moved from NPFMC Tier 4 to Tier 3 in 2012. This change should have no significant impact on the resource, as the stocks are still managed as part of the GOA shallow-water flatfish complex.

2 Has the status of the resource changed?

The status of the GOA northern and southern rock sole stocks is similar to the status of the GOA shallow-water flatfish complex during the 2004 PSEIS and within the range of variability of the estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There are length and age composition data from the GOA NMFS bottom trawl survey for northern and southern rock sole for all survey years, although the data before 1996 are for undifferentiated rock sole. In addition, the fisheries observer program was restructured in 2013. This change will result in differences in the fishery data collected, and the significance of these changes for the GOA northern and southern rock sole stocks will not be determined for several years.

4 Are there new methods of analysis or protocols for evaluating impacts?

The methodology is similar to the 2004 PSEIS.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The current analysis uses modern methods and the GOA northern and southern rock sole assessment model is relatively robust to the assumptions of the analysis.

Review of Conclusions in 2004 PSEIS

draft 6/11/2013

What resource component is this review for? **GOA flathead sole**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.7***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Amendment 75 to the GOA Groundfish FMP (implemented June, 2005) revised the FMP to require that TACs be set equal or less than ABC (FMP Appendices, 2012). Amendment 87 (implemented Nov., 2010) revised the FMP to require annual catch limits (ACLs) and the use of accountability measures to ensure that ACLs are not exceeded, in accordance with National Standard 1 guidelines.

2 Has the status of the resource changed?

Based on a Tier 3 analysis, total biomass of the GOA flathead sole stock at the beginning of 2012 was projected in 2011 to be ~325,000 t, while female spawning biomass was projected to be almost ~110,000 t. The latter is almost 3*x* $B_{35\%}$ (a proxy for B_{msy}) for this stock. Similar values were not available for the 2004 PSEIS, thus a determination of whether the stock was "overfished" could not be made. However, estimates of the trend ion survey biomass indicate that the population has increased since the 2004 PSEIS.

The catch taken in 2010 (3,842 t) was less than 10% of the ABC (47,422 t). While larger than the catch taken in 2002 (2,000 t; 2004 PSEIS, Section 4.9.1.7), the catch in 2010 was also well below the ABC, indicating that the stock continues to be only lightly exploited.

Qualitatively, then, it seems almost certain that the status of the resource has not changed since the 2004 PSEIS.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Yes. Estimates of total biomass and spawning biomass, as well as age and size composition, were not available for GOA flathead sole in the 2004 PSEIS. Estimates of these quantities are now available (Stockhausen et al., 2011).

4 Are there new methods of analysis or protocols for evaluating impacts?

Yes. For the purposes of the 2004 PSEIS, GOA flathead sole was evaluated as a Tier 4 stock. Beginning in 2003, and in subsequent years, GOA flathead sole has been evaluated as a Tier 3 stock (Stockhausen et al., 2011). As such, reliable estimates of $B_{35\%}$ (i.e., a proxy for B_{msy}) are now available that were not at the time of the 2004 PSEIS. However, GOA flathead sole is lightly exploited and similar conclusions would be reached with these (Tier 3) methods as were reached in the 2004 PSEIS.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No.

Citations

NPFMC. 2012. Fishery Management Plan for Groundfish of the Gulf of Alaska: Appendices. http://www.fakr.noaa.gov/npfmc/PDFdocuments/fmp/GOA/GOA_appdcs.pdf

Stockhausen, W. M.E. Wilkins and M.H. Martin. 2011. Chapter 8: Assessment of the Flathead Sole Stock in the Gulf of Alaska. *In:* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska Region. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, Alaska 99510. http://www.afsc.noaa.gov/REFM/docs/2011/GOAflathead.pdf

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/27/2013

What resource component is this review for? **GOA shallow water flatfish**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.8***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

GOA shallow-water flatfish are managed as a complex, however species ABC's are determined under different tiers. The majority of the biomass is northern and southern rock sole which have been moved to Tier 3 in 2012 with the development of an assessment model. Other species in the complex are managed under Tier 5.

2 Has the status of the resource changed?

Rock sole survey biomass increased to 2009, then decreased in 2011. Other flatfish in the complex have generally been increasing or show no trend since 2004.

2 Is there new information regarding the impacts of the groundfish fisheries on the resource?

The Gulf of Alaska NMFS research survey takes place on a biennial basis. These surveys are expected to reflect the impact of groundfish fisheries on the resource.

3 Are there new methods of analysis or protocols for evaluating impacts?

No significant new analyses have been implemented to assess the effect of the groundfish fishery on the GOA shallow-water complex.

4 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No.

Review of Conclusions in 2004 PSEIS

draft 6/11/2013

What resource component is this review for? **GOA deepwater flatfish**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.9***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Yes. Amendment 75 to the GOA Groundfish FMP (implemented June, 2005) revised the FMP to require that TACs be set equal or less than ABC (FMP Appendices, 2012). Amendment 87 (implemented Nov., 2010) revised the FMP to require annual catch limits (ACLs) and the use of accountability measures to ensure that ACLs are not exceeded, in accordance with National Standard 1 guidelines.

2 Has the status of the resource changed?

No. Although an age-structured assessment model now exists for GOA rex sole, this stock remains a Tier 5 species because a reliable estimate for $F_{35\%}$ does not exist--the fishery is selective only for mature fish and this renders an estimate of $F_{35\%}$ highly uncertain. Estimates of the trends in total and spawning biomass, as well as survey biomass from the GOA groundfish trawl survey, indicate that the population has increased since the 2004 PSEIS (Stockhausen et al., 2011). The catch taken in 2010 (3,636 t) was less than the ABC (9,729 t). While larger than the catch taken in 2002 (3,000 t; 2004 PSEIS, Section 4.9.1.10), the catch in 2010 was also well below the ABC, indicating that the stock continues to be only lightly exploited. Qualitatively, then, it seems almost certain that the status of the resource has not changed since the 2004 PSEIS.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Yes. Estimates of current total biomass and spawning biomass, as well as age and size composition, were not available for GOA rex sole in the 2004 PSEIS. Estimates of these quantities are now available (Stockhausen et al., 2011).

4 Are there new methods of analysis or protocols for evaluating impacts?

Yes. Subsequent to the 2004 PSEIS, an age-structured assessment model was developed for GOA rex sole. This model provides time series estimates of total and spawning stock biomass. Current year estimates of total and spawning stock biomass are both currently at high levels relative to estimates for 2004.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The GOA deepwater flatfish stock complex is lightly exploited and similar conclusions would be reached with the current methods as were reached in the 2004 PSEIS.

Citations

NPFMC. 2012. Fishery Management Plan for Groundfish of the Gulf of Alaska: Appendices. http://www.fakr.noaa.gov/npfmc/PDFdocuments/fmp/GOA/GOA_appdcs.pdf

Stockhausen, W. M.E. Wilkins and M.H. Martin. 2011. Chapter 6: Assessment of the Rex Sole Stock in the Gulf of Alaska. *In:* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska Region. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, Alaska 99510. http://www.afsc.noaa.gov/REFM/docs/2011/GOArex.pdf

Review of Conclusions in 2004 PSEIS

draft 6/11/2013

What resource component is this review for? **GOA rex sole**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.10***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Yes. Amendment 75 to the GOA Groundfish FMP (implemented June, 2005) revised the FMP to require that TACs be set equal or less than ABC (FMP Appendices, 2012). Amendment 87 (implemented Nov., 2010) revised the FMP to require annual catch limits (ACLs) and the use of accountability measures to ensure that ACLs are not exceeded, in accordance with National Standard 1 guidelines.

2 Has the status of the resource changed?

No. Although an age-structured assessment model now exists for GOA rex sole, this stock remains a Tier 5 species because a reliable estimate for $F_{35\%}$ does not exist--the fishery is selective only for mature fish and this renders an estimate of $F_{35\%}$ highly uncertain. Estimates of the trends in total and spawning biomass, as well as survey biomass from the GOA groundfish trawl survey, indicate that the population has increased since the 2004 PSEIS (Stockhausen et al., 2011). The catch taken in 2010 (3,636 t) was less than the ABC (9,729 t). While larger than the catch taken in 2002 (3,000 t; 2004 PSEIS, Section 4.9.1.10), the catch in 2010 was also well below the ABC, indicating that the stock continues to be only lightly exploited. Qualitatively, then, it seems almost certain that the status of the resource has not changed since the 2004 PSEIS.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Yes. Estimates of current total biomass and spawning biomass, as well as age and size composition, were not available for GOA rex sole in the 2004 PSEIS. Estimates of these quantities are now available (Stockhausen et al., 2011).

4 Are there new methods of analysis or protocols for evaluating impacts?

Yes. Subsequent to the 2004 PSEIS, an age-structured assessment model was developed for GOA rex sole. This model provides time series estimates of total and spawning stock biomass. Current year estimates of total and spawning stock biomass are both currently at high levels relative to estimates for 2004.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The GOA rex sole stock is lightly exploited and similar conclusions would be reached with the current methods as were reached in the 2004 PSEIS.

Citations

NPFMC. 2012. Fishery Management Plan for Groundfish of the Gulf of Alaska: Appendices. http://www.fakr.noaa.gov/npfmc/PDFdocuments/fmp/GOA/GOA_appdcs.pdf

Stockhausen, W. M.E. Wilkins and M.H. Martin. 2011. Chapter 6: Assessment of the Rex Sole Stock in the Gulf of Alaska. *In:* Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska Region. North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, Alaska 99510. http://www.afsc.noaa.gov/REFM/docs/2011/GOArex.pdf

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

Draft ~6/19/13

What resource component is this review for? **BSAI Pacific ocean perch (POP)**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.11***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management several BSAI trawl fisheries changed in 2008 with the implementation of Amendment 80 to the BSAI Fisheries Management Plan. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. The partitioning of TAC among cooperatives has allowed fishing for POP to occur more gradually throughout the year.

2 Has the status of the resource changed?

The estimated biomass of the BSAI Pacific ocean perch stock has approximately doubled since the 2004 stock assessment, due to high recent survey biomass estimates and evidence of relatively large recent year classes.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There is new scientific information indicating that the population structure for Pacific ocean perch may be at a smaller spatial scale (70 – 400 km; Palof et al. 2011) than the spatial scale for defining the stock or spatially allocating the ABC, which could potentially lead to reductions in yield and biomass if harvest was spatially disproportionate to biomass.

4 Are there new methods of analysis or protocols for evaluating impacts?

In 2010, a Plan Team –SSC stock structure committee developed a template for evaluating the types of information to be considered when defining the spatial bounds of "stocks" (Spencer et al 2010). Part of this template consists of evaluating spatial harvest patterns and whether disproportionate spatial harvesting patterns, if they exist, pose concerns regarding the impact of the fishery within management subareas.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

The stock structure template has not been applied to BSAI POP, in part because the ABC for this stock has a higher degree of spatial partitioning than other BSAI rockfish stocks, which have thus received higher priority for application of the template. Given the sharp rise in biomass in recent years (which has occurred across all spatial subareas), it appears unlikely that conclusions from 2004 PSEIS would be affected from the new information. A full analysis of the impact of disproportionate harvest on yield and biomass for stock stocks which exhibit spatial structure would require population models that accounted for connectivity of populations of fish between subareas, and would be more complex than the models used for the 2004 PSEIS. However, work has begun on developing these types of models to simulate the types of impacts of disproportionate harvesting upon yield and stock size (I. Spies, AFSC, in prep).

References

Palof, K.J., J. Heifetz, and A.J. Gharrett. 2011. Geographic structure in Alaskan Pacific ocean perch (*Sebastes alutus*) indicates limited lifetime dispersal. Mar. Biol. 158:779-792.

Spencer, P., M. Canino, J. DiCosimo, M. Dorn, A.J. Gharrett, D. Hanselman, K. Palof, and M. Sigler. 2010. Guidelines for determination of spatial management units for exploited populations in Alaskan fishery groundfish management plans. Paper prepared for the September 2010 NPFMC Plan Team meeting.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

Draft ~6/19/13

What resource component is this review for? **BSAI Northern rockfish**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.13***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management several BSAI trawl fisheries changed in 2008 with the implementation of Amendment 80 to the BSAI Fisheries Management Plan. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. BSAI northern rockfish are harvested largely as bycatch in the Atka mackerel fishery, which has been affected by Amendment 80. In 2010, the western Aleutian Islands subarea was closed for harvesting Atka mackerel, which has substantially reduced northern rockfish harvest in this area.

2 Has the status of the resource changed?

Northern rockfish were classified in Tier 5 when analysis for the 2004 PSEIS occurred, so status relative to stock size reference points were not available at that time. Beginning in 2004, northern rockfish have been classified in Tier 3 and an age-structure model has been used for their assessment. The estimated stock size has been relatively flat since 2000, with the stock size exceeding $B_{40\%}$ and the fishing mortality rates less than $F_{40\%}$.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There is new scientific information indicating that the population structure for BSAI northern rockfish may be at a smaller spatial scale (100 – 200 km; Gharrett et al. 2012) than the spatial scale for defining the stock or spatially allocating the ABC, which could potentially lead to reductions in yield and biomass if harvest was spatially disproportionate to biomass.

4 Are there new methods of analysis or protocols for evaluating impacts?

In 2010, a Plan Team –SSC stock structure committee developed a template for evaluating the types of information to be considered when defining the spatial bounds of "stocks" (Spencer et al. 2010). Part of this template consists of evaluating spatial harvest patterns and whether disproportionate spatial harvesting patterns, if they exist, pose concerns regarding the impact of the fishery within management subareas. This template was applied to BSAI northern rockfish in 2012, and indicated that disproportionate harvesting has occurred in some years in the central and eastern Aleutian Islands (Appendix A in Spencer and Ianelli 2012).

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

The 2004 PSEIS evaluated the impact of spatial concentration of the catch with respect to, in part, reductions in “genetic diversity”. Given that reductions in genetic diversity would be expected to occur at very low stock sizes, it is not clear that the conclusions from the 2004 PSEIS using this criterion would be affected from new information on stock structure. However, in developing the stock structure template, Spencer et al. (2010) focused on the potential loss of biomass and yield that may occur from harvests that are spatially disproportionate for biomass for stocks that exhibit spatial structure. Under this criterion, it would be expected that consistent disproportionate spatial harvesting would be expected to result in reductions of biomass and yield in subareas with high exploitation rates. A full analysis of these impacts would require population models that accounted for connectivity of populations of fish between subareas, and would be more complex than the models used for the 2004 PSEIS. However, work has begun on developing these types of models to simulate the types of impacts of disproportionate harvesting upon yield and stock size (I. Spies, AFSC, in prep).

In 2013, a workshop was held to discuss how information on stock structure could be used to inform management decisions, with consideration to a variety of risks to the underlying stock and the resource users. The report from this workshop will hopefully provide some guidance for how to evaluate our management policy for stocks like BSAI northern rockfish, which exhibit stock structure at spatial scales smaller than our current management units, and have occasionally shown disproportionate harvesting patterns.

References

Gharrett, A.J., R.J. Riley, and P.D. Spencer. 2012. Genetic analysis reveals restricted dispersal of northern rockfish along the continental margin of the Bering Sea and Aleutian Islands. Trans. Am. Fish. Soc. 141:370-382.

Spencer, P.D., and J.N. Ianelli. 2012. Assessment of the northern rockfish stock in the eastern Bering Sea and Aleutian Islands. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions, pp. 1349-1422. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501.

Spencer, P., M. Canino, J. DiCosimo, M. Dorn, A.J. Gharrett, D. Hanselman, K. Palof, and M. Sigler. 2010. Guidelines for determination of spatial management units for exploited populations in Alaskan fishery groundfish management plans. Paper prepared for the September 2010 NPFMC Plan Team meeting.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

Draft ~6/19/13

What resource component is this review for? **BSAI Shortraker rockfish**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.13***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Shortraker rockfish are harvested as bycatch in other target fisheries, primarily the BSAI POP fishery. The management of the BSAI POP, and several other BSAI trawl fisheries, changed in 2008 with the implementation of Amendment 80 to the BSAI Fisheries Management Plan. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. These management changes have affected the seasonal distribution of harvest, with relatively more harvest occurring in the fall than in previous years.

Additionally, BSAI shortraker rockfish were managed as part of the BSAI rougheye/shortraker species complex when the 2004 PSEIS was completed, and are now managed within their own single-species management category.

2 Has the status of the resource changed?

Shortraker rockfish are managed under Tier 5, and the 2004 PSEIS states that reliable estimates of total and spawning biomass are not available. However, estimates of biomass are obtained from the Tier 5 stock assessments, and are based on smoothing survey biomass estimates. The estimated biomass for 2012 (17,000 t) is a slight decrease from the estimate for 2004 (20,000 t).

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There is no new information regarding the impacts of the groundfish fisheries on BSAI shortraker rockfish.

4 Are there new methods of analysis or protocols for evaluating impacts?

In 2010, a Plan Team –SSC stock structure committee developed a template for evaluating the types of information to be considered when defining the spatial bounds of “stocks” (Spencer et al 2010). Part of this template consists of evaluating spatial harvest patterns and whether disproportionate spatial harvesting patterns, if they exist, pose concerns regarding the impact of the fishery within management subareas. This template is scheduled to be applied to BSAI shortraker rockfish in 2013.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

The 2004 PSEIS evaluated the impact of spatial concentration of the catch with respect to, in part, reductions in “genetic diversity”. Given that reductions in genetic diversity would be expected to occur at very low stock sizes, it is not clear that the conclusions from the 2004 PSEIS using this criterion would be affected from new information on stock structure. However, in developing the stock structure template, Spencer et al. (2010) focused on the potential loss of biomass and yield that may occur from harvests that are spatially disproportionate for biomass for stocks that exhibit spatial structure. Under this criterion, it would be expected that consistent disproportionate spatial harvesting for stocks with spatial structure would be expected to result in reductions of biomass and yield. Limited genetic samples currently exist for BSAI shortraker rockfish.

In 2013, a workshop was held to discuss how information on stock structure could be used to inform management decisions, with consideration to a variety of risks to the underlying stock and the resource users. The report from this workshop will hopefully provide some guidance for how to evaluate our management policy for BSAI rockfish.

References

Spencer, P., M. Canino, J. DiCosimo, M. Dorn, A.J. Gharrett, D. Hanselman, K. Palof, and M. Sigler. 2010. Guidelines for determination of spatial management units for exploited populations in Alaskan fishery groundfish management plans. Paper prepared for the September 2010 NPFMC Plan Team meeting.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

Draft ~6/19/13

What resource component is this review for? **BSAI Blackspotted/rougheye rockfish**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.13***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Blackspotted/rougheye rockfish are harvested as bycatch in other target fisheries, primarily the BSAI POP fishery. The management of the BSAI POP, and several other BSAI trawl fisheries, changed in 2008 with the implementation of Amendment 80 to the BSAI Fisheries Management Plan. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. These management changes have affected the seasonal distribution of harvest, with relatively more harvest occurring in the fall than in previous years. However, in 2010 the western Aleutian Islands was closed for harvesting Atka mackerel, and many of the vessels that target Atka mackerel also target POP. This has resulted in harvesting of western Aleutian Islands POP, and thus the bycatch of blackspotted/rougheye, primarily during the summer in recent years in this subarea.

Additionally, BSAI blackspotted/rougheye rockfish were managed as part of the BSAI rougheye/shortraker species complex when the 2004 PSEIS was completed, and are now managed within their own management category. Fish formerly referred to as rougheye rockfish were found to comprise two species, with the new species blackspotted rockfish being identified. Finally, in 2010 the BSAI ABC for blackspotted/rougheye was partitioned between a Western and Central AI ABC, and an Eastern AI and EBS ABC.

2 Has the status of the resource changed?

Blackspotted/rougheye rockfish were classified in Tier 5 when analysis for the 2004 PSEIS occurred, so status relative to stock size reference points were not available at that time. Beginning in 2009, blackspotted/rougheye rockfish have been classified in Tier 3 and an age-structure model has been used for their assessment. The estimated BSAI stock size has increased since 2000, based largely upon the age and size composition data indicating relatively strong recent year classes.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There is new scientific information indicating that the population structure for BSAI blackspotted rockfish may be at a smaller spatial scale (< 500 km; Appendix A in Spencer and Rooper 2010) than the spatial scale of the BSAI area, and this information led to the partitioning the ABC within the BSAI. Subsequent analyses (Appendix A in Spencer and Rooper 2012) have revealed disproportionate harvesting and a consistent pattern of high exploitation rates in the western Aleutian Islands that exceed those corresponding to the $F_{40\%}$ reference points. Since 2004, approximately 43% of the Aleutian Islands blackspotted/rougheye harvest has occurred in the western Aleutian Islands, an area with approximately 8% of the AI survey biomass. A decline in the western AI survey biomass has occurred since the early 1990s; each of the biomass estimates from 2000 – 2010 (averaging 1,059 t) is below each of the biomass estimates from 1991-1997 (averaging 3,156 t), and the 2012 survey estimate has declined to 335 t, the lowest value on record for this subarea.

4 Are there new methods of analysis or protocols for evaluating impacts?

In 2010, a Plan Team –SSC stock structure committee developed a template for evaluating the types of information to be considered when defining the spatial bounds of “stocks” (Spencer et al. 2010). This template was applied to BSAI blackspotted/rougheye rockfish in 2010, and documents existing genetic information that indicates that the spatial structure is estimated to not exceed ~ 500 km. Additional analyses (Appendix A in Spencer and Rooper 2012) have generated area-specific exploitation rates, and reference exploitation rates that correspond harvesting at $F_{40\%}$.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

The 2004 PSEIS evaluated the impact of spatial concentration of the catch with respect to, in part, reductions in “genetic diversity”. Given that reductions in genetic diversity would be expected to occur at very low stock sizes, it is not clear that the conclusions from the 2004 PSEIS using this criterion would be affected from new information on stock structure. However, in developing the stock structure template, Spencer et al. (2010) focused on the potential loss of biomass and yield that may occur from harvests that are spatially disproportionate to biomass for stocks that exhibit spatial structure. Under this criterion, it would be expected that consistent disproportionate spatial harvesting would be expected to result in reductions of biomass and yield in subareas with high exploitation rates. A full analysis of these impacts would require population models that accounted for connectivity of populations of fish between subareas, and would be more complex than the models used for the 2004 PSEIS. However, work has begun on developing these types of models to simulate the types of impacts of disproportionate harvesting upon yield and stock size (I. Spies, AFSC, in prep).

In 2013, a workshop was held to discuss how information on stock structure could be used to inform management decisions, with consideration to a variety of risks to the underlying stock and the resource users. The report from this workshop will hopefully provide guidance for how to evaluate our management policy for stocks like BSAI blackspotted/rougheye rockfish, which exhibit: 1) stock structure at spatial scales smaller than our current management units; 2) disproportionate harvesting patterns and high subarea exploitation rates; and 3) declines in subarea population abundance.

References

Spencer, P.D., and C.N. Rooper. 2012. Assessment of the blackspotted and rougheye rockfish complex in the eastern Bering Sea and Aleutian Islands. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions, pp. 1423-1496. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501

Spencer, P.D., and C.N. Rooper. 2010. Assessment of the blackspotted and rougheye rockfish complex in the eastern Bering Sea and Aleutian Islands. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands region as projected for 2011, pp.

1127-1194. North Pacific Fishery Management Council, 605 W. 4th Ave, suite 306. Anchorage, AK 99501

Spencer, P., M. Canino, J. DiCosimo, M. Dorn, A.J. Gharrett, D. Hanselman, K. Palof, and M. Sigler. 2010. Guidelines for determination of spatial management units for exploited populations in Alaskan fishery groundfish management plans. Paper prepared for the September 2010 NPFMC Plan Team meeting.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

Draft ~6/19/13

What resource component is this review for? **BSAI other rockfish**
What sections of the PSEIS were reviewed**?** ***Section 4.9.1.13***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Since the 2004 PSEIS, there has not been substantial management changes that has affected BSAI Other Rockfish.

2 Has the status of the resource changed?

BSAI Other Rockfish are managed under Tier 5, and the 2004 PSEIS states that reliable estimates of total and spawning biomass are not available. However, estimates of biomass are obtained from the Tier 5 stock assessments, and are based on smoothing survey biomass estimates. The AI survey biomass estimate for Other Rockfish in 2012 is similar to estimates in the early 2000s, whereas the estimates from the EBS slope survey have increased from 17,000 t in 2002 to 30,000 t in 2012.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There is no new information regarding the impacts of the groundfish fisheries on BSAI Other Rockfish.

4 Are there new methods of analysis or protocols for evaluating impacts?

There are no new methods for evaluating fishery impacts upon BSAI Other Rockfish.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

Given the criteria used for the 2004 PSEIS and the absence of new information for BSAI Other Rockfish, it is unlikely that a reanalysis would yield a seriously different conclusion regarding the impact to the stock.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/13/13

What resource component is this review for? ____Gulf of Alaska Pacific ocean perch
What sections of the PSEIS were reviewed? ___4.9.1.11

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

In November, 2006, NMFS issued a final rule to implement Amendment 68 of the GOA groundfish Fishery Management Plan for 2007 through 2011. This action implemented the Central GOA Rockfish Pilot Program (RPP). The intention of this program is to enhance resource conservation and improve economic efficiency for harvesters and processors in the rockfish fishery. This should spread out the fishery in time and space, allowing for better prices for product and reducing the pressure of what was an approximately two week fishery in July. In a comparison of catches in the four years before the RPP to the four years after, it appears some effort has shifted to area 620 (Chirikof) from area 630 (Kodiak).

In 2012 this was implemented permanently as the Rockfish Program. The Rockfish Program assigns quota shares for primary rockfish species and secondary target species. Primary rockfish species are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish (now dusky rockfish). Secondary target species are Pacific cod, rougheye/blackspotted rockfish, shortraker rockfish, sablefish, and thornyhead rockfish. Each year the quota shares are assigned to a rockfish cooperative. Each rockfish cooperative receives an annual cooperative fishing quota, which is an amount of primary and secondary rockfish species the cooperative is able to harvest in that fishing year. Halibut Prohibited Species Catch is also allocated to participants based on historic halibut mortality rates in the primary rockfish species fisheries. Shore-based processors receiving rockfish quota share must be located within the boundaries of the City of Kodiak. The rockfish cooperative fishing season is authorized May 1 through November 15 of each year, whereas in the past, a very short season in July was prosecuted.

2 Has the status of the resource changed?

The status of the GOA Pacific ocean perch stock is similar to the status during the 2004 PSEIS and within the range of variability of the estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Use of pelagic trawl gear has increased gradually over time and is now 31% of effort for POP in the Gulf of Alaska (GOA POP SAFE, Hanselman et al. 2011). This should reduce any potential effects of the POP fishery on habitat suitability for GOA POP. Several genetic analyses of POP stock structure have suggested that POP are at risk of localized depletion because of very low estimated lifetime movement potential. However, an analysis of localized depletion using fishery catch-per-unit effort data showed that large areas filled back in with similar amounts of fish in subsequent years. The rockfish fishery, which is the main source of mortality for GOA POP, is prosecuted over a longer period of time.

4 Are there new methods of analysis or protocols for evaluating impacts?

The stock assessment and projection models are similar to those used in the PSEIS.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The previous analysis in the 2004 PSEIS was based on the standard projection model which is still used, and the stock assessment that the projection was based on is similar to the one used now.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/13/13

What resource component is this review for? ____Gulf of Alaska northern rockfish
What sections of the PSEIS were reviewed? ___4.9.1.13

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

In November, 2006, NMFS issued a final rule to implement Amendment 68 of the GOA groundfish Fishery Management Plan for 2007 through 2011. This action implemented the Central GOA Rockfish Pilot Program (RPP). The intention of this program is to enhance resource conservation and improve economic efficiency for harvesters and processors in the rockfish fishery. This should spread out the fishery in time and space, allowing for better prices for product and reducing the pressure of what was an approximately two week fishery in July. In a comparison of catches in the four years before the RPP to the four years after, it appears that average catches have increased overall (although, this may be due to increased observer coverage) and have spread out spatially in the western and central Gulf.

In 2012 this was implemented permanently as the Rockfish Program. The Rockfish Program assigns quota shares for primary rockfish species and secondary target species. Primary rockfish species are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish (now dusky rockfish). Secondary target species are Pacific cod, rougheye/blackspotted rockfish, shortraker rockfish, sablefish, and thornyhead rockfish. Each year the quota shares are assigned to a rockfish cooperative. Each rockfish cooperative receives an annual cooperative fishing quota, which is an amount of primary and secondary rockfish species the cooperative is able to harvest in that fishing year. Halibut Prohibited Species Catch is also allocated to participants based on historic halibut mortality rates in the primary rockfish species fisheries. Shore-based processors receiving rockfish quota share must be located within the boundaries of the City of Kodiak. The rockfish cooperative fishing season is authorized May 1 through November 15 of each year, whereas in the past, a very short season in July was prosecuted.

2 Has the status of the resource changed?

The status of the GOA northern rockfish stock is similar to the status during the 2004 PSEIS and within the range of variability of the estimates at that time.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Use of pelagic trawl gear has increased gradually over time in the Gulf of Alaska (GOA Northern rockfish SAFE, Huslon et al. 2011). This should reduce the chance for any effects on habitat suitability from the GOA northern rockfish fishery.

4 Are there new methods of analysis or protocols for evaluating impacts?

The methodology is similar to the 2004 PSEIS.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The current analysis uses modern methods and the Gulf of Alaska northern rockfish assessment model indicates that the conclusions of the 2004 PSEIS are still valid.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/13/13

What resource component is this review for? ____Gulf of Alaska shortraker rockfish
What sections of the PSEIS were reviewed? ___4.9.1.13

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

In November, 2006, NMFS issued a final rule to implement Amendment 68 of the GOA groundfish Fishery Management Plan for 2007 through 2011. This action implemented the Central GOA Rockfish Pilot Program (RPP). The intention of this program is to enhance resource conservation and improve economic efficiency for harvesters and processors in the rockfish fishery. This should spread out the fishery in time and space, allowing for better prices for product and reducing the pressure of what was an approximately two week fishery in July.

In 2012 this was implemented permanently as the Rockfish Program. The Rockfish Program assigns quota shares for primary rockfish species and secondary target species. Primary rockfish species are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish (now dusky rockfish). Secondary target species are Pacific cod, rougheye/blackspotted rockfish, shortraker rockfish, sablefish, and thornyhead rockfish. Each year the quota shares are assigned to a rockfish cooperative. Each rockfish cooperative receives an annual cooperative fishing quota, which is an amount of primary and secondary rockfish species the cooperative is able to harvest in that fishing year. Halibut Prohibited Species Catch is also allocated to participants based on historic halibut mortality rates in the primary rockfish species fisheries. Shore-based processors receiving rockfish quota share must be located within the boundaries of the City of Kodiak. The rockfish cooperative fishing season is authorized May 1 through November 15 of each year, whereas in the past, a very short season in July was prosecuted.

Starting in 2005, Gulf of Alaska shortraker rockfish was separated from the shortraker and rougheye rockfish complex. Shortraker is a stand-alone Tier 5 assessment because of its relatively high value, but is not able to be elevated to a higher tier, primarily because of uncertainty in the validity of age readings. There is no target fishery for shortraker rockfish, but they are retained in the Rockfish program and by longliners fishing sablefish.

2 Has the status of the resource changed?

Because the shortraker rockfish stock is in Tier 5, its stock status cannot be determined. As in the 2004 PSEIS, overfishing is not occurring for the GOA shortraker rockfish stock.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Yes, the stock is now managed separately so catch is better accounted for and impact of the fishery can be is monitored more closely.

4 Are there new methods of analysis or protocols for evaluating impacts?

There has been additional work on determining age compositions of shortraker rockfish and there is also potential to attempt length-based methods to be able to better assess stock status.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. Since the fishery is not opened as a target fishery, it is unlikely that a conservation concern has developed since the 2004 PSEIS.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6-13-13

What resource component is this review for? ____Gulf of Alaska rougheye/blackspotted rockfish
What sections of the PSEIS were reviewed? ___4.9.1.13

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

In November, 2006, NMFS issued a final rule to implement Amendment 68 of the GOA groundfish Fishery Management Plan for 2007 through 2011. This action implemented the Central GOA Rockfish Pilot Program (RPP). The intention of this program is to enhance resource conservation and improve economic efficiency for harvesters and processors in the rockfish fishery. This should spread out the fishery in time and space, allowing for better prices for product and reducing the pressure of what was an approximately two week fishery in July.

In 2012 this was implemented permanently as the Rockfish Program. The Rockfish Program assigns quota shares for primary rockfish species and secondary target species. Primary rockfish species are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish (now dusky rockfish). Secondary target species are Pacific cod, rougheye/blackspotted rockfish, shortraker rockfish, sablefish, and thornyhead rockfish. Each year the quota shares are assigned to a rockfish cooperative. Each rockfish cooperative receives an annual cooperative fishing quota, which is an amount of primary and secondary rockfish species the cooperative is able to harvest in that fishing year. Halibut Prohibited Species Catch is also allocated to participants based on historic halibut mortality rates in the primary rockfish species fisheries. Shore-based processors receiving rockfish quota share must be located within the boundaries of the City of Kodiak. The rockfish cooperative fishing season is authorized May 1 through November 15 of each year, whereas in the past, a very short season in July was prosecuted.

Starting in 2004, shortraker and rougheye rockfish were divided into separate subgroups and assigned individual ABCs and TACs. In 2005, rougheye was moved to Tier 3 status as an age structured model was accepted for determining ABC and OFL. It can now be identified that overfishing is not occurring for this stock, and that the stock is not overfished. In 2008, the rougheye rockfish was formally identified as a complex of two sibling species called rougheye (*Sebastes aleutianus*) and blackspotted (*S. melanostictus*) rockfish. They continue to be assessed as a Tier 3 stock complex.

2 Has the status of the resource changed?

Because the rougheye and blackspotted complex is in Tier 3, it can now be identified that overfishing is not occurring, and the stock is not overfished. This status would have been unknown during the 2004 PSEIS.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Yes, the complex is now managed separately from shortraker rockfish so catch is better accounted for and impact of the fishery can be monitored more closely.

4 Are there new methods of analysis or protocols for evaluating impacts?

The 2004 PSEIS used a projection model for Tier 3 stocks. The rougheye/blackspotted assessment is now an age-structured stand-alone assessment in Tier 3, so impacts of the fishery on the resource can be better monitored and the 2004 projection analysis could be repeated including the RE/BS complex.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

Yes. The change in biomass category could be changed from “unknown” to “insignificant” for both direct/indirect and cumulative effects.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/13/13

What resource component is this review for? ____Gulf of Alaska dusky rockfish
What sections of the PSEIS were reviewed? ___4.9.1.13

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

In November, 2006, NMFS issued a final rule to implement Amendment 68 of the GOA groundfish Fishery Management Plan for 2007 through 2011. This action implemented the Central GOA Rockfish Pilot Program (RPP). The intention of this program is to enhance resource conservation and improve economic efficiency for harvesters and processors in the rockfish fishery. This should spread out the fishery in time and space, allowing for better prices for product and reducing the pressure of what was an approximately two week fishery in July. In a comparison of catches in the four years before the RPP to the four years after, it appears that average catches have increased overall (although, this may be due to increased observer coverage) and have spread out spatially in the western and central Gulf.

In 2012 this was implemented permanently as the Rockfish Program. The Rockfish Program assigns quota shares for primary rockfish species and secondary target species. Primary rockfish species are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish (now dusky rockfish). Secondary target species are Pacific cod, rougheye/blackspotted rockfish, shortraker rockfish, sablefish, and thornyhead rockfish. Each year the quota shares are assigned to a rockfish cooperative. Each rockfish cooperative receives an annual cooperative fishing quota, which is an amount of primary and secondary rockfish species the cooperative is able to harvest in that fishing year. Halibut Prohibited Species Catch is also allocated to participants based on historic halibut mortality rates in the primary rockfish species fisheries. Shore-based processors receiving rockfish quota share must be located within the boundaries of the City of Kodiak. The rockfish cooperative fishing season is authorized May 1 through November 15 of each year, whereas in the past, a very short season in July was prosecuted.

For 2012, widow and yellowtail rockfish were removed from the pelagic shelf rockfish complex effectively leaving dusky rockfish as a stand-alone Tier 3 species. Widow and yellowtail rockfish were moved to a new “Other rockfish” category with the old “Slope rockfish” category species.
Because dusky rockfish is in Tier 3, it can now be identified that overfishing is not occurring, and the stock is not overfished.

2 Has the status of the resource changed?

Because dusky rockfish is in Tier 3, it can now be identified that overfishing is not occurring, and the stock is not overfished. This status would have been unknown during the 2004 PSEIS.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Bycatch estimates decreased for the majority of species in the Central GOA following the implementation of the Rockfish Pilot Program. Use of pelagic trawl gear has increased gradually over time in the Gulf of Alaska (GOA dusky rockfish SAFE, Lunsford et al. 2011). This should reduce the chance for any effects on habitat suitability from the GOA dusky fishery.

4 Are there new methods of analysis or protocols for evaluating impacts?

The 2004 PSEIS used a projection model for Tier 3 stocks. The dusky rockfish assessment is now an age-structured stand-alone assessment in Tier 3, so impacts of the fishery on the resource can be better monitored and the 2004 projection analysis could be repeated including the GOA dusky rockfish stock.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

Yes. The change in biomass category could be changed from “unknown” to “insignificant” for both direct/indirect and cumulative effects.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 3/13/14

What resource component is this review for? Demersal Shelf Rockfish
What sections of the PSEIS were reviewed? 4.9.1.13

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

In 1998 the NPFMC passed an amendment to require full retention of DSR in federal waters. Seven years later, in mid-season 2005, the final rule was published and fishermen must now retain and report all DSR caught in federal waters; any poundage above the 10% bycatch allowance may be donated or kept for personal use but may not enter commerce. The requirement for full retention of rockfish in both federal and state waters allows for better accounting of total mortality.

In 2006 the Alaska Board of Fisheries implemented a regulation to allocate the DSR Total Allowable Catch (TAC) as follows: 16% to the recreational fishery, and 84% to the commercial fisheries.

In 2009, the Alaska Board of Fisheries implemented a regulation that required the estimated harvest of DSR subsistence catch to be deducted from the acceptable biological catch (ABC) of DSR prior to allocation of the TAC.

2 Has the status of the resource changed?

As in 2004, DSR remains in Tier 4, thus stock status cannot be determined. As in the 2004 PSEIS, overfishing is not occurring for the DSR. However, survey estimates have indicated a decline in population biomass despite the continued use of a harvest rate lower than the maximum allowed under Tier 4. Under Tier 4 definitions for setting ABC, $F_{40\%}=0.026$ would be used, but we continue to use a more conservative approach (F=M=0.02).

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

A large proportion of the DSR total mortality is from bycatch in the IFQ halibut fishery. Decreasing halibut quotas in area 3A and 2C have reduced the DSR bycatch in these fisheries as well. New information from the expanded observer program may shed light on whether the full retention rockfish regulation is being complied with.

4 Are there new methods of analysis or protocols for evaluating impacts?

Historically, and at the time of the 2004 PSEIS , the R/V *Delta*, a manned submersible, was used to assess DSR during line transect surveys. Since 2012, the submersible has been replaced with a Remote Operated Vehicle (ROV) since the *Delta* is no longer available for charter. We are using the same survey techniques and survey design with the new vehicle, however we will be including both the submersible and ROV data survey estimates, total catch, and biological data into an age structured assessment (ASA) model is for the 2014 assessment cycle. If this ASA model is accepted it is likely the DSR complex would be moved to Tier 3 and impacts of the fishery on the resource can be better assessed. The ROV is outfitted with a pair of stereo cameras, which allows us to record fish length from the survey, which was previously unavailable.

Also, additional habitat mapping has been conducted since 2004 which allows us to better refine our rockfish habitat estimation.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

The current analyses indicates that the conclusions of the 2004 PSEIS are still valid, however if DSR are moved to a different Tier status after review of the ASA model in 2014, then it is possible that the Category “change in biomass level” could change from unknown to a different rating.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/13/13

What resource component is this review for? ____Gulf of Alaska thornyhead rockfish complex
What sections of the PSEIS were reviewed? ___4.9.1.12

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

In November, 2006, NMFS issued a final rule to implement Amendment 68 of the GOA groundfish Fishery Management Plan for 2007 through 2011. This action implemented the Central GOA Rockfish Pilot Program (RPP). The intention of this program is to enhance resource conservation and improve economic efficiency for harvesters and processors in the rockfish fishery. This should spread out the fishery in time and space, allowing for better prices for product and reducing the pressure of what was an approximately two week fishery in July. In 2012 this was implemented permanently as the Rockfish Program. The Rockfish Program assigns quota shares for primary rockfish species and secondary target species. Primary rockfish species are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish (now dusky rockfish). Secondary target species are Pacific cod, rougheye/blackspotted rockfish, shortraker rockfish, sablefish, and thornyhead rockfish. Each year the quota shares are assigned to a rockfish cooperative. Each rockfish cooperative receives an annual cooperative fishing quota, which is an amount of primary and secondary rockfish species the cooperative is able to harvest in that fishing year. Halibut Prohibited Species Catch is also allocated to participants based on historic halibut mortality rates in the primary rockfish species fisheries. Shore-based processors receiving rockfish quota share must be located within the boundaries of the City of Kodiak. The rockfish cooperative fishing season is authorized May 1 through November 15 of each year, whereas in the past, a very short season in July was prosecuted.

Starting in 2004, Gulf of Alaska thornyhead rockfish complex was downgraded from Tier 3 to Tier 5, primarily because of uncertainty in the validity of age readings for shortstpine thornyhead . There is no target fishery opened for thornyhead rockfish, but they are retained in the Rockfish program and by longliners targeting sablefish.

2 Has the status of the resource changed?

Because the thornyhead complex is now in Tier 5, it can no longer be identified whether the stock is overfished. For 2004 PSEIS, the thornyhead complex was identified as not overfished.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

No.

4 Are there new methods of analysis or protocols for evaluating impacts?

There has been additional tag recovery data collected and there is potential to attempt length-based methods to be able to better assess stock status.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

Yes. Since the fishery is now a tier 5 stock the conclusions reached for the categories **change in biomass**, **spatial/temporal concentration of catch-change in genetic structure**, **spatial/temporal concentration of catch-change in reproductive success, change in prey availability, and change in habitat** would be moved from a finding of “Insignificant” to a finding of “Unknown”. However, it is unlikely that a conservation concern has developed since the 2004 PSEIS.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/13/13

What resource component is this review for? ____Gulf of Alaska other rockfish
What sections of the PSEIS were reviewed? ___4.9.1.13

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

In November, 2006, NMFS issued a final rule to implement Amendment 68 of the GOA groundfish Fishery Management Plan for 2007 through 2011. This action implemented the Central GOA Rockfish Pilot Program (RPP). The intention of this program is to enhance resource conservation and improve economic efficiency for harvesters and processors in the rockfish fishery. This should spread out the fishery in time and space, allowing for better prices for product and reducing the pressure of what was an approximately two week fishery in July.

In 2012 this was implemented permanently as the Rockfish Program. The Rockfish Program assigns quota shares for primary rockfish species and secondary target species. Primary rockfish species are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish (now dusky rockfish). Secondary target species are Pacific cod, rougheye/blackspotted rockfish, shortraker rockfish, sablefish, and thornyhead rockfish. Each year the quota shares are assigned to a rockfish cooperative. Each rockfish cooperative receives an annual cooperative fishing quota, which is an amount of primary and secondary rockfish species the cooperative is able to harvest in that fishing year. Halibut Prohibited Species Catch is also allocated to participants based on historic halibut mortality rates in the primary rockfish species fisheries. Shore-based processors receiving rockfish quota share must be located within the boundaries of the City of Kodiak. The rockfish cooperative fishing season is authorized May 1 through November 15 of each year, whereas in the past, a very short season in July was prosecuted.

Starting in 2012, Gulf of Alaska “Slope rockfish” and the remainder of the “Pelagic shelf rockfish” complex after removing dusky rockfish were reorganized under a new management group called “Other Rockfish”. This group is a catch-all for the remainder of Gulf of Alaska rockfish that are in Tiers 4 and 5. There is a range of life history variants in this complex, and the complex composition changes over geographic clines.

2 Has the status of the resource changed?

Because the other rockfish complex has stocks is in Tiers 4 and 5, its stock status cannot be determined. As in the 2004 PSEIS of “Slope rockfish”, overfishing is not occurring for the GOA other rockfish stock complex.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Improvements in the observer program and catch accounting have yielded better estimates of minor rockfish species catches.

4 Are there new methods of analysis or protocols for evaluating impacts?

Data for most "other rockfish" species is sparse and survey biomass estimates are too imprecise to further develop new more detailed assessments.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. Since the fishery is not opened as a target fishery, it is unlikely that a conservation concern has developed since the 2004 PSEIS.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

~6/19/2013

What resource component is this review for? __**GOA & BSAI squids**________________
What sections of the PSEIS were reviewed? _______**4.9.3**____________

1 Has management of the resource changed?

Management of squids in the BSAI has not changed since 2004; they continue to be managed as a separate stock. In the GOA, squids are now also managed as a separate stock as a result of NPFMC Amendment 87 (http://www.fakr.noaa.gov/sustainablefisheries/amds/95-96-87/amd87.pdf). In both the BSAI and GOA, squids are managed under Tier 6. The OFL in the BSAI is the average catch from 1978-1995; the OFL in the GOA is the maximum catch during 1997-2007.

2 Has the status of the resource changed?

As described in the 2004 PSEIS (section 3.5.3.1), very little information is available regarding the status of squid populations. Catches of squids have been relatively low since 2013 in both areas, but this likely reflects fishery behavior rather than changes in abundance.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Beginning in 2009, the fishery observer program records lengths of squids caught incidentally in groundfish fisheries. This has allowed a better understanding of which species/ life stages are most likely to be caught incidentally. Otherwise, the assessment of impacts in the PSEIS remains unchanged.

4 Are there new methods of analysis or protocols for evaluating impacts?

The development of ecosystem models for the BSAI and GOA has allowed greater exploration of how various ecosystem impacts might affect squid stocks and their predators. In addition, the establishment of a separate squid complex in the GOA allows an evaluation of whether overfishing is occurring.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

It is unlikely that a new analysis would reach a seriously different conclusion. It is likely that many of the potential benefits of Preferred Alternative 2 (which included separate specifications for species groups within the “Other Species” group) will be realized under the new management approach in the GOA.

PSEIS SIR – review of conclusions in 2004 PSEIS

~6/19/2013

What resource component is this review for? **BSAI and GOA Octopus** ____
What sections of the PSEIS were reviewed? __**4.9.3 Other Species**, including

- ***Table 4.1-1 for Significance rating criteria*** *for target species, other species*, forage fish, non-specified species, Pacific halibut, and Pacific herring*
- ***Table 4.9-2 Significance ratings for prohibited, other*, forage, and non-specified species*** *under Preferred Alternative PA.1 and PA.2*
- ***Table 4.10-2b PA.1 and PA.2-impacts of Preferred Alt example FMP bookends***

1 Has management of the resource changed?

There have been substantial changes in management and monitoring of this species assemblage. The "other species" group has been removed from the FMP and replaced with separate regulation for sculpins, sharks, squids, skates, and octopus. The octopus complex, which includes all species of octopus, is now managed as a separate category in the FMPs and has its own annual OFL, ABC, and TAC limits. This management change was implemented in both the BSAI and GOA in 2012. Separate catch accounting for the octopus assemblage has been conducted since 2003. Identification of octopus on AFSC bottom trawl surveys has been improved to the species level, and more data has been collected on size ranges (in weight) of the different species. Identification of octopus in observer and fish ticket data is still collected at the assemblage level (all octopus), but special projects have provided data that indicate that the majority of the commercial catch is one species, *Enteroctopus dofleini*, which is used as the indicator species for the assemblage.

It is unknown whether this management change has affected the resource. Both reporting rates of incidental catch and retention of catch for sale and bait are believed to have increased over the period 2004-2012, but overall incidental catch rates are still believed to be very low in relation to population biomass (see BSAI and GOA SAFEs).

2 Has the status of the resource changed?

No. The status of the resource is still unknown, as listed for the entire "other species" complex in 2004 (Table 9.4-2). While knowledge of the indicator species has improved since 2004, there is still no reliable estimate of biomass for the assemblage or time series of abundance indicators. There is still little information on overall mortality or on changes in biomass, habitat, reproductive success, or genetic structure.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There is substantial new information about the biology of the indicator species for the assemblage, due to completed and ongoing directed research (see the BSAI and GOA Octopus SAFE; NPRB projects 906, 1005, and 1203; and NOAA Cooperative research projects for 2009, 2012, and 2013). None of the new information suggests any change in effects of the fishery on the resource, as fishery practices have changed only slightly since the mid- 1990s (there is no directed fishing for octopus). Since the status of the resource is unknown, the effect of the fishery on the resource remains unknown.

4 Are there new methods of analysis or protocols for evaluating impacts?

Recent information on the discard mortality of octopus suggests that current catch accounting practices (100% mortality assumed) are highly conservative for this assemblage, which would suggest that impacts of the fishery on the resource have been overestimated. This is true for both the period of review for the 2004 PSEIS and the period 2004-2013. In both cases, there is no reason to expect any increase in fishery impacts on the assemblage since 2004

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. Since the status of the resource is unknown, the effect of the fishery on the resource remains unknown. If new information on discard mortality were used, the estimated fishing mortality of the assemblage would be reduced, but the overall mortality rate for the assemblage is still unknown.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/12/13

What resource component is this review for? ___**Sharks**
What sections of the PSEIS were reviewed? ___**Section 4.9.3**

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

As part of the reauthorization of the Magnuson Stevens Fishery Conservation and Management Act, the NPFMC passed amendment 87 (http://www.fakr.noaa.gov/sustainablefisheries/amds/95-96-87/amd87.pdf), which dissolved the Other Species Complex. Sharks are now managed as a separate complex. The effect of this is that the shark complex has a separate ABC set for it.

2 Has the status of the resource changed?

The status of the shark complex in the PSEIS was determined to be unknown. Currently, the shark complex is composed of Tier 6 species and the status of the stock cannot be determined. As in the 2004 PESIS of Other Species/Sharks, overfishing is not occurring in either the GOA or BSAI shark stocks.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Yes, the sharks are now a separate complex. Restructuring of the observer program (which began in 2013) improved observer coverage of fisheries that encounter sharks and will likely result in better catch accounting of this complex.

4 Are there new methods of analysis or protocols for evaluating impacts?

At the time of the 2004 PSEIS the shark stock assessments were based only on catch history. Now, spiny dogfish (*Squalus suckleyi*) is assessed using survey biomass. Modeling methods are being evaluated for spiny dogfish to better assess the status of the stock.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The previous status of the sharks was “unknown”. The shark complex is on a bycatch only status and it is unlikely that a conservation concern has developed since the 2004 PESIS.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/10/2013

What resource component is this review for? **BSAI sculpins**
What sections of the PSEIS were reviewed**?** ***Section 4.9.3***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Historically, sculpins have been managed as part of the BSAI Other Species complex (sculpins, skates, sharks, and octopus). Specifications for this group were set by summing the individual ABCs and OFLs for each species group to create an aggregate OFL, ABC, and TAC. In 2010, the North Pacific Fishery Management Council passed amendment 87 to the BSAI Fishery Management Plan, which separated the Other Species complex into its constituent species groups. Since that time, BSAI sculpins have been managed as an independent complex with its own harvest specifications.

2 Has the status of the resource changed?

The status of the BSAI sculpin complex is similar to the status during the 2004 PSEIS, based on research survey estimates. The sculpin complex in the BSAI includes 48 species, but the six of the largest species comprise over 85% of the total sculpin biomass (bigmouth *(Hemitripterus bolini),* great *(Myoxocephalus polyacanthocephalus),* plain *(Myoxocephalus jaok),* threaded *(Gymnocanthus pistilliger),* warty *(Myoxocephalus verrucosus),* and yellow Irish lord *(Hemilepidotus jordani)*.. These six species are also assumed to have higher catchabilities than the remaining species because smaller species are likely to pass through the net and are difficult to assess in NMFS research surveys. Estimates of the abundance of each of these species, as well as the overall sculpin complex biomass, have not changed significantly since 2004.

2 Is there new information regarding the impacts of the groundfish fisheries on the resource?

BSAI sculpins were not assessed as a separate complex until 2010. Information on the impact of the groundfish fisheries on the resource comes directly from observer data. Two analyses performed on survey data and observer data were highly consistent: 1. length frequencies and 2. relative abundance of each species relative to the total sculpin abundance of the six species, specifically bigmouth *(Hemitripterus bolini),* great *(Myoxocephalus polyacanthocephalus),* plain *(Myoxocephalus jaok),* threaded *(Gymnocanthus pistilliger),* warty *(Myoxocephalus verrucosus),* and yellow Irish lord *(Hemilepidotus jordani).* This suggests that data used in the assessment accurately captures the impacts of the groundfish fisheries on this resource.

3 Are there new methods of analysis or protocols for evaluating impacts?

Since 2010 the sculpin stock assessment has been performed under Tier 5 methodology, and protocols have remained consistent for the 2010-2012 assessments.

4 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The current assessment uses a weighted average of sculpin survey biomass from the past three years in which all three BSAI surveys were performed. Alternative methods were explored, including a weighted average of the most three recent years of each survey and a random effects model, but the resulting ABC and TAC were not significantly different than that achieved with the current methodology.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/10/2013

What resource component is this review for? **GOA sculpins**
What sections of the PSEIS were reviewed**?** ***Section 4.9.3***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Historically, sculpins have been managed as part of the GOA Other Species complex (sculpins, skates, sharks, squid, and octopus). Specifications for this group were set by summing the individual ABCs and OFLs for each species group to create an aggregate OFL, ABC, and TAC. In 2010, the North Pacific Fishery Management Council passed amendment 87 to the GOA Fishery Management Plan, which separated the Other Species complex into its constituent species groups. Since that time, GOA sculpins have been managed as an independent complex with its own harvest specifications.

2 Has the status of the resource changed?

The status of the GOA sculpin complex is similar to the status during the 2004 PSEIS, based on research survey estimates. The sculpin complex in the GOA includes 48 species, but the four largest species comprise over 95% of the total sculpin biomass (bigmouth (*Hemitripterus bolini*), great (*Myoxocephalus polyacanthocephalus*), plain (*Myoxocephalus jaok*), and yellow Irish lord (*Hemilepidotus jordani*).. These four species are also assumed to have higher catchabilities than the remaining species because smaller species are likely to pass through the net and are difficult to assess in NMFS research surveys. Estimates of the abundance of each of these species, as well as the overall sculpin complex biomass, have not changed significantly since 2004.

2 Is there new information regarding the impacts of the groundfish fisheries on the resource?

GOA sculpins were not assessed as a separate complex until 2010. Information on the impact of the groundfish fisheries on the resource comes directly from observer data. Two analyses performed on survey data and observer data were highly consistent: 1. length frequencies and 2. relative abundance of each species relative to the total sculpin abundance of the four species, specifically bigmouth *(Hemitripterus bolini)*, great *(Myoxocephalus polyacanthocephalus)*, plain *(Myoxocephalus jaok)*, and yellow Irish lord *(Hemilepidotus jordani)*. This suggests that data used in the assessment accurately captures the impacts of the groundfish fisheries on this resource.

3 Are there new methods of analysis or protocols for evaluating impacts?

Since 2010 the sculpin stock assessment has been performed under Tier 5 methodology, and protocols have remained consistent for the 2010-2012 assessments.

4 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The current assessment uses a weighted average of sculpin biomass from the past three years in which all three GOA surveys were performed. A random effects model was recently explored as an alternative to the current methodology, but the resulting ABC and TAC were not significantly different than currently estimated.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

Draft ~6/19/2013

What resource component is this review for? **BSAI skates**
What sections of the PSEIS were reviewed? **4.9.3**

1 Has management of the resource changed?

In 2011, the "Other Species" category was broken up and a separate skate complex was established (http://www.fakr.noaa.gov/sustainablefisheries/amds/95-96-87/amd87.pdf). A single set of harvest specifications is applied to the entire skate complex. Assessment of the Alaska skate (*Bathyraja parmifera*, which constitutes over 90% of the BSAI skate biomass) is achieved using an age-structured model, allowing a Tier 3 determination of harvest specifications for that species. The remaining skate species ("other skates") are managed under Tier 5. The Tier 3 and Tier 5 specifications are combined to create a single skate complex set of specifications.

2 Has the status of the resource changed?

The 2004 PSEIS documented the difficulty of studying trends in the status of skate species in the BSAI, due to a general lack of biological information on skates and a specific lack of species identification for skates in the trawl survey before 2000 (PSEIS section 3.5.3.4). Skate biomass increased dramatically in the BSAI during the 1980s, and has since then remained relatively stable. Current survey methods and catch reporting allow enhanced monitoring of skate populations in the BSAI, but the conclusions in the PSEIS regarding the status of skates remain essentially unchanged.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

The fisheries that affect skates in the BSAI remain largely the same as in 2004. Skate catches likely depend mainly on the scale of the target fisheries where they are incidentally caught, i.e. the Pacific cod and flatfish fisheries.

4 Are there new methods of analysis or protocols for evaluating impacts?

The changes in BSAI skate assessment and management allow an improved monitoring of skate stock status. The Alaska skate model permits an evaluation of both overfishing and whether the population is overfished; the Tier 5 status of "other skates" permits an evaluation of overfishing. The Alaska skate stock is not in an overfished condition and no skates have experienced overfishing since the new management measures were adopted.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

The 2004 PSEIS listed the potential impacts on skate stocks (as part of "Other Species") as "unknown". It is likely that a new analysis would be able to provide a more detailed description of such impacts. However, due to the remaining uncertainties regarding bycatch and stock status**, it is unlikely that a new analysis would reach a seriously different conclusion**. It is likely that many of the potential benefits of Preferred Alternative 2 (which included separate specifications for species groups within the "Other Species" group) will be realized under the new management approach.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

~6/19/2013

What resource component is this review for? ___**GOA skates**________________
What sections of the PSEIS were reviewed? _____**4.9.3**_______________

1 Has management of the resource changed?

There have been numerous changes to the management of skates in the GOA since the PSEIS was published (see the 2011 GOA skate SAFE at www.afsc.noaa.gov/refm/stocks/2011_assessments.htm). In 2004, big skates (*Raja binoculata*) and longnose skates (*Raja rhina*) were moved to a separate management category and managed together under a single TAC in the Central GOA where a directed skate fishery had emerged in 2003. The remaining skates were managed as an "other skates" species complex in the Central GOA, and all skates including big and longnose skates were managed as a single skate complex in the Western and Eastern GOA. In 2005, the current management scheme was established:

- Big and longnose skates are each managed as single stocks, with harvest specifications for each stock.
- Separate ABCs and TACs for big and longnose skates are established for each GOA regulatory area.
- Big and longnose OFLs are established on a GOA-wide basis.
- The remaining skate species in the skate complex are managed as a single "other skates" stock, with GOA-wide specifications.
- Directed fishing is prohibited for all skate species in the GOA

2 Has the status of the resource changed?

The 2004 PSEIS documented the difficulty of studying trends in the status of skate species in the GOA, due to a general lack of biological information on skates and a specific lack of species identification for skates in the trawl survey before 2000 (PSEIS section 3.5.3.4). In general, skate species increased during the 1980s and the various populations have remained relatively stable since then. Current survey methods and catch reporting allow enhanced monitoring of skate populations in the GOA, but the conclusions in the PSEIS regarding the status of skates remain essentially unchanged.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

The fisheries that affect skates in the GOA remain largely the same as in 2004, with the exception that directed fishing for skates is currently prohibited. A small-scale state-waters fishery was conducted in 2009 & 2010, but has been discontinued. There continues to be interest in developing a directed skate fishery in the GOA. As described in the 2004 PSEIS, incidental catches of skates in the IPHC halibut fishery continue to be a large source of uncertainty regarding total skate catches. As described in the 2011 GOA skate SAFE, an analysis that applied IPHC longline survey species composition data to IPHC halibut catch records estimated a substantial amount of halibut fishery bycatch; however this analysis was deemed insufficient for inclusion in the official catch reporting. Changes to the fishery observer program implemented in 2013 will likely enhance the accounting of skate bycatch in the GOA. Other than those changes, the information regarding potential impacts on GOA skates remains unchanged from the 2004 PSEIS.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

Draft 18 March 2014
compiled by IPHC staff

What resource component is this review for? Pacific Halibut
What sections of the PSEIS were reviewed? ___________________

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Have there been substantial changes in the management program that have affected the resource, since the 2004 PSEIS (e.g., species is now managed independently, rather than as part of a complex; implementation of catch share privileges or closure areas affecting fisheries targeting resource)?

The most significant change has been the implementation of (1) a license limited access program for the halibut sport guided (charter) fishery in IPHC Areas 2C (southeast Alaska) and 3A (southcentral Alaska) (2011), and (2) a Catch Sharing Plan between commercial and guided recreational halibut harvesters for Areas 2C and 3A, beginning in 2014. Management measures to restrict harvest within the guided sector included both size limits and daily effort controls.

2 Has the status of the resource changed?

Is the status of the resource different than described in the 2004 PSEIS, and if so, how? What has affected the change in status? Is the current status within the range of variability analyzed in the 2004 PSEIS?

The resource has declined from historic high levels in the late 1990s and is now near the long-term average abundance for the stock. The decrease in abundance is largely related to the passing through the stock of extremely strong cohorts generated in the late 1980s. Subsequent recruitments have been average to below-average, resulting in the stock returning to average levels. Current status is within the range of historic assessments.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Are the fisheries affecting the resource differently than described in the 2004 PSEIS? Is this difference within the range of variability analyzed in the 2004 PSEIS? Has the difference been analyzed in a subsequent NEPA analysis (e.g., the difference in impact is the result of a management change for which an EA or EIS was written)? Is there new scientific information or research indicating or suggesting a change in our understanding of the impact of the fisheries on the resource?

Impacts of groundfish fisheries on the halibut resource are believed to have decreased since 2004, due to reductions in estimated halibut mortality in groundfish trawl fisheries. Most of this decline is associated with improved bycatch controls in the Bering Sea/Aleutian Islands Amendment 80 trawl fleet, through the use of fishery cooperatives, which include bycatch mortality pools. The International Pacific Halibut

Commission conducted additional analyses of the impacts of trawl bycatch mortality on lost yield and spawning biomass for the halibut stock.

4 Are there new methods of analysis or protocols for evaluating impacts?

Has a new methodology been developed for better understanding or evaluating impacts of the fisheries on the resource? Has that methodology been used in NEPA analyses of management actions affecting the resource, since the 2004 PSEIS?

The International Pacific Halibut Commission analyses referred to item 3 helped inform the reduction in halibut PSC limits for the Gulf of Alaska, scheduled for implementation over the 2014-2016 period. That information was included in the NEPA analysis conducted as part of GOA FMP Amendment 95.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

If new information is available, consider whether taking that information into account would cause you to reach a different conclusion about the effect of the groundfish fisheries on the resource. Provide a rationale if you conclude that it would not or some discussion if you think this issue needs further investigation. We are not asking for the new analysis to be undertaken, only for you to provide a discussion of whether it is merited.

No new information concerning bycatch impacts is currently available; however, the relationship of bycatch mortality to long-term yield from the halibut resource is currently being investigated within a Management Strategy Evaluation. It is uncertain at this point whether the impact of the halibut bycatch mortality will be less or more but that evaluation is being undertaken as a part of the International Pacific Halibut Commission's ongoing research. Although the IPHC includes all sources of mortality in annual stock assessments, and therefore accounts for bycatch in estimated fishery yields, mortality of halibut <26 inches is not included in IPHC's annual limits. The degree that this source of mortality has become more influential in population trends is largely unknown; however, bycatch of all sizes currently comprises a larger fraction of the total mortality than in previous analyses (20% of the projected 2014 removals from all sources). There is the potential, even under current PSC limits, that bycatch mortality could preclude all directed fishery activities in specific regulatory areas if further declines in apportioned biomass estimates are observed.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

Jeff Guyon –June 10, 2013
NMFS/AFSC/ABL

What resource component is this review for? ____**Prohibited Species**____
What sections of the PSEIS were reviewed? ___**4.9.2.2 Pacific Salmon or Steelhead Trout** ____

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Since the 2004 PSEIS, the following fishery management plan amendments have been made regarding the salmon bycatch:

1. Amendment 91 to the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area (implemented in 2011) and
2. Amendment 93 to the Fishery Management Plan for Groundfish of the Gulf of Alaska (implemented in 2012).

These amendments set a cap for the number of Chinook salmon that can be caught as bycatch in both the Bering Sea and the Gulf of Alaska.

2 Has the status of the resource changed?

The 2004 PSEIS focuses on both Chinook and chum salmon and specifically highlights issues for western Alaska. Since 2004, Yukon and Kuskokwim River Chinook salmon escapements have declined through 2011 to about a third of what they were in 2004 (2012 ADF&G Chinook Research Plan – see Figures 13 and 14 in http://www.adfg.alaska.gov/static/home/news/hottopics/pdfs/chinook_research_plan.pdf). Federal commercial fishing disaster declarations have been issued for Yukon River Chinook salmon for each year through 2008-2012. Other disaster declarations have also been issued for the Kuskokwim and Cook Inlet areas.

The Upper Yukon stock of chum salmon, also known as the fall stock, is a general indicator species which is monitored for treaty purposes. Since 2004 when the run size was 614 thousand fish, the estimated run size for fall Yukon River chum salmon has varied significantly with the run peaking over 2.3 million fish in 2005, but generally trending back to 2004 levels in more recent years (The United States and Canada Yukon River Joint Technical Committee – Yukon River Salmon 2011 Season Summary and 2012 Season Outlook -Table 18 in http://yukonriverpanel.com/salmon/wp-content/uploads/2009/03/jtc-report-summary-2011-preseason-2012.pdf)

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2004, there was limited stock composition information available for both the Chinook and chum salmon bycatch in the Bering Sea and Gulf of Alaska trawl fisheries. Since then, there have been a number of genetic stock composition analyses completed for sample sets from the 2005-2011 Bering Sea Chinook salmon bycatch, 2010-2011 Gulf of Alaska Chinook salmon bycatch (very limited sample sets), and 2005-2011 Bering Sea chum salmon bycatch. These analyses were completed using more refined baselines than available in 2004. In addition, coded wire tags (CWTs) recovered from Chinook salmon caught in the trawl bycatch have been analyzed each year through 2012. Additionally, for 2011, the North Pacific Observer Program instituted a systematic random sampling protocol for the collection of genetic and CWT samples in the Bering Sea. This has produced the most representative genetic sample set available to date for understanding the stock composition of the Chinook and chum salmon bycatch in the Bering Sea.

4 Are there new methods of analysis or protocols for evaluating impacts?

Since 2004, the impacts of the both the Bering Sea Chinook and chum salmon bycatch relative to escapement and maturity have been completed and incorporated into the associated EIS (Chinook salmon) and draft EA (chum salmon).

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

There has been a considerable amount of information learned since 2004 about the stock origin of salmon caught in the Alaska groundfish trawl bycatch. For the PSEIS, the impacts for chum salmon could be updated using the most current impact analysis drafted for the Environmental Assessment. In addition, the Gulf of Alaska salmon bycatch for both Chinook and chum salmon was thought in 2004 to be composed of a similar stock origin as that in the Bering Sea. We now know that the stock origins for Chinook salmon are very different between these two areas. Consequently, this section could be updated to include the most current information and assessments.

Review of Conclusions in 2004 PSEIS

What resource component is this review for? **BSAI king crab**
What sections of the PSEIS were reviewed**?** ***Section 4.5.2.4 and 4.9.2.4***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

The management measures regulating BSAI king crab as a prohibited species in groundfish fisheries are unchanged since 2004. BSAI king crab remains a Prohibited Species in the BSAI groundfish fisheries. However, implementation of Amendment 80 to the BSAI Groundfish FMP has had some impact on the bycatch of BSAI king crab. Amendment 80 directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-American Fisheries Act (AFA) trawl catcher/processor fleet. This was accomplished by providing the ability to form cooperatives within the newly formed Amendment 80 sector. The partitioning of PSC (prohibited species catch) among the fishery cooperatives has reduced the rate of bycatch per target catch ton.

In 2011, a trawl sweep modification requirement was implemented for vessels participating in the Bering Sea flatfish fishery to reduce impact of the fishery on the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor. Research has demonstrated that this gear modification reduces unobserved mortality of red king crab, southern Tanner crab, and snow crab.

New overfishing definitions and total catch accounting for BSAI crab stocks were implemented in 2008 with Amendment 24. Reference points and biomass values for BSAI king crab are estimated using an assessment model and a 5 Tier system. Starting in 2011, with the implementation of Amendment 38, annual catch limits are set for BSAI crab stocks in addition to OFLs.

2 Has the status of the resource changed?

BSAI king crab species include red king crab (*Paralithodes camtschaticus*), blue king crab (*Paralithodes platypus*), and golden (or brown) king crab (*Lithodes aequispinus*). The status of these stocks are evaluated and reported annually in the Council's SAFE report. Although abundance has been variable since 2004, the status of the majority of these king crabs relative to the status determination criteria has not changed, with the exception of St Matthew blue king crab, which was declared rebuilt in 2009 (NPFMC 2013). Pribilof Islands blue king crab, which was subject to a rebuilding plan, failed to rebuild within the ten year time frame ending in 2011.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2012, a Council discussion paper considered the importance of trawl effort on Bristol Bay red king crab to assess the essential fish habitat of red king crab. The Council recommended continued research on the definition of red king crab habitat at multiple life stages and also continued evaluation of existing Bristol Bay red king crab closure areas.

The Council is also assessing the historical bycatch of crab stocks by groundfish fisheries by gear and the measures currently employed under the BSAI FMP and NMFS regulations to limit the bycatch by crab stock. In February 2014, the Council reviewed a discussion paper that evaluates the existing closure areas for Bristol Bay red king crab, Bering Sea Tanner crab, Bering Sea snow crab, and St. Matthew blue king crab, including information on recent stock distribution and the distribution and amount of crab bycatch in the trawl and fixed gear groundfish fisheries. The discussion paper included review of the proportion of bycatch by trawl and fixed gear fisheries inside and outside of the closure areas and a more detailed history of the closures to help identify the fraction of historical fisheries that occurred in these areas as well as their crab bycatch. This discussion paper is intended to assist the Council in deciding what, if any, action to take to modify the existing management measures for these 4 stocks.

4 Are there new methods of analysis or protocols for evaluating impacts?

No. Since 2004, the stock assessment models have improved greatly. Crab bycatch is accounted for in the estimate of total catch used in the stock assessment models and to evaluate total catch relative to the annual catch limits.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No.

Citations

NPFMC. 2013. Stock Assessment and Fishery Evaluation Report for the King And Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions: 2013 Crab SAFE. North Pacific Fishery Management Council, 605 W. 4th Avenue, #306, Anchorage, AK 99501.

NPFMC. 2014. Crab PSC in the Bering Sea/Aleutian Islands Fisheries. Discussion paper. January. North Pacific Fishery Management Council, 605 W. 4th Avenue, #306, Anchorage, AK 99501.

Review of Conclusions in 2004 PSEIS

draft 6/19/2013

What resource component is this review for? **BSAI Snow crab**
What sections of the PSEIS were reviewed**?** ***Section 4.9.2.4***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

From the perspective of the BSAI Groundfish FMP, management of the BSAI snow crab is qualitatively unchanged. BSAI snow crab remains a Prohibited Species in the BSAI groundfish fisheries. However, implementation of Amendment 80 to the BSAI FMP has had some impact on the bycatch of BSAI snow crab. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. The partitioning of PSC (prohibited species catch) among the fishery cooperatives has reduced the rate of bycatch per target catch ton. New overfishing definitions and total catch accounting for BSAI crab stocks were implemented in 2008 with Amendment 24. Reference points and biomass values for BSAI snow crab are estimated using an assessment model and a 5 Tier system, where snow crab is a Tier 3 stock (Turnock and Rugolo 2011). ABC values are now established for BSAI crab stocks in addition to OFL starting in 2011 with the implementation of Amendment 38.

2 Has the status of the resource changed?

The status of the BSAI snow crab resource has changed since the 2004 PSEIS. BSAI snow crab was considered overfished prior to the 2004 PSEIS and the directed fishery for this stock was under a rebuilding plan. In 2011, the stock was declared rebuilt based on a new assessment model (Turnock and Rugolo, 2011).

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2011, a trawl sweep modification requirement was implemented for vessels participating in the Bering Sea flatfish fishery resulting in less impact of the fishery on the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor. Research has demonstrated that this gear modification reduces unobserved mortality of red king crab, Tanner crab, and snow crab.

4 Are there new methods of analysis or protocols for evaluating impacts?

No.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No.

Citations

Turnock, B.J. and L.J. Rugolo. 2011. 2011 Stock Assessment of Eastern Bering Sea Snow Crab. In: Stock Assessment and Fishery Evaluation Report for the King And Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions: 2011 Crab SAFE. North Pacific Fishery Management Council, 605 W. 4th Avenue, #306, Anchorage, AK 99501. pp. 37-168.

Review of Conclusions in 2004 PSEIS

draft 6/19/2013

What resource component is this review for? **BSAI Tanner crab**
What sections of the PSEIS were reviewed**?** ***Section 4.9.2.4***

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

From the perspective of the BSAI Groundfish FMP, management of the BSAI bairdi Tanner crab is qualitatively unchanged. BSAI bairdi Tanner crab remains a Prohibited Species in the BSAI groundfish fisheries. However, implementation of Amendment 80 to the BSAI FMP has had some impact on the bycatch of BSAI bairdi Tanner crab. The Amendment directly allocated fishery resources among BSAI trawl harvesters in consideration of their historic harvest patterns and future harvest needs in order to improve retention and utilization of fishery resources by the non-AFA trawl catcher/processor fleet. This was accomplished by extending the groundfish retention standards to all H&G vessels and also by providing the ability to form cooperatives within the newly formed Amendment 80 sector. The partitioning of PSC (prohibited species catch) among the fishery cooperatives has reduced the rate of bycatch per target catch ton.

In addition, Amendment 24 (June, 2008) to the BSAI Crab FMP established a 5-tier system for determining the status of crab stocks managed under the FMP, including BSAI bairdi Tanner crab stock. It also established a process for assigning each managed crab stock to a tier and for setting overfishing and overfished levels based on the assigned tier. BSAI bairdi Tanner crab is currently in Tier 3 and is not overfished, nor is overfishing occurring (Rugolo and Turnock, 2012).

2 Has the status of the resource changed?

The technical status of the BSAI bairdi Tanner crab resource has changed since the 2004 PSEIS, although its effective status remains the same. BSAI bairdi Tanner crab was considered overfished prior to the 2004 PSEIS and the directed fishery for this stock was closed (1997/98-2004/05). Subsequently, the directed fishery has been both open (2005/06-2009/10) and closed (2010/11-2011/12). In 2012, the stock was declared rebuilt based on a new assessment model (Rugolo and Turnock, 2012). However, stock abundance remains relatively low compared with historic levels and the State of Alaska did not allow a directed fishery in 2012/13.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

In 2011, a trawl sweep modification requirement was implemented for vessels participating in the Bering Sea flatfish fishery resulting in less impact of the fishery on the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor. Research has demonstrated that this gear modification reduces unobserved mortality of red king crab, Tanner crab, and snow crab.

4 Are there new methods of analysis or protocols for evaluating impacts?

No.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No.

Citations

Rugolo, L.J. and B.J. Turnock. 2012. 2012 Stock Assessment and Fishery Evaluation Report for the Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions. In: Stock Assessment and Fishery Evaluation Report for the King And Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions: 2012 Crab SAFE. North Pacific Fishery Management Council, 605 W. 4th Avenue, #306, Anchorage, AK 99501. pp. 267-416.

Review of Conclusions in 2004 PSEIS

What resource component is this review for? **GOA king and Tanner crab**
What sections of the PSEIS were reviewed**?** ***Section 4.9.2.4***

1 Has management of the resource changed?

Crab remain a Prohibited Species in the GOA groundfish fisheries. Additionally, the Council approved an area closure in Marmot Bay in 2010, to protect Tanner crab from impacts of the groundfish trawl fisheries (implemented in 2014).

Also in 2014, a trawl sweep modification requirement was implemented for vessels participating in the GOA flatfish fishery to reduce impact of the fishery on the seafloor. Elevating devices (e.g., discs or bobbins) are now required to be used on the trawl sweeps to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor.

2 Has the status of the resource changed?

The GOA red king crab species remains at historically low levels, and the Tanner crab stock continues to show high variability in recruitment. Little is known about golden or blue king crab. There have been no changes to the state assessment methodology, and no regulatory changes to the harvest strategy or management structure. The prevailing conditions identified in the 2004 document that likely drive these trends remain unchanged.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There is no substantive new information regarding the impacts of the groundfish fisheries on the resources with respect to state-managed fisheries. More observer coverage is available under the federal restructured observer program. The Council analyzed impacts of the GOA groundfish fisheries on Tanner crab in two NEPA analyses, and instituted a trawl-gear area closure, and the trawl sweep modification requirement in the GOA flatfish fishery. Research has demonstrated that this gear modification reduces unobserved mortality of king and Tanner crab.

4 Are there new methods of analysis or protocols for evaluating impacts?

No. There have been no changes to the state assessment methodology, and no regulatory changes to the harvest strategy or management structure.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The abundance of GOA crab stocks is similar to that reported in the 2004 PSEIS.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

~6/19/2013

What resource component is this review for? ____**BSAI & GOA forage fishes**_______________
What sections of the PSEIS were reviewed? ______**4.9.4**______________

1 Has management of the resource changed?

Forage fish management has not changed in either the BSAI or GOA, except in the way that they are designated in the FMP: they are now listed as "Ecosystem Components" and explicitly removed from the requirement for harvest specifications. As described in the 2004 PSEIS, directed fishing for forage fishes is prohibited and there are strict limits on retention and processing. There are now forage fish reports for both the BSAI and GOA that are published on a biennial basis as appendices to the SAFE documents.

2 Has the status of the resource changed?

As described in the 2004 PSEIS, very little information exists regarding the status of forage fishes (section 3.5.4). While the forage fish reports have been improved with substantial amounts of new information, there remain no reliable estimates of forage fish abundance. The available evidence suggests that forage fish abundance fluctuates independent of fishery activities.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

The forage fish reports now include more detailed information regarding state-waters removals of eulachon; as estimated in the original PSEIS these removals are on a small scale. The eulachon population in the Pacific Northwest has been declared "threatened" under the Endangered Species Act (75 FR 13012). The causes of eulachon declines in the PNW are unknown but are thought to include habitat destruction, overfishing, and climate change effects. Although the threatened population is thought to be discrete from eulachon stocks in Alaska, this development emphasizes the importance of continuing the conservation measures established in the BSAI and GOA FMPs.

4 Are there new methods of analysis or protocols for evaluating impacts?

No new methodologies exist for evaluating impacts. It is hoped that current research regarding forage fish abundance and distribution will provide a better understanding of forage fish populations, but it is unlikely that a reliable index of status will be available in the near future.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

It is unlikely that a new analysis would reach a seriously different conclusion. Forage fishes continue to be caught only incidentally, and there are no new data to suggest that their status has changed.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/7/13

What resource component is this review for? ___**non-specified**________________
What sections of the PSEIS were reviewed? ___**4.9.5**________________

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

There have been no changes to the management of non-specified species. Unofficial Stock Assessment and Fishery Evaluation Reports (SAFEs) have been prepared for grenadiers since 2006. These have undergone annual review by the Plan Team and SSC, but the recommendations are not used for management.

2 Has the status of the resource changed?

The status of unspecified species was unknown due to a lack of data in the PSEIS in 2004. In the unofficial grenadier SAFE reports conducted since 2006, catch, biomass, fishery and survey length frequencies, and indices of abundance are tracked. These data indicate that population trends are stable; catch relative to abundance is < 2%. There is disproportionate catch of females in surveys and in the fishery; however, all data indicate that catch of grenadier has not affected the stock status. Catch of giant grenadier continue to be the vast majority of the grenadier catch.

Age at maturity and natural mortality information is now available for grenadiers. Natural mortality is low, the species are long-lived (at least 58 years maximum age), and the age at which 50% of females are mature is older than most groundfish (23 years).

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Since grenadiers are caught primarily in the sablefish longline fishery and the ABCs and TACs for sablefish have decreased in recent years, the impacts of groundfish fisheries have decreased.

4 Are there new methods of analysis or protocols for evaluating impacts?

In the unofficial grenadier SAFE reports catch, biomass, fishery and survey length frequencies, and indices of abundance are now tracked.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

There is no new information available currently. With the implementation of the observer restructuring in 2013, more information on catch on smaller vessels as well as catch in the Pacific halibut fishery will be available. Since catch has been very low compared to the estimated biomass for grenadier, adding these new catch estimates should not change the conclusion of no observed impact of groundfish fisheries on grenadiers.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/5/13

What resource component is this review for? _**Marine Mammals**__________________
What sections of the PSEIS were reviewed? **Steller sea lions western and eastern population segments**

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Have there been substantial changes in the management program that have affected the resource, since the 2004 PSEIS (e.g., species is now managed independently, rather than as part of a complex; implementation of catch share privileges or closure areas affecting fisheries targeting resource)?

*Yes, With regard to western dps of Steller sea lions there was a recent change in fisheries management due to the conclusions of the 2010 Ground fish biological opinion which found that the management regimes in place at the time "**were likely to adversely modify the designated critical habitat for the western DPS of Steller sea lion" (http://alaskafisheries.noaa.gov/protectedresources/stellers/esa/biop/final/biop1210_chapters.pdf).** This included new closures and restrictions on atka mackerel and Pacific cod fisheries in areas 541 – 543. There is currently a new EIS and likely a new biological opinion due out in the next six months that will again review these closures and potentially propose new fishery regulations. The most up to date source for all of this will be the draft environmental impact statement for the Bering Sea and Aleutain Islands Management Area. (http://alaskafisheries.noaa.gov/newsreleases/2013/sslpmeis051413.htm). Once a preferred alternative is chosen, a new biological evaluation may also be released (depending on whether the chosen alternative is different from the status quo) which will again incorporate all recent information pertinent to this topic.*

There has not been a change in management of the eastern DPS however it should be noted that the eastern dps has been proposed for de-listing from the endangered species list (http://alaskafisheries.noaa.gov/newsreleases/2012/ssledps041812.htm). The final decision on this proposal is expected sometime in the summer of 2013.

Overall, these two documents should serve to update virtually everything in this PEIS review given that they have been put together in the last 12 months and are by far the most comprehensive and up to date sources of information for the western stock of Steller sea lions. In addition the Steller Sea Lion Recovery Plan was re-written in 2008.

2 Has the status of the resource changed?

Is the status of the resource different than described in the 2004 PSEIS, and if so, how? What has affected the change in status? Is the current status within the range of variability analyzed in the 2004 PSEIS?

Yes, the status has changed with regard to the abundance and regionally with regard to the trends. This is all reported in both the EIS and Biop noted above for the western DPS and in the delisting information *for the eastern DPS. Both stocks have increased in number overall. This change in abundance will have a concurrent change in PBR (See 2012 Stock Assessment Report, Allen and Angliss, 2013, http://www.nmfs.noaa.gov/pr/sars/pdf/ak2012.pdf)*

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Are the fisheries affecting the resource differently than described in the 2004 PSEIS? Is this difference within the range of variability analyzed in the 2004 PSEIS? Has the difference been analyzed in a subsequent NEPA analysis (e.g., the difference in impact is the result of a management change for which an EA or EIS was written)? Is there new scientific information or research indicating or suggesting a change in our understanding of the impact of the fisheries on the resource?

*Yes, based on the conclusions of the 2010 Groundfish Biological Opinion, the fisheries were affecting the resource differently in 2010. This may again be changing depending on the final EIS of 2013 and the subsequent Biological Opinion of 2014. Both of these documents should be used to guide this particular topic when necessary. For example, a paper by Zeppelin et la. In 2004 demonstrated that there was, "*Considerable overlap (>51%) in the size of walleye pollock and Atka mackerel taken by Steller sea lions and found in scat, and the sizes of these species caught by the commercial trawl fishery" (Zeppelin et al. 2004).

4 Are there new methods of analysis or protocols for evaluating impacts?

Has a new methodology been developed for better understanding or evaluating impacts of the fisheries on the resource? Has that methodology been used in NEPA analyses of management actions affecting the resource, since the 2004 PSEIS?

There are no new methods per se but there have been more recent analyses using conventional methods since this document was written. In addition, there have been a number of publications on food habits, abundance, foraging behavior, contamitnants, and vital rates since 2004. These and others are all summarized in the EIS and BiOp noted above.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

If new information is available, consider whether taking that information into account would cause you to reach a different conclusion about the effect of the groundfish fisheries on the resource. Provide a rationale if you conclude that it would not, or some discussion if you think this issue needs further investigation. We are not asking for the new analysis to be undertaken, only for you to provide a discussion of whether it is merited.

Possibly, As noted previously, there has been quite a bit of information gathering completed on western DPS Steller sea lions especially since 2004 and is all summarized in the EIS and 2010 BiOp and will be again in the 2014 BiOp. I would suggest a review of those documents rather than a new analysis. A Status Review of the eastern DPS has also been completed as well as a draft Post-delisiting Monitoring Plan. These documents should be sufficient for updating this particular document.

Recent References:

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CASTELLINI, J. M., L. D. REA, C. L. LIESKE, K. B. BECKMEN, B. S. FADELY, J. M. MANISCALCO, and T. M. O'HARA. 2012. Mercury concentrations in hair from neonatal and juvenile Steller sea lions (Eumetopias jubatus): Implications based on age and region in this northern Pacific marine sentinel piscivore. EcoHealth 9(3):267-277.

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Template for PSEIS SIR – review of conclusions in 2004 PSEIS
draft 6/5/12

What resource component is this review for? _**Marine Mammals**__________________
What sections of the PSEIS were reviewed? **Northern Fur Seals**
Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Have there been substantial changes in the management program that have affected the resource, since the 2004 PSEIS (e.g., species is now managed independently, rather than as part of a complex; implementation of catch share privileges or closure areas affecting fisheries targeting resource)?

No, the management program has not changed, but the population has continued to decline. The Eastern Pacific stock of northern fur seals are still considered depleted under the Marine Mammal Protection act and still declining at just under 5% annually (between 1998 – 2012; Towell et al. 2013 (http://www.afsc.noaa.gov/nmml/pdf/2012-nfs-pup-adult-counts-pribs.pdf). In 2007 NMFS published a new conservation plan (National Marine Fisheries Service. 2007. Conservation plan for the Eastern Pacific stock of northern fur seal (Callorhinus ursinus)) that summarized all relevant information to date at the time. National Marine Fisheries Service, Juneau, Alaska. In addition, the 2012 Stock Assessment Report. Subsistence harvest has declined significantly since the dates listed in the 2004 version of this document. In 2012 less than 500 sub adult males were taken for the subsistence harvest in the Pribilof Islands.

A recent petition to change the harvest regulations for both islands would, if approved, potentially increase the number of harvested fur seals on both islands. This is most notable by the request to harvest fur seal pups on both islands (http://alaskafisheries.noaa.gov/protectedresources/seals/fur/analysis/ea0412.pdf).

2 Has the status of the resource changed?

Is the status of the resource different than described in the 2004 PSEIS, and if so, how? What has affected the change in status? Is the current status within the range of variability analyzed in the 2004 PSEIS?

Yes, the status has changed with regard to the abundance with significant declines on both Pribilof islands in the last 15 years. This decline for the stock has been partially offset by an increase in abundance on Bogoslof Island where an annual rate of increase of 38% has occurred since 1980 and the population estimate of almost 23,000 pups now exceeds that of St. George Island (Towell and Ream, 2012, http://www.afsc.noaa.gov/nmml/PDF/BogPupMem11_final.pdf) I cannot tell given the information provided if this change in status is within the range of variability analyzed in the 2004 PSEIS nor is there definitive information as to what may have affected this change in status or what caused it.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Are the fisheries affecting the resource differently than described in the 2004 PSEIS? Is this difference within the range of variability analyzed in the 2004 PSEIS? Has the difference been analyzed in a subsequent NEPA analysis (e.g., the difference in impact is the result of a management change for which an EA or EIS was written)? Is there new scientific information or research indicating or suggesting a change in our understanding of the impact of the fisheries on the resource?

It is unknown if the fisheries are affecting northern fur seals differently now than in 2004 but there is additional published literature available indicating similar habitat and prey use by both consumers (see list below). To my knowledge there has not been subsequent NEPA analysis. A paper published in 2006 by C. Gudmndson et al described an analysis of northern fur seal prey habits that included scat and spew samples. This study found that prey remains from adult pollock did not appear as often in the scat as in spew samples. "The differences in walleye pollock age classes between scat and spew samples seem to indicate that size estimations of pollock consumed by northern fur seals have likely been underestimated in previous studies using G.I. tracts and scat" (Gudmundson et al. 2006). In fact the study reported that the percent overlap between age classes of walleye Pollock caught by the commercial trawl fishery and those found in northern fur seal scat on the Pribilof Islands was between 4 – 15% while it was between 89 – 95% for spews.

4 Are there new methods of analysis or protocols for evaluating impacts?

Has a new methodology been developed for better understanding or evaluating impacts of the fisheries on the resource? Has that methodology been used in NEPA analyses of management actions affecting the resource, since the 2004 PSEIS?

There are no new methods per se but there have been more recent analyses using conventional methods since this document was written. In addition, there have been a number of publications on food habits, abundance, foraging behavior, and disease since 2004 (see list below). I don't know of any new NEPA analysis of management actions since the 2004 PSEIS.

Would a new analysis using the latest methods and information reach a seriously different conclusion? If new information is available, consider whether taking that information into account would cause you to reach a different conclusion about the effect of the groundfish fisheries on the resource. Provide a rationale if you conclude that it would not, or some discussion if you think this issue needs further investigation. We are not asking for the new analysis to be undertaken, only for you to provide a discussion of whether it is merited.

Possibly. If an analysis were to be completed that showed a strong link between commercial fisheries and the decline of northern fur seals it would likely have some effect on management decisions. There is ongoing research looking at this topic or at least looking for correlates and associations that would lead to further examination. Currently the cause of the ongoing decline is unknown.

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Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/24/13

What resource component is this review for? _Marine Mammals
What sections of the PSEIS were reviewed? _Harbor seals, Other Pinnipeds (but only the four ice-associated seals: bearded, ribbon, ringed and spotted. Not walrus, elephant seals or sea otters).

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component

1 Has management of the resource changed?

Have there been substantial changes in the management program that have affected the resource, since the 2004 PSEIS (e.g., species is now managed independently, rather than as part of a complex; implementation of catch share privileges or closure areas affecting fisheries targeting resource)?

Harbor seals: Yes, in 2010 the three previously recognized stocks of harbor seals in Alaskan waters were subdivided into twelve stocks (Allen and Angliss 2012).

Ice-associated seals: In October, 2006, NMFS entered into an agreement with the Ice Seal Committee, an Alaska Native Organization representing five coastal regions of communities that use ice-associated seals for nutritional and cultural purposes. Also, see #2 for the potential for critical habitat designation for bearded and ringed seals.

2 Has the status of the resource changed?

Is the status of the resource different than described in the 2004 PSEIS, and if so, how? What has affected the change in status? Is the current status within the range of variability analyzed in the 2004 PSEIS?

Harbor seals: Prior to subdividing the three stocks into twelve (see #1), harbor seals in Bristol Bay, the Pribilof Islands and Lake Iliamna, AK were part of a single Bering Sea stock. Harbor seals in Lake Iliamna have recently been petitioned for listing as "threatened" or 'endangered' under the Endangered Species Act (ESA), and the NMFS is currently preparing a Status Review of that population to aid in a listing decision. Harbor seals in the Aleutian Islands have declined substantially since the early 1980s, especially in the western Aleutians (Small et al. 2008).

Ice-associated seals: Mostly out of concerns about effects of climate change on sea ice habitat, all four ice-associated seal species were the subjects of petitions for listing under the ESA. The NMFS prepared Status Reviews on each of the four species and determined that:

1) **Ribbon seals** should not be listed under the ESA (Boveng et al. 2008). However, NMFS is currently revisiting this determination (National Marine Fisheries Service 2011) and will publish an updated Status Review and proposed decision in July, 2013.
2) **Spotted seals** should not be listed in Alaskan waters, but a small Asian population was listed as "threatened" (Boveng et al. 2009, National Marine Fisheries Service 2010).
3) The Arctic subspecies of **ringed seals** (*P. h. hispida*) including all ringed seals in Alaskan waters, was listed as "threatened" (Kelly et al. 2010, National Marine Fisheries Service 2012a). The NMFS is currently considering critical habitat designations.

4) The “Beringia” Distinct Population Segment (DPS) of **bearded seals**, including the Bering, Chukchi, Beaufort, and East Siberian Seas, was listed as “threatened” (Cameron et al. 2010, National Marine Fisheries Service 2012b). The NMFS is currently considering critical habitat designations.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Are the fisheries affecting the resource differently than described in the 2004 PSEIS? Is this difference within the range of variability analyzed in the 2004 PSEIS? Has the difference been analyzed in a subsequent NEPA analysis (e.g., the difference in impact is the result of a management change for which an EA or EIS was written)? Is there new scientific information or research indicating or suggesting a change in our understanding of the impact of the fisheries on the resource?

Harbor seals: Splitting the three stocks into twelve led to individual stocks with lower abundance. For example, the Pribilof Island stock of harbor seals (which used to belong to the larger Bering Sea stock) is small, with a population estimate of only 232 (Allen and Angliss 2012). Such a low population suggests the potential for groundfish fisheries to have significant impacts on this stock, but there is no new information on the issue or management plan. Declines of harbor seals in the Aleutian Islands show the same geographic pattern as declines in Steller sea lions, with the strongest declines in the west, and less severe declines to the East. Although the cause of these declines has not been determined, the geographic pattern suggests a possible connection to the mechanism(s) responsible for the sea lion decline.

Ice-associated seals: Although not “new” information, the Status Reviews referenced in #2 were more comprehensive summaries of the available literature on the food habits of ice-associated seals. For example, in contrast to the PSEIS, the status reviews indicate that various species of demersal/groundfish are important to both ribbon and bearded seals, at least in some areas, seasons and/or years.

4 Are there new methods of analysis or protocols for evaluating impacts?

Has a new methodology been developed for better understanding or evaluating impacts of the fisheries on the resource? Has that methodology been used in NEPA analyses of management actions affecting the resource, since the 2004 PSEIS?

No. New and unique analyses are not required; the need is for good data. New field efforts are required.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

If new information is available, consider whether taking that information into account would cause you to reach a different conclusion about the effect of the groundfish fisheries on the resource. Provide a rationale if you conclude that it would not, or some discussion if you think this issue needs further investigation. We are not asking for the new analysis to be undertaken, only for you to provide a discussion of whether it is merited.

Harbor seals: Given the paucity of information about the foraging ecology of this species, especially in the Aleutian Islands, it is unlikely that new methods of analysis would lead to a different conclusion about the effects of groundfish fisheries..

Ice-associated seals: The “new” information referenced in #3 is limited (e.g., small sample sizes, little to no indication of size/age of prey taken, contrasting study results), so firm conclusions would be difficult or impossible to develop. But given the more comprehensive, and in some cases differing, reviews of food habits presented in the status reviews, a re-analysis may be warranted.

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Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/4/13

What resource component is this review for? _Marine Mammals__________________
What sections of the PSEIS were reviewed? Killer whale (transients), Other toothed whales, Baleen whales

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Have there been substantial changes in the management program that have affected the resource, since the 2004 PSEIS (e.g., species is now managed independently, rather than as part of a complex; implementation of catch share privileges or closure areas affecting fisheries targeting resource)?

No

2 Has the status of the resource changed?

Is the status of the resource different than described in the 2004 PSEIS, and if so, how? What has affected the change in status? Is the current status within the range of variability analyzed in the 2004 PSEIS?

Killer Whale (Transients):

In January 2004 the North Gulf Oceanic Society (NGOS) and the National Marine Mammal Laboratory (NMML) held a joint workshop to match identification photographs of transient killer whales from this population. That analysis of photographic data resulted in the following minimum counts for 'transient' killer whales belonging to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock. A total count of 552 individual whales have been identified in the Gulf of Alaska, Aleutian Islands, and Bering Sea transient killer whale stock (Allen and Angliss, 2013). Line transect surveys from 2001-2003 estimated transient killer whale abundance at 249 (CV = 0.50), with 95% confidence interval of 99-628 (Zerbini et al. 2007). Unclear how this new information would affect the analysis in the 2004 PSEIS.

AT1 transients: At least 11 animals were alive in 1998, but it appears that as of 2009, only 7 individuals remain alive. The AT1 group has been reduced to 32% (7/22) of its 1984 level (Matkin et al. 2008). This should not change the conclusions reached in the 2004 PSEIS.

Other Toothed Whales:

The Alaska Resident stock of killer whales in general continues to increase in population size. However, a few pods in Prince William Sound have declined by a few animals (i.e., AB25, AE, AN20, AS30, AY: Allen and Angliss, 2013). Unclear how this new information would affect the analysis in the 2004 PSEIS.

Harbor porpoise: Because the most recent abundance estimates are 11-13 years old and information on incidental harbor porpoise mortality in commercial fisheries is not well understood, all Alaska stocks of harbor porpoise (Gulf of Alaska, Bering Sea, and Southeast) are classified as strategic stocks. Unclear how this new information would affect the analysis in the 2004 PSEIS.

In the 2004 PSEIS, Cook Inlet belugas were listed as depleted under the MMPA. The population has continued to decline. Cook Inlet beluga whales were listed as a Distinct Population Segment under the Endangered Species Act in 2008 and Critical Habitat was designated throughout much of Cook Inlet in 2011. This change in status may require reanalysis.

The Bristol Bay beluga stock continues to increase in size. The Alaska Department of Fish and Game and the Alaska Beluga Whale Committee conducted beluga surveys in Bristol Bay in 1999, 2000, 2004 and 2005, with maximum counts of 690, 531, 794, and 1,067 (Lowry et al. 2008). Using the correction factors described above and the maximum counts for 2004 and 2005 gives population estimates of 2,455 and 3,299 (L. Lowry, University of Alaska Fairbanks, pers. comm.).

No new information on Pacific white-sided dolphins, Dall's porpoise, sperm whales, or beaked whales (Allen and Angliss, 2013).

<u>Baleen Whales</u>:

Humpback whales: A large-scale study of humpback whales throughout the North Pacific was conducted in 2004-06 (the Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project). Initial results from this project (Calambokidis et al. 2008, Barlow et al. 2011), including abundance estimates and movement information, have been reported in Baker et al. (2008), and are also summarized in Fleming and Jackson (2011); however, these results are still being considered for stock structure analysis (Allen and Angliss, 2013). This may require reanalysis.

North Pacific right whales were relisted under the ESA as a species in 2008 and Critical Habitat was designated in the Bering Sea and Gulf of Alaska in 2006. Abundance estimates as of 2008 indicate fewer than 60 whales in Alaska waters (Wade et al., 2011). This change in status should not affect the conclusions reached in the 2004 PSEIS.

The Western Arctic bowhead whale stock has been increasing in recent years; the estimate of 12,631 (in 2004) is between 22% and 124% of the pre-exploitation abundance (estimates ranging roughly from 10,000 to 55,000), and this stock may now be approaching its carrying capacity (Brandon and Wade 2004, 2006). This should not affect the conclusions reached in the 2004 PSEIS.

For Eastern North Pacific gray whale, the most recent estimate of abundance is from the 2006/2007 southbound survey, or 19,126 (CV=7.1%) whales (Laake et al. 2009). Because of observed interannual differences in correction factors used to correct for bias in estimating pod size (Rugh et al. 2008), the time series of abundance estimates dating back to 1967 was reanalyzed. Laake et al. (2009) developed a more consistent approach to abundance estimation that used a better model for pod size bias and applied their estimation approach to reestimate abundance for all 23 surveys. This reanalysis did not change the current status of Eastern North Pacific gray whales which is continuing to increase at about 3.2% per year (Punt and Wade 2010). This should not affect the conclusions reached in the 2004 PSEIS. However, three gray whales from the western North Pacific that were tagged with satellite transmitters (one in 2010, two in 2011) migrated from Russian waters crossing the Bering Sea and Gulf of Alaska after passing through Unimak and Umnak passes, following eastern North Pacific gray whales during their southbound migration to Mexico (see Mate et al. 2011; Mate and Ilyashenko, unpublished data, http://mmi.oregonstate.edu/sakhalin2010Map). On the northward migration, the one whale still transmitting locations followed the coastline from Mexico to Alaska before entering the Bering Sea through Unimak Pass then returning along the ice edge to Russian waters. Since this discovery additional photographic matches have been found between whales observed off Sakhalin Island, Russia, and in the Mexico lagoons. The western population of North Pacific gray whales (WGW), once thought extinct, is now estimated at 130 individuals and feeds primarily off northeastern Sakhalin Island, Russia, during summer.

No new information on fin whales, sei whales, minke whales (Allen and Angliss, 2013) or blue whales (Carretta et al. 2012).

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Are the fisheries affecting the resource differently than described in the 2004 PSEIS? Is this difference within the range of variability analyzed in the 2004 PSEIS? Has the difference been analyzed in a subsequent NEPA analysis (e.g., the difference in impact is the result of a management change for which an EA or EIS was written)? Is there new scientific information or research indicating or suggesting a change in our understanding of the impact of the fisheries on the resource?

Killer Whale (Transients):

In previous assessments, there were six different federal commercial fisheries in Alaska that could have had incidental serious injuries or mortalities of killer whales and were observed. In 2004, the definitions of these fisheries were changed to reflect target species; these new definitions have resulted in the identification of 22 observed fisheries that use trawl, longline, or pot gear. Of these fisheries, there were two which incurred serious injury and mortality of killer whales (any stock) between 2007 and 2009: the BSAI flatfish trawl and the BSAI Greenland turbot longline. The mean annual (total) mortality rate for all fisheries for 2007-2009 was 1.5 (CV =0.19) (note: This does not include the AT1 pod with a known range limited to waters of Prince William Sound and Kenai Fjords where there are no federally managed commercial fisheries). Unclear how this new information would affect the analysis in the 2004 PSEIS.

Other Toothed Whales:

Over the past few years, observers have collected tissue samples of many of the killer whales which were killed incidental to commercial fisheries. Genetics analyses of samples from the killer whales have indicated that the mortalities incidental to the BSAI flatfish trawl and the BSAI Pacific cod fisheries are of the “resident” type, and mortalities incidental to the BSAI pollock trawl fishery are of the “transient” type (M. Dahlheim, pers. comm., National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA 98105). The mean annual estimated level of serious injury and mortality of Alaska resident killer whales is 1.49/year (Allen and Angliss, 2013). There are many reports of killer whales consuming the processing waste of Bering Sea groundfish trawl fishing vessels (Perez 2006). However, the ‘resident’ stock of killer whales is most likely to be involved in such fishery interactions since these whales are known to be fish eaters, while ‘transient’ whales have only been observed feeding on marine mammals. Recently, several fisheries observers reported that large groups of killer whales in the Bering Sea have followed vessels for days at a time, actively consuming the processing waste (Fishery Observer Program, unpubl. data, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115). On some vessels, the waste is discharged in the vicinity of the vessel’s propeller (NMFS unpublished data); consumption of the processing waste in the vicinity of the propeller may be the cause of the propeller-caused mortalities of resident killer whales in the BSAI flatfish trawl fishery. Unclear how this new information would affect the analysis in the 2004 PSEIS.

One harbor porpoise mortality was observed in 2007 in the Bering Sea/Aleutian Islands flatfish trawl, which is the only harbor porpoise mortality observed during the 2007-2010 period. Therefore, the mean annual (total) mortality rate resulting from observed mortalities was 0.53 (Allen and Angliss, 2013). Because the abundance estimates are 13 years old and information on incidental mortality in commercial fisheries is sparse, the Bering Sea stock of harbor porpoise is classified as a strategic stock. Unclear how this new information would affect the analysis in the 2004 PSEIS.

Between 2007 and 2010, there was one observed serious injury of a sperm whale in the Gulf of Alaska sablefish longline fishery (Allen and Angliss, 2013). This animal was designated as seriously injured because it became caught in the gear, and was released alive with trailing gear. Unclear how this new information would affect the analysis in the 2004 PSEIS.

There were no serious injuries or mortalities incidental to observed commercial fisheries reported for Pacific white-sided dolphins, beluga whales, or any of the beaked whales (Perez 2006; Allen and Angliss, 2013). However, for Bristol Bay belugas it is unknown whether the U. S. commercial fishery-related mortality level is insignificant and approaching zero mortality and serious injury rate (i.e., 10% of PBR; less than 4.9 per year) because a reliable estimate of the mortality rate incidental to commercial fisheries is currently unavailable. Similarly, current observer data on fisheries within Cook Inlet are lacking; however, no mortalities in U. S. commercial fisheries have been reported for this beluga stock. Thus annual mortality levels are considered insignificant and approaching zero mortality and serious injury rate, although the lack of recent fisheries data is a concern for this small population.

Baleen Whales:

Humpback whales: For the Western North Pacific stock, the estimated human-related mortality rate based solely on mortalities that occurred incidental to U. S. commercial fisheries is 0.37; therefore, the estimated fishery mortality and serious injury rate exceeds 10% of the PBR (0.2) and cannot be considered insignificant and approaching zero (Allen and Angliss, 2013). This may require reanalysis.

No mortalities or serious injuries by groundfish commercial fisheries were reported for fin whales, minke whales, North Pacific right whales, bowhead whales (Allen and Angliss, 2013), gray whales, or blue whales (Carretta et al. 2012). However, there is little information on western gray whales that may migrate through Alaska waters during the winter months.

4 Are there new methods of analysis or protocols for evaluating impacts?

Has a new methodology been developed for better understanding or evaluating impacts of the fisheries on the resource? Has that methodology been used in NEPA analyses of management actions affecting the resource, since the 2004 PSEIS?

No

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

If new information is available, consider whether taking that information into account would cause you to reach a different conclusion about the effect of the groundfish fisheries on the resource. Provide a rationale if you conclude that it would not, or some discussion if you think this issue needs further investigation. We are not asking for the new analysis to be undertaken, only for you to provide a discussion of whether it is merited.

Potentially for Cook Inlet beluga whales now listed as a DPS under ESA.

Also, Bering Sea harbor porpoise, Western North Pacific stock of humpback whales, western gray whales, and killer whales (see notes above).

Citations

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Zerbini, A. N., J. M. Waite, J. Durban, R. LeDuc, M. E. Dahlheim and P. R. Wade. 2007. Estimating abundance of killer whales in the nearshore waters of the Gulf of Alaska and Aleutian Islands using line-transect sampling. Mar. Biol. 150(5):1033-1045.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

What resource component is this review for? _Marine Mammals – Sea otters___________________
What sections of the PSEIS were reviewed? 4.9.8.9

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Yes. On August 9, 2005, U.S. Fish and Wildlife Service (USFWS) published a final rule (70 FR 46366) to list the southwest Alaska Distinct Population Segment (DPS) of the northern sea otter (*Enhydra lutris kenyoni*) as threatened under the Endangered Species Act.

On October 8, 2009, the USFWS published a final rule designating 15,164 square kilometers (5,855 square miles) as critical habitat for the southwest Alaska DPS of the northern sea otter (74 FR 51988). The critical habitat rule became effective on November 9, 2009. The critical habitat is designated in five units: the Western Aleutian Unit; the Eastern Aleutian Unit; the South Alaska Peninsula Unit; the Bristol Bay Unit; and the Kodiak, Kamishak, Alaska Peninsula Unit. Within these units, critical habitat occurs in nearshore marine waters ranging from the mean high tide line seaward for a distance of 100 meters, or to a water depth of 20 meters. While sea otter critical habitat predominately occurs within state waters, DOI has designated some critical habitat within federal waters where water depth is 20 meters or less.

On September 6, 2013, the USFWS announced the availability of the recovery plan for the southwest Alaska DPS of the northern sea otter (78 FR 54905). The recovery plan describes the status, current management, recovery objectives and criteria, and specific actions needed to enable us to delist the southwest Alaska DPS of the northern sea otter (USFWS 2013a).

2 Has the status of the resource changed?

Yes. The southwest Alaska DPS of the northern sea is now listed as threatened under the Endangered Species Act. However, based on the most recent comprehensive assessment of the northern sea otter status in the 2013 Recovery Plan, the population abundance and trends have generally not notably changed since the early 2000s (USFWS 2013a).

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Yes. In 2006, NMFS and the USFWS consulted on the southwest Alaska DPS of the northern sea otter and the consultation concluded that the groundfish, crab, and scallop fisheries are not likely to adversely affect sea otters.

In response to the designation of critical habitat, NMFS reinitiated Section 7 consultation. The biological assessment evaluated the potential effect of the BSAI Groundfish and GOA Groundfish FMPs on the southwest Alaska DPS of the northern sea otter and its critical habitat. The analysis concluded that the Alaska federally managed fisheries authorized by the FMPs and State of Alaska parallel groundfish fisheries are not likely to adversely affect the southwest Alaska DPS of the northern sea otter or its designated critical habitat. On July 10, 2013, the USFWS concurred with NMFS's determination that authorization of the specified fisheries is not likely to adversely affect the southwest Alaska DPS of the northern sea otter and will not result in adverse modification of sea otter critical habitat (NMFS 2013, USFWS 2013b).

4 Are there new methods of analysis or protocols for evaluating impacts?

No.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. NMFS conducted a new analysis for the Biological Assessment and arrived at a practically similar conclusion (NMFS 2013).

6 References:

NMFS. 2013. Biological Assessment of the Effects of the Federal Fisheries, State Parallel Groundfish Fisheries and Pacific Halibut Fisheries on the Southwest Alaska Distinct Population Segment of the Northern Sea Otter and Its Designated Critical Habitat. URL: *http://alaskafisheries.noaa.gov/protectedresources/seaotters.htm*

USFWS. 2013a. Southwest Alaska Distinct Population Segment of the Northern Sea Otter (*Enhydra lutris kenyoni*) - Recovery Plan. U.S. Fish and Wildlife Service, Region 7, Alaska. 171pp. URL: http://www.fws.gov/alaska/fisheries/mmm/seaotters/pdf/Recovery%20Plan%20SW%20AK%20DPS%20Sea%20Otter%20Aug13.pdf

USFWS. 2013b. Letter Re: Statewide NMFS groundfisheries (Consultation Number 2011-0180). From Ellen W. Lance, Endangered Species Branch Chief, to NMFS. URL: http://alaskafisheries.noaa.gov/protectedresources/seaotters/usfws_groundfishdetermination0713.pdf

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 7/17/13

What resource component is this review for? Seabirds
What sections of the PSEIS were reviewed? Short-tailed Albatross; Laysan and Black-footed Albatross; shearwaters; Northern fulmars; Species of management concern (Red-legged Kittiwakes, Marbled and Kittlitz's murrelets); Other piscivorous species (most alcids, gulls, and cormorants); other planktivorous species (Storm-petrels and most Auklets); Spectacled Eiders and Steller's Eiders

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Have there been substantial changes in the management program that have affected the resource, since the 2004 PSEIS (e.g., species is now managed independently, rather than as part of a complex; implementation of catch share privileges or closure areas affecting fisheries targeting resource)?

The primary management action affecting seabird resources was the requirement for longline vessels to use seabird mitigation measures (i.e., streamer lines). This was implemented in February 2004, just before release of the PSEIS. The Freezer Longline fleet had largely adopted the practice of deploying streamer lines in 2002, taking advantage of free streamer lines supplied first by the US Fish and Wildlife Service and later by NOAA Fisheries. Use of seabird avoidance gear has likely reduced overall bycatch by 100,000 birds since implementation (Fitzgerald, pers comm). An analysis of the reduced overall bycatch and reduction in bycatch rates is currently underway at the AFSC in partnership with Washington Sea Grant Program. Another management change – implementation of the restructured observer program in 2013 – will allow a better evaluation of total fishery impacts on the resource in the future.

2 Has the status of the resource changed?

Is the status of the resource different than described in the 2004 PSEIS, and if so, how? What has affected the change in status? Is the current status within the range of variability analyzed in the 2004 PSEIS?

Status of the various seabird species groups remains unchanged. The short-tailed albatross population continues to grow at an ca 7.5% rate and is currently estimated to be 4,023 individuals (STAL Recovery Team information). The USFWS and Japanese counterparts have spent 5 years rearing and fledging translocated Short-tailed albatross chicks on Mukojima Island. The project translocated 70 chicks and 69 fledged. In 2012/13 one nesting attempt occurred but failed. This was a 2008 bird. Re-establishing a colony on the island is a goal of the Short-tailed albatross recovery team. The USFWS was petitioned to list the Black-footed albatross at threatened under the ESA. A review was completed on 7 October, 2011 where the FWS determined that listing was not warranted at the time (Federal Register Vol 76, No. 195: 62504-62565). Populations of other birds, such as Northern Fulmars, are extremely difficult to survey and assess due to the remote locations and difficult terrain of their colonies. Trend information for many of these species is not available.

Review of conclusions in 2004 PSEIS SIR

~6/19/2013

What resource component is this review for? __**Habitat**___________
What sections of the PSEIS were reviewed? **3.6,_4.1__4.4**________________

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Have there been substantial changes in the management program that have affected the resource, since the 2004 PSEIS (e.g., species is now managed independently, rather than as part of a complex; implementation of catch share privileges or closure areas affecting fisheries targeting resource)?

Substantial changes to the management of habitat have included implementation of regulations to protect habitat that provides structural relief and gear modifications to limit adverse impacts of trawling on the seafloor. In 2005 in the Aleutian Islands, closure areas that prohibit all bottom trawling in the Aleutians, except in small discrete "open" areas were implemented, and Habitat Conservation Zones with high density coral and sponge habitat were closed to all bottom-contact fishing gear. In 2008 in the Bering Sea, measures were enacted to conserve benthic fish habitat by "freezing the footprint" of bottom trawling by limiting trawl effort only to those areas more recently trawled. A deep slope and basin area and three habitat conservation areas around St Matthew Island, St Lawrence Island were closed to bottom trawling. In 2005 in the Gulf of Alaska several new HAPCs were implemented; the Slope Habitat Conservation Areas, Seamount Habitat Protection Areas, and the Gulf of Alaska Coral Habitat Protection Areas. In 2011 for the Bering sea flatfish fishery elevating devices (e.g., discs or bobbins) are required to be used on the trawl sweeps, to raise the sweeps off the seabed and limit adverse impacts of trawling on the seafloor.

For more information see

http://alaskafisheries.noaa.gov/npfmc/conservation-issues/habitat-protections.html
and
http://alaskafisheries.noaa.gov/npfmc/conservation-issues/gear-mods.html

2 Has the status of the resource changed?

Is the status of the resource different than described in the 2004 PSEIS, and if so, how? What has affected the change in status? Is the current status within the range of variability analyzed in the 2004 PSEIS?

The status or condition of habitat described in the PSEIS was rated as "conditionally significant adverse". This status was based on the conclusion that, coupled with historical impacts, impacts to long-lived slow growing species (i.e. corals) could cause long-term damage and possibly irreversible loss of living habitat. The word "conditionally" was used to indicate that a significant impact is based on credible scientific information and professional judgement, but more complete information is need for certainty. The current status of habitat is the same as in the 2004 PSEIS because long lived slow growing species have likely not recovered from the impacts of historical fishing and impacts continue in areas that are open to bottom trawling.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

As mentioned in the PSEIS, a separate analysis of Essential Fish Habitat (EFH) overlapped PSEIS development. This analysis, resulting in the 2005 EFH EIS, carried out many of the overarching policies anticipated in the preferred alternative. It updated and detailed the designation of EFH for all species managed under the Management Plans, established a process for considering proposed habitats for designation as Habitats of Particular Concern (HAPC), analyzed the effects of fisheries on EFH, and proposed precautionary actions to minimize those effects. That analysis and its subsequent reconsideration in 2009 clearly represent new information regarding the impacts of groundfish fisheries on habitat.

Some additional research on effects of fishing

Additional research on the habitat requirements of different species
EFH funded habitat research – e.g., flatfish juvenile habitat

Research and development of modifications to trawl gear to reduce effects on habitat
Bottom trawl sweep modifications to reduce effects on structure and epifauna, implemented through regulations for Bering Sea and GOA flatfish fisheries.

Limited additional research on the recovery of habitat from damage due to trawl gear
Some EFH funded research
Revisting sites that were trawled 13 years ago in the eastern Gulf of Alaska to evaluate long term effects of trawling on sponge habitat

Improved resolution of data on the distribution of fishing effort due to broader implementation of VMS in Alaska fisheries.
Vast majority of fishing effort is now tracked with VMS, providing much higher resolution of the footprint of those efforts. Full use of such data would likely indicate more area unaffected by fishing but fished areas having higher fishing intensities over analyses based on averaging effort over larger spatial scales. The net effect would be a lowering of LEI estimates, albeit likely small.

Additional information on the distribution of habitat types and features
Efforts to provide better technology for characterizing habitats
Detailed habitat mapping in the Gulf of Alaska and Aleutian Islands in the vicinity of fishing activities and for studies of corals

Development of an Alaska Essential Fish Habitat Research Plan (Sigler et al 2012)

Consideration of the EFH EIS analysis resulted in a number of precautionary management actions to reduce the effects of fishing on habitat. This included a number of new areas closed to fishing, particularly bottom trawling, and modifications to fishing gear, specifically trawl sweeps. The existence of those actions will also affect any new analysis of the effects of fishing on habitat.

4 Are there new methods of analysis or protocols for evaluating impacts?

The 2005 EFH EIS included a detailed analysis of the effects of fishing on EFH of Alaska marine species managed under FMPs. This analysis, described in Appendix B of the EIS, included 1) an analysis of the distribution and intensity of the effects of fishing on classes of features that function as habitat for fish (infaunal prey, epifaunal prey, biological structure and non-living structure) and 2) expert assessments of the potential for that distribution of effects to affect the life history functions of spawning, breeding, feeding, and growth to maturity for each of the managed species. Those assessments were made against the standard of whether they exceeded effects that were 'more than minimal and not temporary'.

The effects of fishing analysis was based on a model developed by Jeff Fujioka (Fujioka 2006), that considered the combination of fishing intensity, sensitivity of habitat features to fishing, and recovery rates of habitat features to estimate a long-term effects index (LEI), representing the proportional reduction in the habitat feature from the unfished state should that fishing intensity be continued indefinitely. The spatial distribution of LEI values for each habitat features class provided a useful and accessible description of fishing's effects on habitat, which could then be considered by experts on each managed species to assess the potential for significant effects on life-history processes. A significant limitation on this assessment was the lack of comprehensive data to map the distribution of functional habitat features or the distribution of their use by each life-history stage of the species. These limited the assessment to use of a map of the proportional reduction of such features (LEI) and expert knowledge of the biological needs of each species.

Although this methodology for evaluating impacts is different from that used in the PSEIS, it is important to note that the scope of PSEIS is broader than the EFH EIS. The EFH EIS considered impacts of fishing on benthic marine habitat from the perspective of managed species that are dependent on habitat features. The scope of the PSEIS was broader and considered adverse impacts to marine benthic habitat from the perspective of ecosystem structure and function, as well as managed species.

Other models for the effects of fishing have been proposed and applied in different areas. Such models either provide less specific information or require information that is not available for Alaska fisheries e.g., distribution of habitat features or growth rates of such features). At this point, the Fujioka model remains a good fit for analysis of the effects of Alaska's fisheries on EFH. Nevertheless, the next cyclical reassessment of the EFH EIS analysis has just begun and may identify an improved or superior model.

Fujioka, J.T. 2006. A model for evaluating fishing impacts on habitat and comparing fishing closure strategies. Can. J. Fish. Aquat. Sci. 63:2330-2342

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

By and large, analyses and research subsequent to the PSEIS have confirmed its general conclusions. In fact, the PSEIS used much of the same fishing data and an early version of the Fujioka model in its analyses. Both the PSEIS and the EFH EIS identified that fishing reduced habitat features.
The EFH EIS also assessed whether the distribution and intensity of those effects matched with life-history requirements of managed species in a way that indicated that their habitat was affected in a way that was more than minimal and not temporary. That assessment, and a subsequent reassessment in 2009, identified few places indicating that standard had been exceeded. (A specific area of concern for red king crab in the Amak Island area is receiving further review). Appropriately, many assessments indicated substantial uncertainty, primarily due to lack of specific knowledge of the distribution of fish use of habitat features, particularly for juveniles and spawning concentrations. This uncertainty motivated precautionary management actions to reduce fishing effects on habitat. Those actions, and a general reduction in fishing intensity, if anything, may result in some reduction of the estimated effects on reanalysis.

In a similar way, further research studies on the processes that underlie the effects of fishing on benthic habitat, while increasing the specificity and certainty of knowledge, have not demonstrated any substantial errors in the information used in the 2005 EFH EIS or the PSEIS analysis. A subsequent analysis will provide more specific estimates with less uncertainty, but is not likely reach seriously different conclusions.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/5/13

What resource component is this review for? _**Socioeconomics**______
What sections of the PSEIS were reviewed? _**4.9-235 through 4.9351; Table 4.10-2b; Table 4.9-6; Table 4.2-2_**

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

Have there been substantial changes in the management program that have affected the resource, since the 2004 PSEIS (e.g., species is now managed independently, rather than as part of a complex; implementation of catch share privileges or closure areas affecting fisheries targeting resource)?

The document (Section 4.9, Socioeconomics pages 235-351, in particular) makes references to increasing the number of fisheries that will be rationalized in the coming years. Since 2004, we have seen the rationalization of AM80 groundfish, the rockfish fishery, and the P. cod freezer longliners. BSAI crab has also been rationalized, though it is obviously not part of the groundfish FMP, but references are made to crab stocks at points throughout this resource component and to excess capacity in the crab fisheries (now essentially gone). As such, much of the speculation about potential rationalization programs, or unrealized benefits or costs of such programs, can be better articulated at this time. Accordingly, statements about unrealized benefits and the amount of those benefits should probably be toned down a bit, as fishery rationalization has already occurred in many fisheries and there is not nearly as much unexplored territory as back in 2004.

Bycatch management in this document could be updated to reflect the new Chinook salmon bycatch IPA's and hard cap as well as Steller sea lion closures.

2 Has the status of the resource changed?

Is the status of the resource different than described in the 2004 PSEIS, and if so, how? What has affected the change in status? Is the current status within the range of variability analyzed in the 2004 PSEIS?

The document makes reference to projected trends in particular species repeatedly in different parts of this section (there are too many instances to mention; this document restates much of the same information and conclusions in each section of the Socioeconomics portion). Basically, you'll need to read through the specific references to species trends and see if the projected trends based upon the information in 2004 have played out. Similarly, references are made to the impacts of climate change and I believe we have seen more of the impacts of climate change since this document was published.

Specific statements that appear repeatedly and should be checked include:

- *Downward trends in salmon and crab fisheries
- *Significant decreases in sablefish and rockfish
- *Large increases in catch of P.cod expected

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

Are the fisheries affecting the resource differently than described in the 2004 PSEIS? Is this difference within the range of variability analyzed in the 2004 PSEIS? Has the difference been analyzed in a subsequent NEPA analysis (e.g., the difference in impact is the result of a management change for which an EA or EIS was written)? Is there new scientific information or research indicating or suggesting a change in our understanding of the impact of the fisheries on the resource?

There are some impacts that the document doesn't address which have become issues of concern for the public and considered by the Council. For example, in the analysis of the preferred alternatives in Section 4.9.9.1.1, there is no discussion of the impacts of rationalization on crew and the concerns that have arisen about the way in which high lease rates affect the financial return or average daily wages for crew members aboard vessels. Sections about "Employment and Payments to Labor" assume impacts are insignificant. It is sort of assumed that crew are not adversely impacted but I think we have seen many crew feel as though their compensation has decreased per day. This may be true and it may be due to excess crew labor relative to boats on the water, but it should be addressed in the document or at least acknowledged.

This section repeatedly makes reference to "model results" that predict changes in vessel landings, by species, with accompanying estimates of changes in catch and revenue. It seems as though whatever model generated these predictions could be updated to reflect data covering the last 7 or so years. I doubt any of the specific estimates (e.g., P.cod is expected to increase by about 29%, 44% or 49% -- different numbers are given in two paragraphs on page 4.9-301 and on page 4.9-321) are likely to be accurate today (errors notwithstanding). It's probably worthwhile noting that the P.cod longline CP fleet has been rationalized.

Comments are also made about decreases in ex-vessel value occurring with rockfish and sablefish, but this doesn't appear to be accurate. There is no recognition of rockfish being rationalized.

Comments are made on 49-308 about what will happen if head-and-gut fisheries are rationalized (and they were through AM80) and one should check to see if the species-specific predictions listed there are accurate or can be updated.

4.9-313 comments about significant reductions in excess capacity among CPs seems overstated, as nearly all CPs are rationalized at this point.

Impacts of salmon closures on Average Cost sections of the document should be included/addressed.

The entire section on Regional Socioeconomic Effects beginning on page 4.9-325 makes very specific statements about community impacts coming from a model. I would recommend running this model with newer data to see if the same trends arise. Given the specificity here, it's likely to be stale.

4 Are there new methods of analysis or protocols for evaluating impacts?

Has a new methodology been developed for better understanding or evaluating impacts of the fisheries on the resource? Has that methodology been used in NEPA analyses of management actions affecting the resource, since the 2004 PSEIS?

You may want to check with AKR staff, but I believe Ben Muse has developed economic impact models for the most recent Steller sea lion closures. The Biop has also been released. There are also published papers describing the impacts of crab rationalization:
Abbott, Joshua K.; Garber-Yonts, Brian; Wilen, James E.; Marine Resource Economics, 2010, v. 25, iss. 4, pp. 333-54
Matulich, Scott C.; Marine Resource Economics, 2009, v. 24, iss. 2, pp. 187-93
Matulich, Scott C.; Marine Resource Economics, 2008, v. 23, iss. 3, pp. 253-71

I recognize that crab is not part of this PSEIS, but there are interesting insights into effects of rationalization on various groups.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

If new information is available, consider whether taking that information into account would cause you to reach a different conclusion about the effect of the groundfish fisheries on the resource. Provide a rationale if you conclude that it would not, or some discussion if you think this issue needs further investigation. We are not asking for the new analysis to be undertaken, only for you to provide a discussion of whether it is merited.

I don't believe the fundamental impacts of rationalizing fisheries or closing areas to fishing are incorrect in this document. I believe that the Council has essentially slowly implemented many of the policies laid out in this document and that the basic understanding of the effects of rationalization on overcapacity, efficiency, and the nature of the jobs is correct. However, the document seems to reflect the understanding a decade ago of who would win and lose as a result of rationalization; there are some relatively specific predictions about regional economies and how crew and vessel owners will be affected. There are also very specific model results and statements about species trends that could be updated. I believe that given the number of rationalization programs that have been implemented we don't need to rely on those predictions as heavily today, and could likely appeal to actual results rather than predictions. I think the magnitude of the benefits of the preferred alternatives is likely much smaller today given how much of the fishery has already been rationalized, and we also have a better idea of the economic costs of spatial closures due to work done by regional economists estimating, for example, the costs of Steller sea lion closures.

Template for PSEIS SIR – review of conclusions in 2004 PSEIS

draft 6/6/13

What resource component is this review for? _**Ecosystems**__________________
What sections of the PSEIS were reviewed? __**4.9.10**_________________

Please answer the following questions with respect to the resource component in question.

- Please provide rationale and discussion of your response, while at the same time keeping it fairly succinct.
- Where appropriate, reference other documents where analysis can be found in detail.
- Responses can be written out, or in bullets.
- In most cases, we are expecting something in the range of 2-5 pages for a particular resource component.

1 Has management of the resource changed?

No.

2 Has the status of the resource changed?

The Ecosystem Indicators of status, including energy flow, diversity, aggregate top predators, and forage fish have been monitored through the annual publication of the Ecosystem Chapter in the SAFE (e.g. Zador et al. 2012). This has monitored short-term changes in properties – for example, forage fish biomass was significantly below average for 2004-2008, and has since returned towards average. There is no evidence that these variations are outside short or medium-term (3-5 year) range of natural variability as measured over the last 30 years.

3 Is there new information regarding the impacts of the groundfish fisheries on the resource?

There has been substantial new world-wide research (e.g. comparisons between ecosystems) on energy flow within ecosystems, for example, the importance of trophic structure or necessary minimum forage fish biomass required to feed top predators within ecosystems. However, this information does not suggest that impacts of the groundfish fishery on the Alaska ecosystems specifically (BSAI and GOA) have significantly changed. Impacts on ecosystems have been analyzed in multiple EAs on specific management changes and no significant differences have been noted in those EAs.

4 Are there new methods of analysis or protocols for evaluating impacts?

Significant improvements have been made to monitoring critical aspects of the ecosystem through the development of annual Ecosystem Assessments and Report Cards (e.g. Zador et al. 2012). Furthermore, these improvements have been carried forward into Management Strategy Analyses (MSEs) of the impacts of management strategies on different ecosystem aspects. The ecosystem research is currently being developed within the Alaska Fisheries Science Center as an extended Integrated Ecosystem Assessment (IEA) program to provide data for 'end to end' models that connect climate variability to groundfish and salmon (Chinook and chum; prohibited species catch) recruitment. The modeling effort and ecosystem data provide a formal method for evaluating climate impacts on Alaska's large marine ecosystems.

5 Would a new analysis using the latest methods and information reach a seriously different conclusion?

No. The new research and information will enable improved monitoring of the ecosystem research, but to date does not suggest that the conclusions of section 4.9.10 would differ substantially.

Ref: Zador et. al. 2012. Ecosystem Considerations. *In:* Stock assessment and fishery evaluation report for the groundfish resources or the Bering Sea/Aleutian Islands regions. North. Pac. Fish. Mgmt. Council, Anchorage, AK.

RECORD OF DECISION

FINAL ALASKA GROUNDFISH FISHERIES PROGRAMMATIC
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

National Marine Fisheries Service
Alaska Region

1. INTRODUCTION

This Record of Decision (ROD) documents the decision by the National Marine Fisheries Service (hereinafter referred to as NOAA Fisheries) to select the Preferred Alternative set forth in the Alaska Groundfish Fisheries Final Programmatic Supplemental Environmental Impact Statement (PSEIS) as its policy choice for the management of the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) groundfish fisheries. As a first step, NOAA Fisheries approves Amendment 74 to the GOA Fishery Management Plan (FMPs) and Amendment 81 to the BSAI FMP, which amend the previous FMPs to include the management approaches, goals and objectives contained in the Preferred Alternative.

2. BACKGROUND

A. Purpose, Need and Federal Action Addressed in the PSEIS

Environmental Impact Statements (EISs) for the GOA and BSAI Groundfish FMPs were prepared in 1978 and 1981, respectively. The National Environmental Policy Act (NEPA) requires preparation of an EIS or Supplemental EIS (SEIS) when significant environmental changes have occurred. Significant changes have occurred in the GOA and BSAI groundfish fisheries and the GOA and the BSAI environment since the original EISs for the GOA and BSAI FMPs were published approximately 25 years ago. These changes include (but are not limited to) the following: the fisheries have shifted from primarily foreign fisheries to completely domestic fisheries; the FMPs governing the fisheries have been amended numerous times; new information is available about the ecosystem; the science of fisheries management has progressed substantially; public opinion about the management of these fisheries has changed; and several bird and marine mammal species have been listed as threatened or endangered under the Endangered Species Act (ESA).

While Environmental Assessments (EAs) and several EISs have been prepared for BSAI and GOA FMP amendments over the ensuing years, none have comprehensively examined the groundfish FMPs at a programmatic level. In 1999, U.S. District Court Judge Thomas S. Zilly issued a ruling in *Greenpeace v. National Marine Fisheries Service,* 55 F.Supp.2d 1248 (W.D.Wash.1999) that a 1998 SEIS prepared for BSAI and GOA FMPs was legally inadequate and remanded the document to NOAA for additional analyses, directing NOAA Fisheries to produce a "programmatic" SEIS.
The Alaska Groundfish Fisheries PSEIS has multiple purposes. First, it serves as the central

environmental document supporting the management of the BSAI and GOA groundfish fisheries. The historical and scientific information and analytical discussions contained therein are intended to provide a broad, comprehensive analysis of the general environmental consequences of fisheries management in the Exclusive Economic Zone (EEZ) off Alaska. The document also provides Agency decision-makers and the public with an analytical reference document necessary for making informed policy decisions in managing the groundfish fisheries and sets the stage for future management actions. In addition, it describes and analyzes current knowledge about the physical, biological, and human environment in order to assess impacts resulting from past and present fishery activities. The PSEIS is intended to bring both the decision-maker and the public up to date on the current state of the environment, while describing the potential environmental consequences of alternative policy approaches and their corresponding management regimes for management of the groundfish fisheries off Alaska. In doing so, it serves as the overarching analytical framework that will be used to define future management policy with a range of potential management actions.

The federal action addressed in the PSEIS is defined as the management of groundfish fisheries and the authorization of groundfish fishery activities off Alaska, pursuant to the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area and the Fishery Management Plan for the Gulf of Alaska Groundfish Fishery.

B. Roles of the Department of Commerce/NOAA and North Pacific Fishery Management Council in the EIS Process

The roles of the Secretary of Commerce, NOAA Fisheries, the North Pacific Fishery Management Council (NPFMC) and stakeholders in the decision-making and fisheries management process are explained in detail in the Final PSEIS, Section 2.4 and Appendix B, Sections B.3.1.1 and B.3.1.2. The Secretary of Commerce, Department of Commerce (DOC) is responsible for marine fisheries management in the United States as prescribed by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 USC 1801, *et. seq*.). NOAA Fisheries is responsible for executing the day-to-day management of the fisheries as well as the enforcement of fisheries management regulations (in conjunction with the U.S. Coast Guard). The MSA established and defined the role of the NPFMC as recommending FMPs, FMP amendments and regulations to the Secretary of Commerce for approval.

Through this NEPA process and Amendments 74 and 81, the NPFMC is setting a course to follow in the future management of the groundfish fisheries of the North Pacific. Future assessments of the impacts and results obtained from such future fishery management actions recommended by the NPFMC and undertaken by NOAA Fisheries will be based on future NEPA analyses. Also, the authority given to the Secretary by the MSA to approve or—if the proposed FMPs or FMP amendments are inconsistent with applicable law—to disapprove or partially approve the FMPs or FMP amendments submitted by the NPFMC for consideration ensures that NPFMC-recommended management measures comply with applicable law.

C. Procedural History of the PSEIS and Amendments 81/74

A Notice of Intent to prepare a PSEIS on the Alaska groundfish fisheries was published in the *Federal Register* on October 1, 1999 (64 FR 53305). NOAA Fisheries released a Draft PSEIS on the Alaska groundfish fisheries for public review and comment in January 2001(February 2, 2001, 66 FR 8788). In November 2001, NOAA Fisheries announced its intent to revise the 2001 Draft PSEIS (November 27, 2001, 66 FR 59228). Based on its review and preliminary analysis of the comments received on the 2001 Draft PSEIS, NOAA Fisheries determined that the Draft PSEIS should be revised to include additional analyses concerning environmental, economic and cumulative impacts; that the alternatives examined in the Draft PSEIS should be restructured from single-focus alternatives to more comprehensive, multiple-component alternatives; and that it should be edited to evaluate more concisely the proposed action. Given these decisions, NOAA Fisheries determined that it would release a revised Draft PSEIS for public review and comment before issuing the Final PSEIS. After extensive public input in the development of the alternatives to be analyzed in the revised Draft PSEIS, NOAA Fisheries released the revised Draft PSEIS for public review and comment in August 2003 (August 29, 2003; 68 FR 52018).

At its April 2004 meeting, the NPFMC recommended that the preliminary Preferred Alternative identified in the 2003 Draft PSEIS be modified, recommended that the modified alternative be identified as the Preferred Alternative in the Final PSEIS, and adopted Amendments 81/74 to the FMPs. The NPFMC's recommendations were based on its review of the findings contained in the 2003 Draft PSEIS and public comment. The NPFMC submitted Amendments 81/74 for Secretarial and public review, and consistent with the requirements of the MSA, NOAA Fisheries published in the *Federal Register* a Notice of Availability of Amendments 81/74 and solicited public comments on the Amendments (June 2, 2004; 69 FR 31091). The Notice of Availability for the Final PSEIS was published by the Environmental Protection Agency on June 4, 2004 (69 FR 31613). While not specifically requesting public comments on the Final PSEIS, NOAA did provide the public with an address and a July 6, 2004, deadline for submitting comments on the document should they wish to do so. The public comment period on Amendments 81/74 closed on August 2, 2004.

As approved by the Secretary of Commerce, Amendments 81/74 amend the existing Goals and Objectives sections of the FMPs to incorporate the management approach and objectives contained in the Preferred Alternative of the Final PSEIS.

D. PSEIS as a Planning Tool

For purposes of the PSEIS, NOAA Fisheries presumes that the Alaska groundfish fisheries result in some significant effects, both positive and negative, to the natural and socio-economic environments. The PSEIS has been structured in a manner that identifies these effects (direct, indirect, and cumulative) to the extent possible and explores alternative fisheries policies and specific management actions that might serve to mitigate adverse impacts. It is expected that managers and the public will work together in determining the most efficient ways of achieving the goals and objectives stated in the FMPs.

Producing this PSEIS has served its purpose of informing the decision-maker and the public on the issues and potential environmental consequences of the Preferred Alternative and other alternatives. This PSEIS will also serve managers and the public in the future as a reference and guide for the mutual development of FMP amendments. To the degree that the effects of proposed management measures already fall within the Preferred Alternative FMP bookends, or within the range illustrated by the bookends, anticipated efficiencies in preparing second-level tiered EAs or EISs can be achieved to the benefit of managers, the public, and the resource. The Agency recognizes that the PSEIS will require periodic updates as new information becomes available and/or significant changes occur in relation to the fisheries or the environment.

The lead agency for the PSEIS is the Alaska Region of NOAA Fisheries. The Alaska Department of Fish & Game (ADF&G) and the U.S. Fish & Wildlife Service (USFWS) were cooperating agencies under NEPA regulations at 40 CFR section 1501.6.

3. ALTERNATIVES CONSIDERED

The following is a brief summary of the programmatic alternatives considered in detail in the Final PSEIS (including the no action alternative) and other alternatives considered but eliminated from detailed study in the PSEIS. Further detailed information on the programmatic alternatives may be found in Chapter 2 (Section 2.6) and Chapter 4 (Sections 4.2 and 4.3) of the PSEIS and a description of the evolution of the alternatives considered in detail in the Final PSEIS may be found on pages 2-44 of the Final PSEIS. NOAA Fisheries is selecting the Preferred Alternative in the Final PSEIS as the groundfish fisheries management policy for the GOA and BSAI groundfish fisheries off Alaska.

As mentioned above, two Draft PSEISs were prepared and released to the public for review and comment. In the 2001 Draft PSEIS, six alternatives to status quo were considered in detail. Based on public comment, those alternatives were modified from single-focus alternatives to more comprehensive, multiple component alternatives. The 2003 revised Draft PSEIS analyzed five alternatives: a no action alternative (Alternative 1), an aggressive harvest management alternative (Alternative 2), a precautionary management alternative (Alternative 3), a highly precautionary alternative (Alternative 4) and a preliminarily Preferred Alternative that is a modified version of Alternative 3 that also incorporates elements of Alternatives 1 and 4. The Final PSEIS also presents an analysis of five alternatives. With the exception of the Preferred Alternative, the alternatives in the Final PSEIS are identical to those presented in the 2003 Draft PSEIS. The preliminarily Preferred Alternative presented in the 2003 Draft PSEIS was modified in response to public comments and finalized as the Preferred Alternative in the Final PSEIS.

The alternatives analyzed in the Final PSEIS are comprised of three elements: a management approach statement that describes the goals, rationale, and assumptions behind the alternative; a set of management objectives that complement and further refine the goals set forth in the management approach; and, except for the no action/status quo alternative (Alternative 1), a pair of example FMP "bookends" that illustrate and frame the range of implementing management measures for that alternative.

The management approach statement and objectives serve to define the policy direction NOAA Fisheries and the NPFMC will follow in the management of the fisheries under each alternative. The example FMP bookends serve two purposes: first, they provide an additional level of analytical detail that facilitates the comparison of the physical, biological and socioeconomic effects of the alternatives in relation to the environmental baseline (i.e., the condition of the environment and the fisheries up through 2001 and 2002); and second, they provide the public with an illustration of the types and range of management measures NOAA Fisheries and the NPFMC envision using to achieve the goals of the alternative in 2004 and beyond. It is important to note that because the FMP bookends and the associated management measures are illustrative in nature (i.e. they are not binding to NOAA Fisheries or the NPFMC), they are not integral to Amendments 81/74 and will not be included in the revised FMPs. As programmatic policies, the alternatives provide NOAA Fisheries and the NPFMC with a range of potential management measures that allows flexibility under the MSA to adaptively manage the groundfish fishery through more specific FMP amendments.

A. No Action Alternative

Alternative 1. Alternative 1 is the no action alternative for the PSEIS. Under this alternative, the groundfish fisheries would continue to be managed based upon the present risk-averse policy. This policy assumes that fishing does result in some adverse impacts to the environment and that, as these impacts become known, mitigation measures will be developed and appropriate FMP amendments will be implemented.

Alternative 1(a) represents the policy language currently stated in the FMPs, dating from 1979 and 1985 for the BSAI and GOA FMPs, respectively.

Alternative 1(b) is a substitute for the written policy language in the current FMPs and would include objectives that explicitly address the variety of concerns that are balanced by the NPFMC and NOAA Fisheries in current management considerations. Alternative 1(b) encapsulates a risk-averse conservation and management program that is based on a conservative harvest strategy. The Alternative 1(a) and 1(b) policies are both represented by current BSAI and the GOA FMPs (i.e. FMP 1) and incorporate and analyze all of the management measures adopted by the NPFMC through its June 2002 meeting.

In the current FMPs, the total allowable catch (TAC) is determined annually based on a conservative harvest strategy that calculates the overfishing level (OFL) and maximum acceptable biological catch level (*max* ABC) by means of a six-tier system wherein the amount and quality of information available for a given stock or stock complex determines the formula that is used to define the rate of fishing mortality and the size of buffer between OFL and ABC. The status of each stock (in Tiers 1-3) is also examined annually with respect to the minimum stock size threshold (MSST), as defined in the National Standard Guidelines.

Optimum yield (OY) is specified in the current FMPs as a range that is aggregated across all stocks and does not vary with biomass. The current FMPs require the sum of the individual groundfish

TACs to fall within the OY range specified in the plan (2 million metric ton (mt) cap in the BSAI; 800,000 mt cap in the GOA). Taking into account the ecosystem considerations of the food web, the FMPs also prohibit directed fishing for forage fish species. Through amendments over the last 25 years, the current FMPs have built up a network of spatial and temporal closures, intended to protect resources of concern, as well as to minimize gear conflicts. In the BSAI, various areas around the Pribilof Islands and in Bristol Bay are closed year-round to trawling in order to protect red and blue king crab habitat, and areas of historically high bycatch of chinook and chum salmon are closed seasonally. Also in the BSAI, waters within 12 nautical miles (nm) of Walrus Islands are closed to groundfish fishing to minimize fishery disturbance of walrus haulouts sites. In the BSAI and the GOA, Steller sea lion protection measures permanently close the area within 3 nm of rookeries to all fishing. Additionally, these measures impose trawl prohibitions within 3 to 20 nm of most sea lion rookeries and haulouts, and prohibit fishing in Seguam Pass to address concerns over the potential loss of sea lion prey species to commercial fishing. In the GOA, trawling is prohibited in southeast Alaska east of 140° W, and a 2.5 nm^2 area designated as the Sitka Pinnacles Marine Reserve is closed to groundfish fishing to protect habitat for rockfish and lingcod.

The current BSAI FMP prohibits directed fishing for pollock with non-pelagic trawl gear. Directed fishing for sablefish with pot gear is prohibited in the GOA. Non-pelagic trawling is prohibited in the Bristol Bay Red King Crab Savings Area in the BSAI and in Cook Inlet in the GOA. Additionally, various areas around Kodiak Island are closed to non-pelagic trawling either year-round or seasonally to protect crab stocks.

Groundfish fisheries in the BSAI and GOA are required to discard any incidental catch of halibut, Pacific salmon (including steelhead trout), crab, and herring. These species are known collectively as prohibited species. The FMPs currently set prohibited species catch (PSC) limits on many of these species, with penalties ranging from closure of a particular zone or of the whole management area to a directed fishery or fisheries for a specified season or the remainder of the year. Also under FMP 1, the Improved Retention/Improved Utilization (IR/IU) program requires full retention, by vessels fishing for groundfish, of all incidentally caught pollock and Pacific cod fit for human consumption, as well as full utilization of the two species by inshore processors. A minimum utilization standard of 15 percent is set for all at-sea processors. The NPFMC has also adopted a policy to require full retention of demersal shelf rockfish by longline and jig vessels in the southeast Outside District of the GOA. A Vessel Incentive Program encourages bycatch reduction by setting bycatch reduction standards biannually. Inseason bycatch management measures establish fishing seasons for bycatch management and give the Regional Administrator, NOAA Fisheries Alaska, the authority to close areas with high bycatch.

“The Reasonable and Prudent Measures” adopted from the most recent USFWS Biological Opinion for short-tailed albatross stipulate the use of certain seabird avoidance measures and require that take of more than four short-tailed albatross within two years trigger consultation with the USFWS. Pending the results of the consultation, there is potential for the fisheries to close. To further reduce the possibility of the take of albatross impacting the fisheries, in 2001 the NPFMC adopted a policy to require all longline vessels to adopt more stringent seabird avoidance methods.

A License Limitation Program for groundfish vessels over 32 feet (ft) length overall (LOA) (with certain jig gear exceptions) and a moratorium on entry into the groundfish fisheries are in place for the BSAI and the GOA. An Individual Fishing Quota (IFQ) program is in place for sablefish in the BSAI and GOA, which includes provisions for community purchase of quota share. In the BSAI, the directed fishery for pollock is organized into cooperatives as authorized under the American Fisheries Act (AFA). A multi-species Community Development Quota (CDQ) program apportions 7.5 to 10 percent of all BSAI groundfish quota to 65 western Alaska communities currently participating in the CDQ Program.

Alternative 1 monitors the groundfish fishing effort through federal and state reporting requirements and through the use of the North Pacific Groundfish Observer Program. All vessels equal to or more than 60 ft but less than 125 ft LOA are required by regulation to have an observer on board 30 percent of the time; for vessels 125 ft or more LOA, this increases to 100 percent. For AFA and CDQ catcher boats greater than 60 ft LOA, one observer must be on board at all times, and for catcher processors and motherships, two observers must be on board at all times. The program also has observers at inshore processing plants. Additional monitoring tools include reporting requirements for BSAI and GOA vessels that submit daily or weekly logbooks including information on the composition of catch and the locations of the hauls. The ADF&G also collects data from fish tickets at the point that catch is sold. Mandatory vessel monitoring systems for all directed Atka mackerel, pollock, and Pacific cod fishing verify vessel location. FMP 1 is described in full in Table 4.2-1 of the Final PSEIS.

B. Other Policy Alternatives Considered in Detail

Alternative 2. This alternative represents a more aggressive harvest management policy than Alternative 1. This alternative would maximize biological and economic yield from the resource while still preventing overfishing of the groundfish stocks. Such a management approach would, among other things, be based on the best scientific information available, take into account individual stock and ecosystem variability, and continue the cooperation between NOAA Fisheries and other agencies in protecting threatened and endangered species. A more aggressive harvest strategy would be implemented based upon the concept that the present policy is overly conservative and that higher harvests can be taken without overfishing the target groundfish stocks. This policy alternative assumes that fishing at the recommended levels would have no adverse impact on the environment, except in specific cases that are known and mitigated.

Example FMP 2.1 illustrates a more aggressive harvest strategy than Alternative 1 by removing many of the existing constraints from the fisheries. As the policy is based on an assumption that the impacts of fishing on the environment are generally known and mitigated, the precautions currently built into the existing TAC-setting process would be alleviated. The buffer between the ABC level and the OFL is removed, and the maximum OY for the groundfish stocks in the BSAI is released from its two million mt cap and allowed to float as the sum of the OFLs for the BSAI groundfish stocks.

Example FMP 2.1 also removes physical constraints from the fisheries by repealing the various closure areas currently in place. The fishery would be returned to an open-access scenario, where time and area closures, gear restrictions, and PSC restrictions are repealed. The potential impact of the groundfish fisheries on Steller sea lions, however, means that the current mitigating suite of protection measures that constrain fishing around rookeries and haulouts and protect Steller sea lion prey species (pollock, Pacific cod and Atka mackerel) when at low biomass levels would remain in place (Figures 4.2-2 and 4.6-1; specific details on the example FMP 2.1 map are provided in Section 4.2.3 of the Final PSEIS). This is required by the ESA to avoid determinations of jeopardy and adverse modification. The same applies to the impact of groundfish fishing on short-tailed albatross, with the consequent take limits remaining in effect.

The federally-mandated effort limitation program for the directed BSAI pollock fishery, enacted under the AFA, would remain in place, with its accompanying CDQ allocation, but all other effort limitation programs (such as the sablefish IFQ program and the multi-species CDQ program) would be repealed. Reporting requirements would remain in place, in order to keep track of the impact of the fisheries, but the Observer Program, except as federally mandated by the AFA, would be repealed, as would vessel monitoring system requirements. Example FMP 2.1 is described in full in Table 4.2-1 of the Final PSEIS.

Example FMP 2.2 represents a more moderate illustration of Alternative 2, but continues the policy of a more aggressive harvest strategy than Alternative 1. In this case, the mechanisms for setting ABC and TAC remain the same as in the current FMPs (see Alternative 1 for further detail), but the existing regulatory-capped maximum OY of 2 million mt in the BSAI would be removed in favor of a maximum OY equaling the sum of individual groundfish ABCs in the BSAI. Additionally, bycatch reduction incentives and bycatch restrictions would be repealed, other than those related to PSC limits or IR/IU. Under the assumption that fishing does not have an impact on the environment other than what is generally known and mitigated, the NPFMC's more stringent seabird avoidance measures recommended in 2001 would be repealed, leaving only the mitigation measures recommended by USFWS to avoid jeopardy or adverse modification for short-tailed albatross. Closure areas in example FMP 2.2 mirror those in Alternative 1. Example FMP 2.2 is described in full in Table 4.2.-1 of the Final PSEIS.

Alternative 3. This alternative represents a more precautionary management policy than Alternative 1. This alternative would accelerate the existing precautionary management measures through community or rights-based management, ecosystem-based management principles and, where appropriate and practicable, increased habitat protection and additional bycatch constraints. Under this approach, additional conservation and management measures would be adopted as necessary to respond to social, economic or conservation needs, or if scientific evidence indicated that the fishery was negatively impacting the environment. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management.

Example FMP 3.1 illustrates a management approach that accelerates precautionary management measures by increasing conservation-oriented constraints on the fisheries where necessary, formalizing precautionary practices in the FMPs, and initiating scientific review of existing practices as a necessary precursor to the decision of how best to incorporate adequate precautions.

Example FMP 3.1 would implement changes to the TAC-setting process following a comprehensive review of existing TAC-setting processes. Precautionary measures such as setting TAC less than or equal to the ABC and specifying MSSTs for Tiers 1 through 3 in accordance with National Standard Guidelines, would be formalized in the FMP. Sharks and skates would be removed from the Other Species management category and given their own TACs, and criteria to do the same for other target stocks would be developed. Efforts would be accelerated to develop ecosystem indicators for setting TAC limits, as per ecosystem management principles.

In order to balance the needs of social and economic stability with habitat protection and resource conservation, a review would be conducted of the existing closure areas in the BSAI and the GOA (for closure areas under FMP 3.1, see Figure 4.2-4 and Section 4.2.3 of the Final PSEIS). The closure areas would be evaluated against a Marine Protected Area (MPA) methodology, which would be developed as part of this alternative. The NPFMC and NOAA Fisheries would also seek to initiate joint consultation and research with USFWS to develop fishing methods that reduce incidental take of threatened and endangered species. To mitigate any adverse impacts of fisheries management decisions on fishing communities, and to comply with other national directives, formal procedures would be implemented to encourage increased participation of Alaska Natives in fishery management.

Example FMP 3.1 recognizes that the anticipated community or rights-based management programs may ultimately address bycatch reduction objectives (a review of bycatch rates under current programs has already begun) but, a moderate reduction of PSC limits will be pursued as an intermediary step. Additionally, PSC limits for crab, herring, and salmon would be authorized in the GOA, in addition to the halibut PSC limits authorized under the current GOA FMP. Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through improvements in the Observer Program and third party verification of economic data. Example FMP 3.1 is described in full in Table 4.2-1 of the Final PSEIS.

Example FMP 3.2 implements the acceleration of existing precautionary measures on a more rapid timeline than Example FMP 3.1. Rather than reviewing existing practices prior to incorporating increased precaution, this bookend implements changes to many aspects of the FMPs concurrently with the initiation of scientific research efforts necessary to bring management measures in line with a precautionary policy.

Example FMP 3.2 significantly accelerates precautionary management by incorporating an uncertainty correction into the estimation of ABC for all species. Additionally, OY would be specified separately for each stock or stock complex rather than for the groundfish complex as a whole (i.e., OY would be set as a formula rather than as a range, eliminating the BSAI 2 million mt cap), and would be set equal to the respective stock or stock complex's TAC. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. Example FMP 3.2 would also incorporate stock-specific biological reference points in the tier system where scientifically justifiable. This could result in Tier 3 rockfish stocks, for example, being capped at $F_{60\%}$, a lower and more conservative harvest rate, compared to $F_{40\%}$, the rate currently used. In implementing this bookend, criteria would be developed for specifying MSSTs for Tiers 4 through 6, along with a list of priority candidate stocks; and the development of criteria for moving stocks from the Other Species and Non-specified Species management categories would minimally result in sharks and skates being given their own TACs.

Example FMP 3.2 also reexamines the existing closure system in the BSAI and the GOA. The bookend sets a guideline of 0 to 20 percent of the EEZ (3 to 200 nm) to be closed as an MPA, of which no more than five percent should be completely closed to commercial fishing as a designated No-Take Marine Reserve. The remainder of the closed area would be designated as a no-bottom-contact MPA. The objective of these measures would be to provide greater protection to a full range of marine habitats within the 1,000 m bathymetric line (Figure 4.2-5; specific details on the example FMP 3.2 map are provided in Section 4.2.3 of the Final PSEIS). The guideline aims to provide greater protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species, while at the same time respecting traditional fishing grounds and maintaining open area access for coastal communities. Additionally, the bookend would extend the existing bottom-trawl ban on pollock to the GOA.

Additional conservation benefits would be realized in example FMP 3.2 through the comprehensive rationalization of all fisheries (except those already part of a cooperative or IFQ program.) In adopting rationalization programs such as cooperative-style programs with built-in community protections, habitat and bycatch concerns would also be addressed by reducing concentrated effort in the fisheries. To increase precautions regarding bycatch, PSC limits would be significantly reduced (and set for all prohibited species in the GOA), but would not be expected to act as a proportionate restraint on the fisheries due to the incentives for bycatch reduction under cooperatives, or other bycatch incentive programs implemented as necessary under this bookend.

In accordance with ecosystem principles, the NPFMC and NOAA Fisheries would seek to initiate joint consultation and research with USFWS to develop fishing methods that reduce incidental take of all seabird species. Formal procedures would also be implemented to increase consultation with and representation of Alaska Natives in fishery management. Example FMP 3.2 is described in full in Table 4.2-1 of the Final PSEIS.

Alternative 4. This policy alternative represents a highly precautionary approach to managing fisheries when faced with scientific uncertainty. This alternative policy shifts the burden of proof to the users of the resource, the NPFMC, and NOAA Fisheries, to demonstrate that the fisheries would not have a detrimental effect on the environment. It would involve a strict interpretation of the precautionary principle. Management decisions would involve and be responsive to the public, but would decrease emphasis on industry and community concerns in favor of ecosystem processes and principles. This policy assumes that fishing does produce adverse impacts on the environment, but due to a lack of information and uncertainty, characterization of these impacts is difficult. The initial restrictive and precautionary conservation and management measures would be modified or relaxed when additional, reliable scientific information becomes available that indicates that such measures are no longer necessary to protect the resource from potentially adverse impacts caused by fishing.

Example FMP 4.1 illustrates an FMP where current levels of fishing are significantly reduced and other precautionary restrictions are implemented until scientific research shows that the fisheries have no adverse effect on the sustainability of the resource and its environment. A modified TAC-setting process would create a more substantial buffer between ABC and the OFL by setting a fishing mortality rate at a very low level ($F_{75\%}$) for all Steller sea lion prey species and for rockfish (a long-lived, slow-growing species). Also, the ABC for each stock or stock complex in Tiers 1 through 5 would be adjusted downward based on the lower bound of a confidence interval surrounding the survey biomass estimate. OY would be specified separately for each stock or stock complex rather than for the groundfish complex as a whole (i.e., OY would be set as a formula rather than as a range, eliminating the BSAI 2 million mt cap), and would be set equal to the respective stock or stock complex TAC. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. For species managed as members of a stock complex, rather than setting TAC as the aggregate of the individual members' ABCs, the maximum ABC value for each stock would be determined and the TAC set equal to the lowest value among the group. Where sufficient biological information is available, such as with eastern Bering Sea pollock, TAC would be distributed on a smaller spatial scale. MSSTs would be determined for all tiers.

To further mitigate the possibility of the fisheries having a detrimental biological and ecosystem impact, 20 to 50 percent of the EEZ would be designated as no-take marine reserves (i.e., no commercial fishing), covering the full range of marine habitats within the 1,000-m bathymetric line (Figure 4.2-6 of the Final PSEIS; specific details on the example FMP 4.1 maps are provided in Section 4.2.3 of the Final PSEIS). As part of this area in the Aleutian Islands, a Special Management Area would be established to protect coral and other live bottom habitats. The closed area would include spawning reserve areas for intensively fished species. Under the FMP 4.1 example, comprehensive trawl exclusion zones would be set to protect all Steller sea lion critical habitat, and trawling would be restricted to only those fisheries that cannot be prosecuted with other gear types (i.e, the flatfish fisheries).

In an effort to reduce waste and the risk of adverse impact to the environment, existing PSC limits would be halved under this bookend, as would bycatch (discard) and incidental catch rates. IR/IU would be extended to all target species. Stringent PSC limits would be set for salmon, crab, and herring in the GOA, and as information becomes available, bycatch limits would be set for non-target species also. Protection measures would be set for all seabird species.

Because this policy alternative necessitates greater research and data-gathering efforts, example FMP 4.1 would expand observer coverage to 100 percent for all vessels over 60 ft LOA and require 30 percent observer coverage on vessels presently exempted from observer coverage (i.e., vessels under 60 ft LOA). Vessel monitoring systems would be made mandatory for all groundfish vessels, as would motion-compensated scales for weighing all catches at sea or at shore-based processors. Cooperative research and data-gathering programs would be initiated as well to expand the use of Traditional Knowledge in fisheries management. Example FMP 4.1 is described in full in Table 4.2-1 of the Final PSEIS.

Example FMP 4.2 expands the precautionary principles of Alternative 4 by temporarily suspending all fishing until the fisheries can be shown to have no adverse effect on the resource and its environment. Scientific research and data-gathering efforts would continue under this FMP. The Agency would conduct an environmental review of each groundfish fishery. Such an environmental review would likely require up to two years to complete. Until such a review is completed and a fishery certified, the TAC for all species in that fishery would be set at zero. All areas of the EEZ would be closed to all fishing (i.e. commercial, recreational, and subsistence); bycatch and incidental catch, as well as the take of seabirds and marine mammals, would then necessarily be reduced to zero in the short-term. Once the reviews are completed, those fisheries that are found to have no significant adverse impacts on the environment would be authorized under a specific set of regulations. If a fishery is found by this review to produce significantly adverse environmental effects, and mitigation measures can not be designed to mitigate those effects, that fishery would not be certified and would remain closed until more scientific information is known. Example FMP 4.2 is described in full in Table 4.2-1 of the Final PSEIS.

Preferred Alternative. The Preferred Alternative and its example FMPs represent a management approach that incorporates forward looking conservation measures that address differing levels of uncertainty about the effects of fishing and the marine ecosystem. It is a modified version of Alternative 3 that also incorporates elements of Alternatives 1 and 4.

For purposes of soliciting public comment, the NPFMC and NOAA Fisheries identified a Preferred Alternative (preliminary) in the 2003 Draft PSEIS. Comments received on the preliminary Preferred Alternative were used by the NPFMC to further refine the alternative. The Preferred Alternative in the Final PSEIS maintains the ecosystem approach embodied in the preliminary preferred alternative, while expanding on the protection of non-ESA-listed seabirds and marine mammals, and emphasizing the importance of cooperation and consultation with state and federal agencies and organizations. The NPFMC and NOAA Fisheries believe that the Preferred Alternative identified in the Final PSEIS is a realistic and responsible approach that addresses and complies with the various goals, objectives, and requirements of the MSA and other applicable law. The policy elements contained in the Preferred Alternative are consistent with the National Standards and reasonably balance the competing interests reflected therein.

The management approach and the objectives in the Preferred Alternative reflect a conservative precautionary approach to fisheries management and communicate a policy direction for the future. This management approach has, in recent years, been labeled the precautionary approach. As part of the policy, measures will be considered and adopted, as appropriate, which accelerate the precautionary adaptive management approach through community or rights-based management, ecosystem-based management principles that protect managed species from overfishing, and, where appropriate and practicable, increased habitat protection and bycatch constraints. All management measures will be based on the best scientific information available. Given this intent, the fishery management goal is to provide sound conservation of the living marine resources; provide socially and economically viable fisheries and fishing communities; minimize human-caused threats to protected species; maintain a healthy marine resource habitat; and incorporate ecosystem-based considerations into management decisions. This management approach recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management, and will utilize and improve upon the NPFMC and NOAA Fisheries' existing open process to involve the public in decision-making. For the full text of the alternative, including a description of the example FMP bookends for the Preferred Alternative, see Section 2.6.9 of the Final PSEIS.

The example FMP bookends for the Preferred Alternative (FMP PA.1 and PA.2) serve to illustrate management concepts and future actions that logically flow from the Preferred Alternative and provide sufficient detail to allow for focused analysis of their environmental consequences. Example FMP PA.1 and FMP PA.2 are described in full in Table 4.2-2 of the Final PSEIS.

Example FMP PA.1 illustrates a conservative management approach that continues current risk-averse practices, increases conservation-oriented constraints on the fisheries as appropriate, formalizes precautionary practices in the FMPs, and initiates scientific review of existing practices to assess and improve fishery management.

FMP PA.1 implements changes to the TAC-setting process following a comprehensive review. Precautionary practices such as setting TAC less than or equal to the ABC, and specifying MSSTs for Tiers 1-3 in accordance with National Standard Guidelines, would be formalized in the FMP. The NPFMC and NOAA Fisheries would continue to use and improve harvest control rules to maintain a spawning stock biomass with the potential to produce sustained yields on a continuing basis, and to distribute allocations by area, season, and gear as appropriate. Efforts to develop ecosystem indicators to be used in TAC-setting, as per ecosystem management principles, would be continued.

To balance the needs of social and economic stability with habitat protection and resource conservation, the NPFMC and NOAA Fisheries would develop an MPA efficacy methodology, including the development of definitions, program goals, objectives, and criteria for establishing MPAs. Additionally, the existing habitat and bycatch area restrictions would be maintained. Measures are also retained to protect ESA-listed species. To minimize bycatch, a moderate reduction of PSC limits in the BSAI will be initiated, and PSC limits or other appropriate measures for protection of crab, herring and salmon would be authorized in the GOA. Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through improvements in the Observer Program and existing reporting requirements.

Existing programs addressing excess capacity and overcapitalization are maintained under this example FMP, with continued development of rights-based management to be undertaken as needed. In order to mitigate adverse impacts of fisheries management decisions on fishing communities and to comply with other national directives, procedures to encourage increased participation of Alaska Natives in fishery management would be pursued.

Example FMP PA.2 accelerates adaptive precautionary management by increasing conservation measures that provide a buffer against uncertainty, instituting research and review of existing measures, and expanding data collection and monitoring programs. Example FMP PA.2 significantly accelerates precautionary management by incorporating an uncertainty correction into the estimation of ABC for all species. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. The calculation of the OY caps would be periodically reviewed to determine their relevancy to current environmental conditions and stock levels. Example FMP PA.2 would also develop and implement criteria for using key ecosystem indicators in TAC-setting, and other precautionary practices such as developing appropriate harvest strategies for rockfish stocks. In implementing this bookend, data would be collected and analysis undertaken to allow the specification of MSSTs for priority stocks in Tiers 4-5. The development of criteria to manage target and non-target species consistently, and for removing some stocks from the Other Species and Non-specified Species management categories, would initially consider breaking sharks out of the Other Species category for TAC-setting and management purposes in the BSAI, as well as consider breaking sharks and skates out of the Other Species category in the GOA.

FMP PA.2 also re-examines area restrictions in the BSAI and the GOA by reviewing the existing system of closure areas in the BSAI and the GOA (see Section 4.2.3 of the Final PSEIS), and evaluating them in conjunction with developing MPAs. The example FMP considers adopting MPAs, with a guideline of 0 to 20 percent of the EEZ (3 to 200 nm) to be closed as a MPA. The objective of these measures is to provide greater protection to a full range of marine habitats within the 1,000-m bathymetric line. This area would incorporate an Aleutian Islands Special Management Area to protect coral and living bottom habitat, and also any modification to the 2002 Steller sea lion closures. The closed area may also mitigate adverse effects that occur due to fishing. The guideline aims to provide greater protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species, while at the same time respecting traditional fishing grounds and maintaining open area access for coastal communities. Additionally, the bookend would extend the existing BSAI bottom-trawl ban on pollock to the GOA.

To increase precaution regarding bycatch, existing PSC limits would be reduced, and limits would be set for all prohibited species in the GOA, with appropriate in-season closure areas. The achievement of these bycatch reductions is expected to be realized through the comprehensive rationalization of all fisheries (except those already part of a cooperative or IFQ program), which reduces concentrated effort in the fisheries, or through bycatch incentive programs implemented in this example FMP.

In accordance with ecosystem principles, the NPFMC and NOAA Fisheries would seek to cooperate with USFWS to develop fishing methods that reduce incidental take of seabird and marine mammal species in the groundfish fisheries, if appropriate and practicable. Procedures would also be pursued to increase consultation with and representation of Alaska Natives in fishery management.

Increases in observer coverage and improvements to the observer data that are collected would enhance effective monitoring and timely reaction to change in the environment and the fisheries. Additionally, the bookend explores programs that would expand the mandatory economic data collected from industry.

C. Alternatives Not Considered in Detail

A No-fishing Policy. A permanent "no-fishing" policy would end all commercial groundfish fishing in the EEZ off Alaska. Adoption of such a policy would be inconsistent with one stated purpose of the MSA: "to promote domestic commercial and recreational fishing under sound conservation and management principles." When the NPFMC first prepared its GOA and BSAI groundfish FMPs, it considered a no-fishing policy. In its analysis of this alternative, the NPFMC found that adopting this policy would result in the economic ruin of the fishing industry and place great hardship on fishing communities economically and socially dependent upon the BSAI and GOA groundfish resources. The NPFMC believed this policy violated the MSA by preventing the U.S. from exploiting the social and economic benefits of groundfish of the BSAI and GOA in the Nation's interest.

NOAA Fisheries subsequently reviewed and prepared a detailed analysis of the effects of a no-fishing policy in its 1998 Final SEIS. Such a policy would reduce EEZ fishing mortality to zero for all target groundfish and non-target species, resulting in no commercial catch except for harvests within the State of Alaska's jurisdiction and beyond 200 miles. The primary impact of this action would be to eliminate the impact of fishing on the physical and biological environment in the EEZ.

However, closing the BSAI and GOA groundfish fisheries would likely result in alterations to existing predator–prey relationships, which over time could influence the population dynamics of particular marine resources. Some fish stocks could decline below current levels. A no-fishing policy also would eliminate thousands of jobs in the groundfish harvesting, processing, and support sectors. It would idle over $1 billion of harvesting and processing capital, decrease the income of groundfish fishermen and processing plant employees by several hundred millions of dollars, and decrease the value of U.S. seafood exports by more than $500 million. Few opportunities appear to offset these losses to the fishing industry, to the communities that depend on the fisheries, and to the Nation. In short, implementation of such a policy would have widespread effects on the natural, physical and socio-economic environment.

NOAA Fisheries concluded that such a policy was not a reasonable choice among the alternatives considered in its 1998 SEIS. NOAA Fisheries again considered "no fishing" as a policy alternative during the development of this PSEIS but rejected full consideration of such a policy alternative because it would be based on the premise that no fishing could occur in the Federal groundfish fisheries off Alaska regardless of the level of scientific data demonstrating the sustainability of such a fishery. Such a policy runs counter to the MSA requirement that conservation and management measures prevent overfishing while achieving, on a continuing basis, OY from each fishery for the U.S. fishing industry (16 USC 1851(a)(1)). In contrast, approval of Alternative 4 would establish an extremely precautionary policy to fisheries management that permits fishing when it can be demonstrated that the fishery would not have a detrimental effect on the environment and that relieves restrictions on fishing when new scientific data support such a change.

Alternatives that Result in Specific Fishery Regulations. A number of public comments received either during the scoping process or on the 2001 and 2003 Draft PSEISs requested the development of alternatives that go beyond policy and actually include regulatory changes to the fisheries. NOAA Fisheries rejected these requests as beyond the scope and purpose of this programmatic EIS. As explained in the PSEIS, NOAA Fisheries prepared this NEPA analysis by applying the applicable guidelines and procedures found in the Council on Environmental Quality's (CEQ) NEPA implementing regulations at 40 CFR 1500 *et seq*. (CEQ regulations). The specific regulatory changes requested by some members of the public qualify as action-specific federal actions that fall outside the scope of a programmatic EIS and will require individual NEPA analyses tiered to this programmatic document, should they be adopted. Accordingly, such analyses will tier to this document under applicable regulations.

A PSEIS on the federal groundfish fisheries off Alaska that included specific regulatory changes would require an intricate level of detailed alternatives and a commensurately detailed analysis. However, neither NEPA nor the courts require NOAA Fisheries to prepare such a document. NOAA's own NEPA guidelines (NAO 216-6 Section 5.09a) state that "a programmatic environmental review should analyze the broad scope of actions within a policy or programmatic context by defining the various programs and analyzing the <u>policy alternatives</u> under consideration and the <u>general</u> environmental consequences of each" (emphasis added). Furthermore, the court stated that ". . . a programmatic analysis would not require consideration of detailed alternatives with respect to each aspect of the plan—otherwise a programmatic analysis would be impossible to prepare and would merely be a vast series of site-specific analyses," *Greenpeace v. National Marine Fisheries Service*, 55 F. Supp. 2d 1248, 1276 (W.D. Wash. 1999).

NOAA Fisheries has determined that a PSEIS for the federal groundfish fisheries off Alaska should essentially be a broad environmental review of the GOA and BSAI groundfish FMPs and alternatives to them. The PSEIS includes a cumulative impact analysis of management actions as a whole, and examines policies and potential future actions from a variety of environmental perspectives. The

PSEIS therefore provides a broad look at the long-range policy alternatives and the associated issues and is therefore more qualitative in nature.

Findings contained within this analysis could result in FMP amendments that, in turn, could lead to formal rule-making and implementation of regulatory changes to the current management regime governing the groundfish fisheries off Alaska. Such specific regulatory changes will be attended by case-specific, detailed analyses in subsequent second-level tiered EAs or EISs. In this PSEIS, however, NOAA Fisheries' goal is to provide the public with insight into the environmental effects that result from the current management regime as a whole as well as from alternative management regimes at a broad, programmatic level.

The Oceans Alternative. In a letter dated November 6, 2003, and in more than three thousand form letters, a collection of environmental interest groups, as part of their comments in the 2003 Draft PSEIS, submitted the "Oceans Alternative." The interest groups included the Alaska Oceans Program, Center for Biological Diversity, Earthjustice, Greenpeace USA, National Environmental Trust, The Ocean Conservancy, and Trustees for Alaska. Attachment E of the Final PSEIS Comment Analysis Report (Appendix G of the Final PSEIS) provides an excerpt of the joint submission, which outlines the specific elements of the Oceans Alternative. For the most part, these are the same environmental groups who had previously submitted comments on the alternatives contained in the 2001 Draft PSEIS. Their 2001 comments served, in part, as the basis for restructuring Alternatives 3 and 4 for analysis in the 2003 Draft PSEIS. The November 2003 letter, as well as letters, were provided in their entirety to members of the NPFMC and NOAA Fisheries officials prior to their making a final decision on the Preferred Alternative. Using the description of the alternative as stated in the form letters, the Oceans Alternative can be summarized as a management policy that "requires resource managers to: 1) proactively avoid harm rather than assuming that fisheries cause no harm; 2) maintain large margins of safety to avoid unforeseen impacts; and 3) protect all types of marine habitat, reduce overall catch levels, conserve biological diversity, ensure the integrity of the food web, protect marine fish, birds, mammals and invertebrates (such as crab and corals), and provide for ecologically sustainable fishing opportunities across generations."

Upon receipt of these comment letters, NOAA Fisheries carefully reviewed them to determine whether the Oceans Alternative was in fact a new alternative distinguishable from the range of alternatives already defined and analyzed in the 2003 Draft PSEIS. The Agency has concluded that it is not. The determination is based on a number of factors. The first component of the Oceans Alternative is to pro-actively avoid harm rather than assume that fisheries cause no harm. This component of the Oceans Alternative is embodied in the Preferred Alternative as well as Alternatives 1, 3, and 4 in the Final PSEIS. Under the existing management policy, neither NOAA Fisheries nor the NPFMC assume that fisheries cause no harm. Fisheries can be found to certainly cause harm at the level of individual fishes. However, the analysis of the federal groundfish fisheries off Alaska has shown there is no evidence that groundfish fishing causes harm at the target groundfish stock or population level. This PSEIS and prior MSA and NEPA documents show that there is considerable uncertainty with regard to the impacts of the groundfish fishery on non-target and non-specified species. Any fisheries-induced adverse impacts on these species are unknown at this time. For this reason, NOAA Fisheries and the NPFMC have taken management actions to reduce these potential impacts by setting bycatch limits, restricting certain gear types, and establishing closed areas. All the PSEIS alternatives, as well as the Oceans Alternative, incorporate an adaptive management strategy whereby managers will revise the FMPs based on new scientific information and public input.

The second component of the Oceans Alternative is to maintain large margins of safety to avoid unforeseen impacts. This component also can be found in Alternatives 1, 3, 4 and the Preferred Alternative. Each of these alternatives differs in matters of degree. The PSEIS describes the steps scientists and managers take to insert a protective buffer between the ecosystem and the commercial groundfish fisheries. For example, the NPFMC and NOAA Fisheries routinely adopt groundfish TAC levels that are below a target species ABC. The determination of a species ABC has built-in safety margins to reduce the risk of adverse impacts, although under Alternative 1, most of these precautionary measures are not formalized. Alternatives 3 and 4 differ from Alternative 1 by instituting formal precautionary measures in the TAC-setting process, with Alternative 4 representing the most highly precautionary management approach. Other examples also are provided in the PSEIS for each alternative and by their FMP bookends. Therefore, the concept of establishing a certain margin of safety is already captured in the range of alternatives and need not be analyzed further at the programmatic level.

The third component of the Oceans Alternative, "protect all types of marine habitat, reduce overall catch levels, conserve biological diversity, ensure the integrity of the food web, protect marine fish, birds, mammals and invertebrates (such as crab and corals), and provide for ecologically sustainable fishing opportunities across generations," can reasonably be shortened to "maintaining healthy ecosystems and sustainable fisheries." It is important to point out that this component encompasses key elements of the MSA, the Sustainable Fisheries Act (SFA), the NOAA Fisheries Strategic Plan, and many of the recommendations of the National Research Council (NRC). NOAA Fisheries relied heavily on all these documents in its restructuring of the programmatic alternatives adopted in June 2002 and analyzed in the 2003 Draft PSEIS, and indeed this component is encompassed to a greater or lesser degree in all the alternatives.

NOAA Fisheries evaluated each of the alternatives and the Preferred Alternative against federal statutory requirements, the NOAA Fisheries Strategic Plan, the recommendations of the Agency's Ecosystem Principles Advisory Panel and the National Research Council in Section 4.11.1 of the Final PSEIS. As stated previously, Alternatives 1, 3, 4 and the Preferred Alternative all contain the basic components of ecosystem-based management, but to varying degrees, with Alternatives 3, 4 and the Preferred Alternative providing the strongest examples of this approach. The Oceans Alternative recommends both policy changes as well as specific management tools and measures that illustrate the alternative. The recommended policy changes are very similar to those presented in the organizations' earlier comments and in Alternative 4. All the ecosystem-based management concepts are captured in Alternative 4. All the Oceans Alternative recommended management measures are either already reflected in the Alternative 4 FMP bookends, or fall within the range of actions that could be considered under the Alternative 4 policy. It also was determined that some, but not all, of the recommended management goals and measures in the Oceans Alternative could also be considered within the range of the Preferred Alternative FMP bookends. For example, the organizations recommend that a way to implement the Oceans Alternative policy goal of reducing the bycatch of prohibited species is to reduce the PSC caps by 10 percent over five years. Currently the Agency's Preferred Alternative contains an identical goal with FMP bookends illustrating a range of actions ranging from maintaining the PSC caps at existing levels to reducing them by as much as 20 percent (no time limit specified); thus the proposed measure provided in the Oceans Alternative clearly fits within the range of actions to be pursued by managers in the years ahead as the Preferred Alternative.

Similarly, to achieve the Oceans Alternative goal to protect habitat, the organizations have proposed filling necessary data gaps and establishing a network of MPAs, understood as no-take reserves, to protect 20 to 50 percent of the fishable EEZ. Under Alternative 4, an identical goal exists and in its

FMP bookends the Agency illustrated and analyzed a management plan where 50 percent of the fishable area was designated as no-take marine reserves. This scenario was developed using proposed site locations obtained from Greenpeace and other public comments. NOAA Fisheries also analyzed as part of Alternative 3, FMP 3.2, a less restrictive MPA scenario. The Agency believes these differences provided sufficient contrast for comparing the programmatic alternatives and the environmental consequences of different MPA proposals including the Oceans Alternative. The Agency's conclusion at both the policy and FMP-level was that the Oceans Alternative would be indistinguishable from Alternative 4.

4. THE ENVIRONMENTALLY PREFERRED ALTERNATIVE

The CEQ regulations require that the ROD specify "the alternative or alternatives which were considered to be environmentally preferable" (40 CFR 1505.2(b)). This alternative has generally been interpreted to be the alternative that will promote the national environmental policy as expressed in section 101 of NEPA. Ordinarily, this means that the alternative causes the least damage to the physical and biological environment and is the alternative that best protects, preserves, and enhances historic, cultural, and natural resources.

Alternative 4 of the Final PSEIS, which is described in the earlier section on alternatives, is the environmentally preferred alternative. Alternative 4 represents a highly precautionary management policy. Alternative 4 explicitly shifts the burden of proof from the resource to the managers and users of the federal groundfish resources off Alaska. This alternative, as defined by its policy goals and objectives and illustrated by its FMP bookends, would substantially reduce the harvest levels in the fisheries, establish a system of marine reserves where a large portion of the continental shelf would be closed to all commercial fishing, phase out bottom trawl gear, and establish lower bycatch limits. As a result, this alternative would produce the lowest amount of fish harvest, the least amount of bycatch, the least adverse impact to marine mammals, seabirds, and species listed under the ESA, and the least adverse impact to benthic habitat.

5. NOAA FISHERIES DECISION AND FACTORS CONSIDERED IN THE DECISION

A. Public Comments

NOAA Fisheries received two letters from the public on the Final PSEIS. Oceana and the Trustees for Alaska continued to express their concern that, in their opinion, the PSEIS is legally deficient and cannot serve as the basis for legitimate decision-making. Both organizations recommend Secretarial approval of the Oceans Alternative and submitted (by reference) their previously submitted letters on the Draft PSEIS.

The commentors continue to believe that significant changes to the management of the Alaska groundfish fisheries are necessary and that the Preferred Alternative will not bring about those changes. NOAA Fisheries disagrees. The Agency believes that the PSEIS is fully compliant with NEPA, MSA, MMPA, ESA, and other applicable law. NOAA Fisheries also believes that the Preferred Alternative would institute a new policy framework that would apply the principles of ecosystem-based management to these fisheries. The NPFMC is developing a list of management priorities as a workplan for achieving the new policy direction.

The Trustees letter provided comments on the Agency's formal response to their earlier comments. NOAA Fisheries believes that the response to comments as published in the 2004 Comment Analysis Report (Appendix G of the Final PSEIS) adequately addresses those comments and issues. The Trustee's letter did introduce two new comments that are addressed in the following paragraphs.

Final PSEIS New Comment 1: NOAA Fisheries failed to provide information in a format decision makers and the public can readily understand, and failed to reduce paperwork.

Response: NOAA Fisheries disagrees. The Agency recognizes that the seven volume document is substantial and somewhat complex, but its length and level of complexity are commensurate with the scope of the action, the analyses and the complex nature of the subject matter as well as the Agency's NEPA requirements that the PSEIS "... shall provide [a] full and fair discussion of significant environmental impacts and shall inform decision-makers and the public of reasonable alternatives..." (40 CFR 1502.1) and shall "...rigorously explore and objectively evaluate..." (40 CFR 1502.14(a)) those alternatives while "...devoting substantial treatment to each alternative considered in detail..." (40 CFR 1502.14(b)). NEPA also requires that the PSEIS "...succinctly describe the environment of the areas to be affected...by the alternatives under consideration." (40 CFR 1502.15). To meet these NEPA requirements, the PSEIS describes one of the most complex and little understood environments with which humans interact and analyzes the environmental effects of five different alternatives at a policy level and nine FMPs at a management measures level. In preparing the document, the Agency attempted to present all the information and analyses required of it by NEPA in as accessible a format as possible without sacrificing the integrity and usefulness of that information and those analyses.

In recognition of the potential complexity of the PSEIS, a professional editor was utilized to translate highly technical information in an effort to ensure the information is accessible to the lay person. The editor also supervised the document layout, ensuring that each section of the document was prefaced by an informative summary, that the document was organized in a logical manner, and that useful and descriptive tables of contents and indexes were provided for easy navigation through the document. In response to public comments, the graphics and tables were moved from the body of the document and published in their own separate volume, with all figures and tables numerically indexed to make it easier for a reader to use these often referred-to illustrations no matter where in the document they were reading. Also in response to public comments, analyses and information not considered fundamental to the impact statement were moved to appendices or referenced. In preparing the Final PSEIS, the Agency made the document readily available in both printed and electronic formats. In the electronic version, links were inserted that would take the reader to each cited figure, table, or reference.

In order to comply with the reduction of excessive paperwork requirements of NEPA (40 CFR 1500.4) and in addition to the editorial elements and changes discussed above, the Agency, among other things, reduced the number of pages from approximately 7,000 in the 2003 Draft to about 6,000 pages in the Final, encouraged the use of CD or Internet copies of the PSEIS, rather than printed copies, conducted an extensive scoping process to identify and narrow the scope of significant issues and, in response to public comments, reduced the number of alternatives and subalternatives in the 2001 draft from six to five in the Final PSEIS. The PSEIS also includes an Executive Summary on which interested parties could rely to inform them of the purpose and scope of the document, the action being addressed, the results of the analyses and the final Agency action. In the Executive Summary the Agency published a list of "fifty frequently asked questions and answers " as a method of improving the transfer of information contained in the document as well as to better inform the public as to the public decision-making process being followed by NOAA Fisheries. In taking these steps, NOAA Fisheries has, to the extent practicable, reduced excessive paperwork and fully complied with the NEPA paperwork reduction requirements.

Final PSEIS New Comment 2: NOAA Fisheries failed to objectively evaluate environmental impacts.

Response: NOAA Fisheries disagrees. The Agency used scientifically sound and accepted methods for analyzing the alternatives and their FMP bookends. The entire PSEIS, including sections describing new methodology, was submitted to the NPFMC Scientific and Statistical Committee for review. NOAA Fisheries also subjected the 2001 Draft PSEIS to an external review by nationally recognized experts on NEPA prior to its release to the public. The results were generally positive, and where improvements and clarifications were recommended, the PSEIS was revised accordingly. The claim that NOAA Fisheries "...violated NEPA by failing to draw conclusions where adverse data or data gaps indicate significant adverse impacts", is inaccurate. The commentors provided no specific examples of where NOAA Fisheries has "...violated NEPA by failing to draw conclusions where adverse data or data gaps indicate significant adverse impacts." Impact tables based on our analysis of each of the alternatives are found in Sections 4.5 – 4.9 and in Appendix A of the PSEIS (Tables 4.1-1 through 4.9-7). In fact, the Agency has received national recognition by the American

Association of Environmental Professionals for introducing a new finding category (conditionally significant adverse effect). Where in the past the traditional NEPA finding of "unknown" would have been used in cases where there was insufficient data to definitively conclude the significance of an effect, NOAA Fisheries chose in this PSEIS to instead elevate those fishery effects where professional opinion suggests that significant adverse effects might be occurring. In doing so, the Agency is applying a precautionary approach in this PSEIS and believes that both the decision-maker and the public are better informed as to the data gaps and uncertainties of fishery impacts on the environment. NOAA Fisheries considers this an appropriate and reasonable approach for evaluating the different policy alternatives in the PSEIS. In cases where the Agency found conditionally significant effects, NOAA Fisheries has recommended that these effects serve as topics for further research so that in the future the data can be available to determine the significance of an effect.

B. The Decision

NOAA Fisheries selects the Preferred Alternative in the Final PSEIS as its policy choice for management of the BSAI and GOA groundfish fisheries. As a first step, NOAA Fisheries approves Amendments 81 and 74 to the BSAI and GOA FMPs, which amend the FMPs to contain the management approach and goals and objectives contained in the Preferred Alternative. The rationale for this decision is discussed below. The rationale is fully supported by the environmental analysis documented in the Final PSEIS, as required by law and regulation.

NOAA Fisheries has made this decision after careful review of the public comments on a series of draft environmental impact statements prepared pursuant to NEPA, including the Draft PSEIS issued January 2001 and the revised Draft PSEIS issued August 2003.

C. Rationale for the Decision

NOAA Fisheries' decision to select the Preferred Alternative in the Final PSEIS and thereby approve Amendments 81/74, was reached after a comprehensive review of the relevant environmental, economic, and social consequences of the Final PSEIS alternatives. Taking into account the MSA National Standards, the MMPA, the ESA, other applicable statutory and policy considerations, and all public comment, NOAA Fisheries identified a number of key fisheries management issues upon which to base its decision to approve the Preferred Alternative (Amendments 81 and 74 to the BSAI and GOA FMPs). Listed below is a description of each of the key fisheries management issues considered by NOAA Fisheries, as well as a brief explanation of how the fisheries management policies embodied in the Preferred Alternative successfully address each of the issues. The Preferred Alternative, taken as a whole, is the alternative that best balances its suite of management measures to enable NOAA Fisheries and the NPFMC to address the key management issues while meeting their statutory, regulatory, and national policy requirements, goals, and objectives.

Precautionary Management In Light of Scientific Uncertainty.

NOAA Fisheries has concluded that the Preferred Alternative in the Final PSEIS is substantially more precautionary than Alternative 2 and more precautionary than Alternative 1 (no action/status quo). Although the Preferred Alternative is less precautionary than Alternative 4, the Preferred Alternative is a sufficiently precautionary approach in light of the scientific uncertainty associated with fisheries management, as the Preferred Alternative incorporates forward looking conservation measures that address differing levels of uncertainty. Under this approach, NOAA Fisheries and the NPFMC will seek to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles that protect managed species from overfishing, and, where appropriate and practicable, increased habitat protection and bycatch constraints (the Preferred Alternative policy is illustrated by FMP PA.1 and FMP PA.2). Predictions about the impacts under the Preferred Alternative are difficult to describe at this time due to the uncertainties involved in defining ecosystem management and the impacts of protecting areas. The Preferred Alternative's increased emphasis on relatively less abundant species, through protection measures and increased monitoring, represents an approach towards ecosystem management. Because the implications of such management are uncertain, the tendency under the Preferred Alternative will be to tread cautiously while accelerating research and data-gathering. The large potential gain in flexibility in industry fishing practices from rationalization has the potential to create ecosystem benefits, thus enhancing the precautionary aspects of the Preferred Alternative.

Prevention of Overfishing.

While all the alternatives contain various measures to prevent overfishing at differing levels of risk, NOAA Fisheries has determined that, of the alternatives analyzed in the Final PSEIS, the Preferred Alternative represents the best balance between the prevention of overfishing and the achievement of OY on a continuing basis. Each example FMP for the Preferred Alternative contains a number of management measures that promote the sustainability of fisheries and fishery resources while providing economic and social benefits to the Nation. Also, the bookends represent a range of actions that could impose additional constraints to fishery removals beyond those currently in place, further advancing the prevention of overfishing.

Promotion of Sustainable Fisheries.

The goal of promoting sustainable fisheries and communities under the Preferred Alternative is likely to be successful. The precautionary adjustments made to quota management decrease the risk of inadvertently overfishing managed species. Additionally, the transition to rights-based management under this alternative will promote the objectives of increasing efficiency, stability, and safety in the long-term.

Preservation of the Food Web.

As a whole, through its goal to accelerate precautionary management measures through ecosystem-based principles, and its objectives to develop indices of ecosystem health and to take ecosystem factors into account in ABC-setting, NOAA Fisheries determined that the Preferred Alternative will make many improvements beyond the status quo in achieving the goal of preserving the food web. The emphasis in the Preferred Alternative is on using the best scientific information available to determine catch levels, and on providing additional protection against uncertainty by the designation of MPAs and reserves. Although Alternative 4 contains a highly precautionary approach to preserving the food web, the Preferred Alternative is likely to provide protection to a broad range of food web components given the improvements that are likely to be implemented under its management strategy.

Management of Incidental Catch and Reduction of Bycatch and Waste.

Several policy changes adopted in the Preferred Alternative would change the incidental catch of target and non-target species, and bycatch (regulatory and economic discards). Under FMP PA.1, the cap on OY is maintained, so the absolute amount of target and non-target groundfish catch is unlikely to change. The calculation of OY caps would be revisited under FMP PA.2 to determine if the caps are still relevant to environmental conditions and the current knowledge of stock levels. However, the amount of incidental catch of groundfish and subsequent discard of groundfish (bycatch) is likely to decrease due to the policy emphasis on rationalization. Other measures would likely lead to reductions of incidental catch for various species. These additional measures include reductions in PSC limits for prohibited species, the uncertainty correction used to calculate ABC, reduced rockfish harvest rates, and the separation of sharks and skates from the other species complex. The latter would ensure that these species are not harvested above the maximum fishing mortality threshold. Furthermore, criteria would be developed for defining the membership within species complexes and the circumstances when species should be broken out of complexes. NOAA Fisheries determined that, of all the alternatives considered, the Preferred Alternative contains the best approach to managing incidental catch and reducing bycatch and waste to the extent practicable given other management concerns such as the economic and social costs to the commercial fishing industry and fishery-dependent communities.

Avoidance of Impacts to Marine Mammal and Seabirds.

The goal of minimizing human-caused threats to protected species and, if appropriate and practicable, other seabird and marine mammal species, is met in the Preferred Alternative by actively adjusting seabird and marine mammal protection measures, and by conducting periodic reviews of endangered and threatened marine mammal fishery interactions. This approach, which may provide additional conservation measures in response to scientific evidence, is expected to continue protection to ESA-listed marine mammals and seabirds and may increase protection for other seabirds and marine mammals.

Reduction and Avoidance of Impacts to Habitat.

The Preferred Alternative has the potential to reduce and avoid impacts to habitat by careful placement of MPAs. The analysis contained in the Final PSEIS demonstrates that careful placement of MPAs is required to avoid unintended consequences (see section 4.10). Under the Preferred

Alternative, placement of MPAs in lightly fished or not fished areas will provide mitigation and result in avoidance of future habitat impacts if fisheries were to move effort into surrounding areas; MPAs established in heavily fished areas likely would not encompass entire habitat types or areas of fishing intensity but likely would be kept small to minimize the displacement of large amounts of fishing effort into surrounding areas. In the short-term, information from the Observer Program could be used to identify candidate MPA sites. Although not providing the highly precautionary approach to protecting habitat contained in Alternative 4, NOAA Fisheries determined that the Preferred Alternative will result in improvements beyond the status quo in achieving the goal of reduction and avoidance of impacts to habitat that will promote the ecosystem and the sustainability of the groundfish fisheries.

Promoting Equitable and Efficient Use of Fishery Resources.

NOAA Fisheries determined that the Preferred Alternative best promotes increased social and economic benefits through the elimination of the race-for-fish while also emphasizing the long-term economic value of the fishery through the promotion of rights-based allocations to individuals, sectors, and communities. In addition, the Preferred Alternative promotes ecosystem-based management and is likely to increase non-market, recreational, and tourism values assigned to the ecosystem. It is not possible to determine the long-term effect on overall ecosystem value (commercial and non-market values combined) because it is not known whether the fishing sectors, even with rights-based allocations, will be able to adapt to the changes resulting from the increased emphasis on ecosystem tools and, in particular, the potential increase in the number and significance of closed areas.

Increasing Alaska Native Participation.

The goals and policies for Alaska Native consultation and participation in fishery management under the Preferred Alternative would increase from current levels by expanding informal and formal consultation between NOAA Fisheries and the NPFMC, and Alaska Native participants and tribal governments. Local and Traditional Knowledge would be more formally incorporated in fishery management and additional data would be collected. Other goals and objectives in the Preferred Alternative, such as reductions in PSC limits, may benefit subsistence salmon use by reducing bycatch levels in the groundfish fisheries.

Improving Data Quality, Monitoring and Enforcement.

The Preferred Alternative data quality, monitoring, and enforcement objectives conform with the overall policy intent of the alternative, namely to accelerate precautionary management in two ways: where appropriate, to take steps to incorporate uncertainty and ecosystem considerations into fishery management, and at the same time, to increase efforts to improve scientific understanding and diminish uncertainty. The objectives in the Preferred Alternative result in data collection on direct fishery impacts and interactions as well as on broader ecosystem relationships and indirect effects, and emphasize the importance of enforcement concerns in fishery management.

By selecting the Preferred Alternative and approving Amendments 81 and 74 to the BSAI and GOA groundfish FMPs, respectively, both the Agency and the NPFMC will apply the new policy to all actions currently under consideration by the Agency and the NPFMC and that all future actions must be consistent with this policy or a reasonable explanation must be provided as to why a deviation from the policy is warranted. Furthermore, the NPFMC has developed a list of priorities as part of its workplan for addressing those aspects of the new fisheries management policy that are not sufficiently addressed in the FMPs. For information on the NPFMC's workplan, see its website at http://www.fakr.noaa.gov/npfmc.

D. National Policy Considerations

NOAA Fisheries is mandated by a variety of federal statutes to manage, conserve, and protect the Nation's living marine resources. Some of the main tenets of the Agency's legislative mandates require a balancing of objectives. For instance, the MSA directs the Agency to manage living marine resources for optimum sustainable utilization, while the Marine Mammals Protection Act (MMPA) prohibits exploitation of marine mammals and directs the Agency to protect and maintain them at optimum sustainable population levels. The alternatives analyzed in the PSEIS consider all of the statutory requirements and Executive Order (EO) mandates relevant to fisheries management. The alternatives represent different ways in which the objectives embodied in the statutes and EOs can be balanced. The following statutes and EOs are at the heart of federal fisheries management and play an integral part in defining the scope of the policies, goals, and objectives contained in, and management measures that flow from, an FMP. The Preferred Alternative complies with each of these national policies as described below as well as in Table 4.11-1 of the Final PSEIS.

The Magnuson Stevens Fishery Conservation and Management Act of 1976 (MSA).

The Preferred Alternative seeks to provide sound conservation of living marine resources, provide socially and economically viable fisheries and fishing communities, minimize threats to listed species, and maintain a healthy habitat (see Table 4.11-1 of the Final PSEIS for further details).

Endangered Species Act of 1973 (ESA).

Protection to threatened and endangered species is explicitly incorporated into the Preferred Alternative policy with a commitment to modify its FMPs as new scientific evidence becomes available.

Marine Mammal Protection Act (MMPA).

The Preferred Alternative policy statement sets as a goal the periodic review of marine mammal populations and fishing interactions and to develop fishery management measures as necessary.

Regulatory Flexibility Act (RFA).

Initial Regulatory Flexibility Act analyses or certifications will continue to be prepared on all future regulatory packages.

EO 12866 – Regulatory Planning and Review.

Regulatory Impact Reviews will continue to be included in all regulatory packages.

EO 12898 – Environmental Justice Guidance Under NEPA.

The Preferred Alternative policy explicitly recognizes that Alaska Native consultation is an important part of the decision-making process.

EO 13084 – Consultation and Coordination with Indian Tribal Governments.

The Preferred Alternative policy explicitly recognizes that Alaska Native consultation is an important part of the decision-making process.

EO 13158 – Marine Protected Areas.

The Preferred Alternative policy seeks to maintain and protect EFH and will consider implementation of a MPA program to mitigate adverse effects and protect habitat areas of particular concern. An MPA program would review and certify existing areas and consider additional use of MPAs and No-Take Reserves.

While the statutes, EOs, and regulations under which NOAA Fisheries operates define the national fisheries management policies considered in choosing the management direction captured by the Preferred Alternative, NOAA Fisheries also incorporated into its decision-making process national policy considerations outside the statutory context, such as those recommended by the NRC and by NOAA Fisheries' own Ecosystem Principles Advisory Panel.

The NOAA Fisheries Ecosystems Advisory Panel was established under the SFA and tasked with proposing ways of expanding the application of ecosystem principles in fishery conservation and management. The Panel's report, published in 1999, developed six general ecosystem-based management policies, which have been used to guide development of the alternatives analyzed in the PSEIS and, to some degree, the selection of the final Preferred Alternative.

In 1999, the NRC published recommendations for new performance standards for fishery management in "Sustaining Marine Fisheries" (NRC 1999). Overall, the NRC recommended the adoption of an ecosystem-based approach to fishery management with the goal to "rebuild and sustain populations, species, biological communities, and marine ecosystems at high levels of productivity and biological diversity . . . while providing food, revenue, and recreations for humans"

(NRC 1999). The NRC's recommendations have also guided development of the alternatives and, to some degree, the selection of the Preferred Alternative.

The recommendations of the NRC and the Ecosystems Advisory Panel have not been formally incorporated into statute, but the policy considerations they recommend are to some extent already embodied in the MSA, MMPA, and other statutes. These policy considerations have provided significant guidance throughout the preparation of the PSEIS, the evaluation of the alternatives, and the selection of the final Preferred Alternative. See PSEIS section 4.11 for a discussion of the statutory and non-statutory National policy considerations and a detailed comparison of the recommendations of the NRC and the Ecosystems Advisory Panel and the policies encapsulated in the Preferred Alternative.

6. MITIGATION MEASURES AND MONITORING

Section 4.9 in the Final PSEIS describes a number of ways that the Preferred Alternative, as a policy framework, will mitigate the adverse effects of fishing and produce benefits to the environment over time (see generally the direct/indirect and cumulative effects analyses and discussions in Section 4.9). Using the more precautionary management approach, NOAA Fisheries and the NPFMC anticipate fully considering the ecosystem when taking future management and regulatory actions. The MSA and NEPA analyses, which will be prepared on all future actions, will explicitly evaluate each alternative in its ability to achieve the policy goals and objectives approved in the Preferred Alternative.

The PSEIS identifies numerous information gaps and scientific data needs (see Chapter 5 of the Final PSEIS). The Agency acknowledges that expanded research to collect new information and fill existing data gaps is dependent on the Agency's receiving additional research funding. While additional funds are not certain, NOAA Fisheries intends to pursue the funding necessary to meet future research needs and improve the scientific information available for managing the fisheries. With that improved knowledge, future fisheries management will have the ability to address the public's concerns about the sustainability of the Alaska groundfish fisheries and a healthy marine ecosystem. Through data collection measures that will result in reducing uncertainty, the Preferred Alternative is likely to be effective in achieving the goal of accelerating the use of precautionary management measures. The objectives to improve the Observer Program and observer data will increase the quality of fishery data by implementing increased flexibility of, and potentially expanding, observer coverage. Additionally, the expanded collection of economic data and the potential for independent verification will allow for more accurate and credible assessments of economic impacts.

The alternative also emphasizes the importance of enforcement concerns in fishery management. NOAA Fisheries Office for Law Enforcement will continue to enforce all federal fishing regulations in Alaska. Future management actions will consider the impacts of such actions on the Agency's law enforcement capabilities.

7 CONCLUSION

Through the PSEIS and documented in this ROD, NOAA Fisheries has analyzed programmatic alternatives, associated environmental consequences, the extent to which those impacts can be mitigated, and has considered the objectives of the proposed action. NOAA Fisheries also has considered public and agency comments received during the PSEIS review periods. Consequently, NOAA Fisheries concludes that at a policy level, the Preferred Alternative adopts reasonable, practical means to avoid, minimize, or compensate for environmental harm from the action. Future action-specific alternatives consistent with the approved management framework will be carefully considered following the procedures authorized by the MSA and NEPA.

CONTACT PERSON

Further information concerning this ROD may be obtained by contacting Steven K. Davis, NOAA Fisheries Alaska Region, 709 West 9th Street, Juneau, AK. 99802-1668, (907) 271-3523.

Signed: William T. Hogarth   Date: 26 August 2004

William Hogarth
Assistant Administrator for Fisheries, NOAA

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
PROGRAM PLANNING AND INTEGRATION
Silver Spring, Maryland 20910

MAY 18 2004

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act of 1969 (NEPA), we enclose for your review the Final Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement (PSEIS).

This PSEIS has several purposes. First, it serves as the primary decision document for determining the future overarching management policies and directions of the Fishery Management Plan for the Groundfish Fishery of the Gulf of Alaska and the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area (FMPs). These FMPs were developed by the North Pacific Fishery Management Council (Council) and approved and implemented by the Secretary of Commerce. In serving this decision making purpose and as a NEPA document, the PSEIS will provide the Council, NOAA Fisheries, and the public with critical information on the status of these fisheries' and environmental impacts necessary to determine preferred policies and approaches for the Alaska groundfish management program. Thus, the PSEIS will guide specific future fishery management actions.

The PSEIS also serves as the current primary environmental review document supporting the FMPs. It summarizes and analyzes the best scientific information about the natural and physical environment in the Gulf of Alaska and Bering Sea and Aleutians Islands areas and the relationship of people with that environment. It assesses the environmental impacts resulting from past and present fishery management regimes and from the expected impacts of alternative future fishery management regimes. Significant environmental and fishery changes have occurred since the original Environmental Impact Statements (EISs) for the FMPs were prepared approximately 25 years ago.

Additional copies of the Final PSEIS may be obtained from Steven K. Davis at NOAA Fisheries, P.O. Box 21668, Juneau, AK 99802, (907) 271-3523 or Anne Maki at (907) 261-9741. The document is also accessible electronically through the Alaska Region's website at http://www.fakr.noaa.gov/.

Comments or questions on this document submitted during the agency's 30-day review period for the Final PSEIS must be received by July 3, 2004. Written comments on the Final PSEIS should be submitted by mail to James W. Balsiger, Alaska Regional Administrator, NOAA Fisheries, P.O. Box 21668, Juneau, AK 99802. Electronic comments may be submitted by e-mail to groundfish.final_pseis@noaa.gov; include in the comment subject line the following Final PSEIS identifier: Final PSEIS Groundfish. A copy of your comments should be submitted to me by mail to the NOAA Strategic Planning Office (PPI/SP), SSMC3, Room 15603, 1315 East-West Highway, Silver Spring, Maryland 20910; by fax to 301-713-0585; or by e-mail to nepa.comments@noaa.gov.

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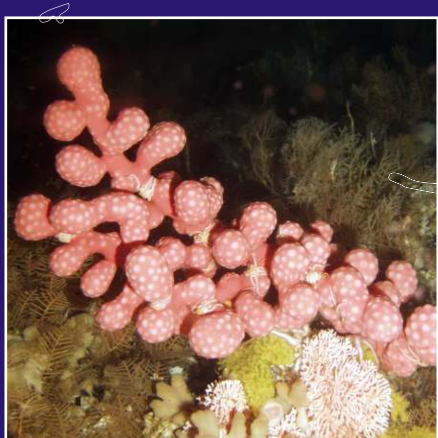
NOAA Fisheries is not required to respond to comments received as a result of the issuance of the Final PSEIS. Comments received will be reviewed and considered for their impact on the issuance of a Record of Decision (ROD) and will made part of our administrative record.

Sincerely,

Susan A. Kennedy
Acting NEPA Coordinator

Alaska Groundfish Fisheries

Final Programmatic Supplemental Environmental Impact Statement



United States Department of Commerce

National Oceanic and Atmospheric Administration

National Marine Fisheries Service Alaska Region

June 2004

Programmatic Supplemental Environmental Impact Statement
for the
Alaska Groundfish Fisheries Implemented Under the Authority of the
Fishery Management Plans* for the *Groundfish Fishery of the Gulf of Alaska
and the *Groundfish of the Bering Sea and Aleutian Islands Area*

June 2004

Lead Agency:	USDC National Oceanic and Atmospheric Administration National Marine Fisheries Service Alaska Region Juneau, Alaska, and Seattle, Washington
Responsible Official:	James W. Balsiger, Administrator, Alaska Region and Douglas P. DeMaster, Director, Alaska Fisheries Science Center
For Further Information Contact:	Alaska Regional Office National Marine Fisheries Service 709 West 9th Street, Suite 453 P.O. Box 21668 Juneau, Alaska 99802-1668 (907) 586-7247
Cooperating Agencies:	USDI Fish and Wildlife Service State of Alaska Department of Fish and Game US Coast Guard

Abstract: The environmental impact statements for the Gulf of Alaska and Bering Sea Aleutian Islands groundfish Fishery Management Plans (FMPs) were prepared in 1978 and 1981, respectively. During the intervening years, numerous changes have occurred that warrant preparation of a Programmatic Supplemental Environmental Impact Statement (PSEIS). These changes include the shift from primarily foreign fisheries to completely domestic fisheries; that the FMPs governing the fisheries have been amended numerous times; that new information is available about the ecosystem; that the science of fisheries management has progressed substantially; that public opinion about management of these fisheries has changed; and that several bird and marine mammal species have been listed as threatened or endangered under the Endangered Species Act. This PSEIS was prepared to establish a new baseline of environmental and economic information, bringing the federally managed groundfish fisheries into compliance with the National Environmental Policy Act as well as serve as the supporting document for the reauthorization of the Alaska groundfish fisheries. This PSEIS presents the impacts of groundfish fishing on the biological and economic environments that result from a broad array of policy-level programmatic fisheries management alternatives. Included in this final PSEIS is the recommended preferred alternative of the North Pacific Fishery Management Council, and its environmental consequences. Impacts are disclosed, both significantly beneficial and significantly adverse as required by the National Environmental Policy Act. The preferred alternative is a new policy framework that represents a conservative, precautionary approach to ecosystem-based fisheries management, and communicates a policy direction for the future. The preferred alternative is a realistic and responsible approach that addresses and complies with the various goals, objectives and requirements of the

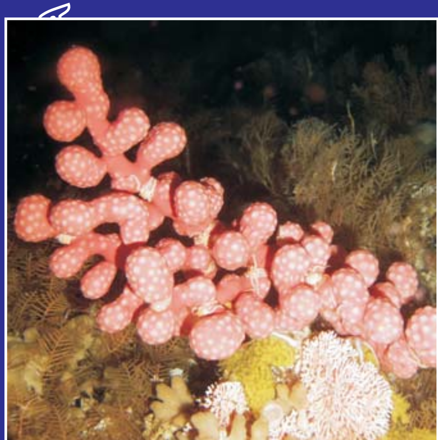
Magnuson-Stevens Act and other applicable law. A biological assessment on the preferred alternative was prepared according to procedures implementing the Endangered Species Act, and it is included in the PSEIS appendix.

ALASKA GROUNDFISH FISHERIES

FINAL PROGRAMMATIC SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

EXECUTIVE SUMMARY

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE



United States Department of Commerce

National Oceanic and Atmospheric Administration

National Marine Fisheries Service Alaska Region

June 2004

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FIGURES

ACRONYMS AND ABBREVIATIONS

ABC	Acceptable Biological Catch
max ABC	Maximum ABC
ADF&G	Alaska Department of Fish and Game
AFA	American Fisheries Act
BSAI	Bering Sea and Aleutian Islands
CDQ	Community Development Quota
CFR	Code of Federal Regulations
CPUE	Catch-per-unit-effort
EA	Environmental Assessments
EBS	Eastern Bering Sea
EEZ	Exclusive Economic Zone
EISs	Environmental Impact Statements
EO	Executive Order
ESA	Endangered Species Act
F	Fishing Mortality Rate
FMP	Fishery Management Plan
ft	Feet
IFQ	Individual Fishing Quota
IR/IU	Improved Retention/Improved Utilization
LOA	Length Overall
m	Meters
MPA	Marine Protected Area
mt	Metric Tons
mi2	Square Miles
NFS	Northwest Food Strategies
MSA	Magnuson-Stevens Act
MSST	Minimum Stock Size Threshold
MSY	Maximum Sustainable Yield
nm	Nautical Miles
NEPA	National Environmental Policy Act
NPFMC	North Pacific Fishery Management Council
NMFS	NOAA Fisheries
OFL	Overfishing Level
OY	Optimum Yield
PA	Preferred Alternative
PSC	Prohibited Species Catch
Programmatic SEIS	Programmatic Supplemental Environment Impact Statement
SEIS	Supplemental EIS
TAC	Total Allowable Catch
U.S.	United States
USFWS	U.S. Fish and Wildlife Service

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ES 1.0 Introduction

This executive summary provides an overview of the findings contained in the final Alaska Groundfish Fisheries Programmatic Supplemental Environment Impact Statement (Programmatic SEIS). For more detailed information, the reader should refer to the final Programmatic SEIS and its appendices.

This Programmatic SEIS has multiple purposes. First, it serves as the central environmental document supporting the Fishery Management Plan (FMP) for the groundfish fishery in the Bering Sea and Aleutian Islands Area (BSAI) and the FMP for the Gulf of Alaska (GOA) groundfish fishery. The historical and scientific information and analytical discussions contained herein are intended to provide a broad, comprehensive analysis of the general environmental consequences of fisheries management in the Exclusive Economic Zone (EEZ) off Alaska. This document also provides agency decision-makers and the public with information necessary for making informed decisions in managing the groundfish fisheries, and sets the stage for future management actions. In addition, it describes and analyzes current knowledge about the physical, biological, and human environment in order to assess impacts resulting from past and present fishery activities. Significant changes have occurred in the environment since the original Environmental Impact Statements (EISs) for the GOA FMP and BSAI FMP were published approximately 25 years ago. While Environmental Assessments (EA) and several EISs have been prepared for FMP amendments over the ensuing years, none have examined the groundfish FMPs at a programmatic level. The National Environmental Policy Act (NEPA) requires preparation of an EIS or Supplemental EIS (SEIS) when significant environmental changes have occurred. Significant changes have certainly occurred in the environment as well as within the fisheries themselves. This Programmatic SEIS is intended to bring both the decision-maker and the public up-to-date on the current state of the environment, while describing the potential environmental consequences of different policy approaches to managing the groundfish fisheries off Alaska. In doing so, it serves as the overarching analytical framework that will be used to define future management policy with a range of potential management actions.

Additionally, this Programmatic SEIS explains the effects of the current groundfish fishery management regime and selected alternative management regimes, on the human environment. These effects are considered in order to assess whether a different type of management regime should be implemented. These alternative management regimes are illustrated by example “bookend” FMPs that represent a reasonable range of management actions that best demonstrate the types of tools and measures that the North Pacific Fishery Management Council (NPFMC) and the National Marine Fisheries Service (NMFS or NOAA [National Oceanic and Atmospheric Administration] Fisheries) would use to implement the policies in the various alternatives. For purposes of this Programmatic SEIS, NOAA Fisheries presumes that the Alaska groundfish fisheries result in some significant effects, both beneficial and adverse, to the human and natural environments. This Programmatic SEIS has been structured in a manner that identifies these effects (direct, indirect, and cumulative) to the extent possible, and explores alternative policies and specific management actions that might serve to mitigate adverse impacts. It is anticipated that future NEPA documents analyzing actions in the Alaska groundfish fisheries will reference this Programmatic SEIS. The Programmatic SEIS will require periodic updates as new information and/or significant changes occur in relation to the fisheries or the environment.

ES 2.0 Defining the Problem

A number of pressing issues face those who participate in and manage the Alaska groundfish fisheries. The range of issues include the effects of the groundfish fisheries on declining Steller sea lion populations and other protected species, the effects of fishing gear on benthic habitat, excess fishing and processing capacity, and the effects of harvesting fish on the North Pacific marine ecosystem. Other notable issues include maintaining sustainable fisheries, reducing bycatch and waste, improving data collection, enforcing regulations, and providing economic stability for fishing communities. These ongoing issues have been targeted by NOAA Fisheries and the NPFMC as a research and management focus.

NEPA requires that a significant federal action (such as a federally authorized fishery) be evaluated for its potential effects on the human environment, which include physical, biological and socioeconomic components. This goal has been achieved by:

- Updating the information contained in the original EISs by providing a historical review of how the groundfish fisheries and the environment have changed since publication of the original EISs.

- Describing how new scientific and fishery information is being utilized.

- Describing the cumulative effects of past, present, and reasonably foreseeable future groundfish fisheries management on the marine ecosystem and the environment (to the extent possible).

- Analyzing the current and alternative management regimes to determine the potential impacts on the human environment.

ES 2.1 The Federal Action: Management and Authorization of the Alaska Groundfish Fisheries

The federal action in this Programmatic SEIS is defined as the management of groundfish fisheries and the authorization of groundfish fishery activities off Alaska, pursuant to the *Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area* and the *Fishery Management Plan for the Gulf of Alaska Groundfish Fishery* (Section 1.2).

These FMPs were prepared by the NPFMC and approved by the Secretary of Commerce in 1978 and 1981, respectively. The GOA FMP has been amended over 55 times and BSAI FMP over 65 times (Section 3.2). As necessary, rules and regulations were prepared to implement each of the FMP amendments. To comply with NEPA, EISs were prepared for the original FMPs prior to their approval by the Secretary of Commerce (NPFMC 1978, NPFMC 1981). An EIS or an EA was also prepared for nearly every plan amendment (Appendix C and Appendix D), and each time a regulation was changed (Appendix E). Since 1991, EAs resulting in a finding of no significant impact have been written for each year's Total Allowable Catch (TAC) specifications. An analysis of these historical FMP amendments has been conducted as part of this Programmatic SEIS. An overview of this analysis is presented in Section 3.2.

ES 3.0 What is the Supplemental Programmatic Environmental Impact Statement?

A Programmatic EIS is typically a broad environmental evaluation that examines a program, such as fisheries management, on a large scale. Federal agencies have been encouraged to develop "multi-tiered" EISs to streamline the NEPA process. This approach avoids repetition by referencing broad, program-oriented issue analyses in the Programmatic SEIS when preparing subsequent EAs or EISs that focus on specific proposed federal actions. A programmatic EIS is usually prepared at the onset of a new federal program. In this case, the GOA and BSAI FMPs have been in place for approximately 25 years, during which time significant changes have occurred in the environment and in the fisheries. Therefore, this Programmatic SEIS has been prepared to provide a comprehensive review of the FMPs.

Programmatic SEIS Timeline

Notice of Intent	October 1999
Scoping Period and Meetings	October 1999 through December 15, 1999
Scoping Report	April 2000
Preparation of First Draft Programmatic SEIS	May through November 2000
Distribution of First Draft Programmatic SEIS	January 2001
Public Meetings	March & April 2001
Completion of Public Review of Draft Programmatic SEIS	July 2001
Review and Synthesis of Public Comments	July through October 2001
NOAA Fisheries Decides to Revise Draft Programmatic SEIS and its Alternatives	November 2001
Preparation of Second Draft Programmatic SEIS	January 2002 through August 2003
Distribution of Second Draft Programmatic SEIS	September 2003
Public Meetings	September & October 2003
Completion of Public Review of Revised Draft Programmatic SEIS	November 2003
Review and Synthesis of Public Comments	November 2003 through March 2004
Final NPFMC Action on Preferred Alternative	April 2004
Final Programmatic SEIS Released	June 2004
Record of Decision issued by NOAA Fisheries	On or before September 1, 2004

ES 3.1 Scope of this Programmatic Supplemental Environmental Impact Statement

NOAA Fisheries determined that the Programmatic SEIS for the Alaska groundfish fisheries should provide a broad analysis of the effects of the GOA and BSAI FMPs on the areas under their management. The Programmatic SEIS includes a cumulative impact analysis of actions that have occurred, and examines policies and potential future actions from a variety of environmental perspectives. By its programmatic nature, this document takes a broad look at the issues and the alternatives, and is somewhat qualitative in nature. More case-specific, detailed analyses can be expected in the future as proposed management actions are evaluated in subsequent second-level tiered EAs or EISs. This Programmatic SEIS provides the Agency and the public with an analytical framework to examine environmental effects resulting from other potential fisheries management regimes. Findings that flow from this analysis are likely to result in a change to the FMP management policy and therefore, FMP and regulatory amendments to implement the policies are anticipated. Future amendments will be developed using the NPFMC process.

ES 3.2 Organization of this Document

The management of the Alaska groundfish fisheries is a large, complex program that continues to evolve as more information is obtained on the fishery resources, the marine ecosystem, and from those that derive benefits from both. The Programmatic SEIS provides a means for informing the public about Alaska groundfish management, the current regime, alternative regimes, known and unknown elements of the ecosystem, and the complex set of laws and regulations that apply to federal fisheries management. To meet its objectives, the document has been organized into a series of chapters and sections, as follows:

Chapter 1 establishes the purpose of and need for the federal action supported by this Programmatic SEIS. It provides an overview of NEPA and its procedural requirements, a history of this document including NOAA Fisheries' methods for conducting the NEPA scoping process and addressing public comments.

Chapter 2 presents the programmatic alternatives that are the focus of this document, beginning with a detailed explanation of the body of fisheries management policies, practices, tools, and methods that will give readers the foundation for a better understanding of the alternatives. This chapter also identifies the NPFMC's and NOAA Fisheries' preferred alternative (PA).

Chapter 3 describes the physical, biological, and socioeconomic resource components of the BSAI and GOA environments, and the eastern Bering Sea (EBS) and eastern North Pacific ecosystems. The objective of this chapter is to present a description of the relevant history and current status of the resources and environment that will serve as the baseline for the analyses of the alternatives. This chapter also includes a discussion of the past cumulative effects on the human environment, as they contribute to the existing baseline condition.

Chapter 4 discusses the effects of groundfish fishing on the environment under the different alternatives and their associated FMP bookends. The analyses examine the direct, indirect, and cumulative effects of each of the hypothetical FMPs that serve as bookends for the range of management actions appropriate to the particular policy alternative. This chapter then builds on these analyses and presents conclusions regarding the overall effects of the policy alternatives.

Section 4.1 provides a description of the methods used to determine the significance of potential consequences, the methods used to analyze the alternatives, and the application of the model output. The analysis of these model regimes and their contrast to the baseline condition established in Chapter 3 is intended to illustrate the general environmental effects of each programmatic policy alternative. In so doing, this Programmatic SEIS will provide the NPFMC and NOAA Fisheries, as well as the public, with information that can be used to guide future policy decisions.

Section 4.2 presents the analytical framework used to evaluate the alternatives. FMP bookends for each alternative were used as proxies for analyzing the policy alternatives. This section describes the FMP bookends and also presents maps that were developed to interpret the policy alternatives and depict some of the differences, such as closure areas, between the alternatives.

Section 4.3 presents abstracts of eleven Qualitative Analysis papers prepared to analyze the FMP components as they relate to the alternatives. These papers describe, in a qualitative manner, the effects of the alternative FMPs on key issues, such as fishing bycatch or overcapacity (the full text of these papers is included as Appendix F).

Section 4.4 provides a review of the comparative baseline statements carried forward for cumulative effects analysis for each key issue category.

Sections 4.5 through 4.9 present, by alternative, a detailed examination of the example FMP bookends and the likely environmental consequences of each alternative.

Section 4.10 analyzes each alternative from a policy-level perspective, drawing on the results from the previous analyses, and Section 4.11 compares the alternatives at the policy-level, presenting the major conclusions of the findings on environmental and social issues.

Chapter 5 focuses on research and management, and provides a brief description of existing research priorities in fisheries management, as well as a list of data gaps and research needs for each policy alternative. This section also presents a discussion of management and enforcement considerations for each policy alternative.

Chapter 6 contains a list of preparers of the document while Chapter 7 presents the distribution list for the document. Chapter 8 contains the literature cited, and Chapter 9 provides an index.

The figures and tables of the document are included in Appendix A. Appendices B through E provide historical information on groundfish management. Appendix F contains the Qualitative Analysis papers, and Appendix G includes the comment analysis report for the 2003 Draft Programmatic SEIS. Appendix H contains model output used to analyze the alternatives. Several appendices (I through L) provide copies of the Federal Register notices relating to the preparation of the Programmatic SEIS. Appendices M and N are informational NPFMC documents, and Appendix O is the Biological Assessment that presents the results from the informal Endangered Species Act consultation.

ES 4.0 What Are the Alaska Groundfish Fisheries?

ES 4.1 What Fish are Harvested?

The BSAI and GOA FMPs authorize and regulate the commercial harvest of various groundfish species. All of the finfish and invertebrate species in the area subject to the management plan are grouped into five management categories: target, prohibited, other, forage fish, and non-specified. Harvest quotas, or TACs, are set annually for target species either individually or by species group. Prohibited species catch (PSC) limits are set for certain species (e.g., salmon, herring, halibut, king crab, and Tanner crab) that are the target of other domestic fisheries, but are taken incidentally in groundfish fishing operations.

Principal groundfish fisheries are directed on pollock, Pacific cod, sablefish, flatfish, Atka mackerel, and rockfish. Gear types used to harvest fish include bottom and pelagic trawls, hook-and-line (longlines), pot, and jig. About 2.2 million metric tons (mt) of groundfish are taken annually in the combined BSAI and GOA fisheries, with groundfish harvested well below their overfishing level (OFL). Some of the stocks are at or near their all time high biomass levels (Bering Sea pollock, Pacific cod, and rock sole), while others are at lower levels of abundance (GOA pollock, various rockfish).

ES 4.2 Where Do the Fisheries Occur?

The groundfish fisheries occur in the North Pacific Ocean and Bering Sea in the United States (U.S.) EEZ from 3 to 200 nautical miles (nm) offshore and between 50°N to 65°N latitude (Figure ES-1). The subject waters, or the action area, are divided into two management areas; the BSAI and the GOA (Section 1.2).

The BSAI groundfish fisheries effectively cover all of the Bering Sea under U.S. jurisdiction, extending southward to include the waters south of the Aleutian Islands west of 170°W longitude to the border of the U.S. EEZ. The GOA FMP applies to the U.S. EEZ of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170°W longitude and Dixon Entrance at 132°40'W longitude. The area of the EEZ off Alaska is more than 900,000 square miles (mi^2), larger than the combined EEZs of the east and west coasts of the U.S. The largest continental shelf off the United States coast in located within the EEZ off Alaska. For purposes of this Programmatic SEIS, we have defined this shelf and slope as the submarine shelf from shore to a depth of 1000 meters (m). When defined in this way, 41.5 percent of the BSAI EEZ is comprised of waters overlying the continental shelf and slope. This is where most, if not all, the domestic groundfish fishing occurs, and it is referred to in the Programmatic SEIS as the "fishable area" of the EEZ. Similarly, in the GOA, most fishing also occurs over the shelf and slope, although in contrast to the Eastern Bering Sea, the shelf is much more narrow and only comprises about 30 percent of the EEZ. The FMPs address those areas in the EEZ directly affected by fishing. The FMPs also manage those fishing activities in the EEZ that can indirectly affect the harvest of fish from nearby areas. The area affected by the groundfish fisheries necessarily includes adjacent State of Alaska and international waters, although the FMPs themselves do not govern activities in those areas.

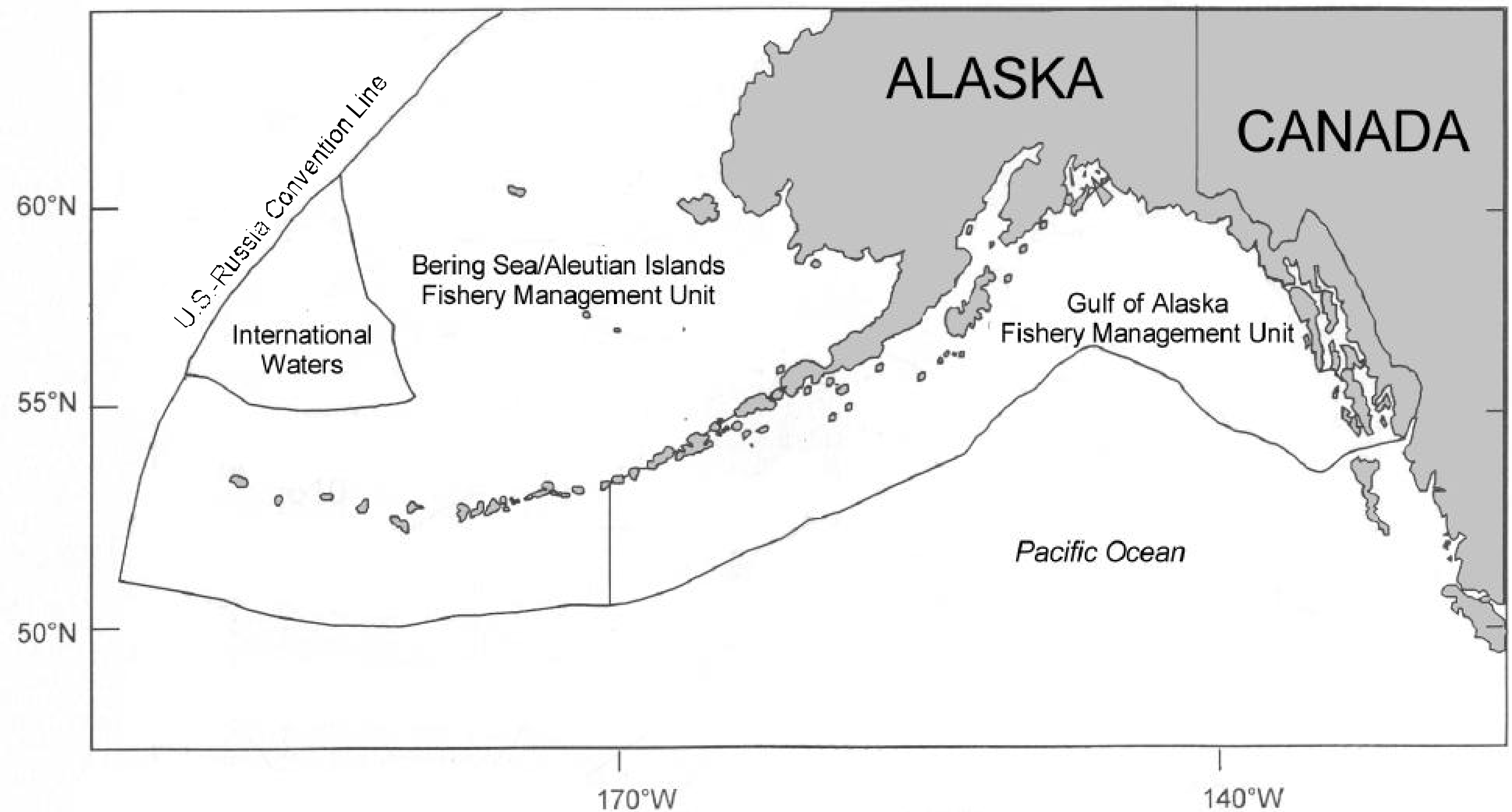

Figure ES-1. SubjectgroundfishfisheriesintheBering Sea andNorth Pacific.

ES 4.3 Who Participates in the Fisheries?

Fishermen and processing workers primarily from the states of Alaska, Washington, and Oregon, participate in BSAI and GOA groundfish harvesting and fish processing (Sections 3.9.2 - 3.9.4). Approximately 2.0 million mt of groundfish were landed in 2001; approximately 91 percent of the harvest came from the Bering Sea, with the remaining nine percent from the GOA. About 73 percent of this catch was pollock. In 2001, the ex-vessel value of the groundfish landed and processed was about $300 million. The approximate wholesale value of the groundfish products produced by the catcher processor and inshore processor/mothership sectors in 2001 was $1.4 billion. Total harvesting and processing employment was estimated at approximately 10,000 full-time equivalent positions, with about 60 percent of the employment going to Alaska residents, and most of the remaining employment going to Washington and Oregon residents. Commercial fishing generates other economic activity in all three states through support services, and generates tax revenue for the State of Alaska and many Alaska communities.

Catcher Vessels: The harvesting sector in 2001 included nine classes of catcher vessels based on primary gear types and fisheries, accounting for 917 vessels. The five trawl classes focus on pollock and, to a lesser extent, Pacific cod. Trawl catcher vessels deliver the vast majority of their fish to at-sea motherships, Bering Sea pollock shore plants, Alaska Peninsula and Aleutian Island shore plants, and Kodiak Island shore plants. Currently, trawlers account for approximately 78 percent of the ex-vessel value of catcher vessel landings. The remaining four vessel classes all use fixed gear. Pot catcher vessels, which are primarily crab vessels that also fish part time in Pacific cod fisheries, account for three percent of the ex-vessel value and payments to labor. Longline catcher vessels focus primarily on high-value sablefish using longline gear in the GOA, and generate approximately six percent of total groundfish ex-vessel value and labor income. The other two fixed-gear catcher vessel classes (vessels less than 32 feet (ft) in length and vessels 33 to 59 ft in length) use longline, pot, and jig gear and have by far the largest number of operations. Both of these fixed-gear classes participate in the groundfish fisheries to augment income from salmon, herring, and halibut fisheries. The larger of these two classes includes more than 514 vessels and generates 12 percent of the total groundfish ex-vessel value, primarily through landings of high-value sablefish and rockfish from the GOA.

Inshore Processors and Motherships: Inshore processing facilities (including shore plants and floating inshore processors) and motherships buy raw fish from catcher vessels and then process and freeze it for future use. In 2001, these operations are estimated to have generated more than $680 million in wholesale product value from groundfish, with nearly $600 million or 87 percent generated by the five classes of shore plants. In addition, these plants generated about $240 million in payments to labor and 4,000 full-time equivalent jobs in 2001. Bering Sea pollock shore plants had by far the largest output value in 2001 (about $415 million in wholesale product value). Shore plants on Kodiak Island were the second largest group of shore plants in projected output value ($81 million wholesale), followed by Alaska Peninsula and Aleutian Islands region shore plants ($49 million wholesale). Shore plants in southcentral and southeast Alaska process relatively small volumes of groundfish (about 6,000 mt each in 2001). Yet, because these plants process a large proportion of high-value species, such as sablefish and rockfish, together they generated about 8 percent of the total wholesale value and payments to labor. Motherships, which process Bering Sea pollock almost exclusively, generated about $77 million in wholesale value in 2001.

Catcher Processors: In 2001, there were 89 catcher processor vessels. Five classes of catcher processors were identified based on primary products and gear types. Catcher processors generated about $740 million in total output (wholesale product value), $266 million in payments to labor, and the equivalent of about 3,900 full-time jobs in 2001. Surimi and fillet trawl catcher processors operate almost exclusively in the BSAI pollock fishery. The twelve surimi vessels generated about 40 percent of total product value for catcher processors, while fillet trawl vessels added ten percent. Head-and-gut trawl catcher processors, which typically focus on flatfish and Atka mackerel, produced about $197 million in wholesale product value. Longline catcher processors, which generally focus on Pacific cod (some also have large sablefish catches), generated approximately $156 million in product in 2001. Pot catcher processors, which fish for Pacific cod when crab fisheries are closed, are comparatively minor participants in the groundfish fisheries, with about $7 million in output value.

Regions and Communities that Benefit from Fishing Activities: In addition to vessels and processors, regions that have significant involvement in BSAI and GOA groundfish fisheries include the Alaska Peninsula and Aleutian Islands, Kodiak archipelago, southcentral Alaska, southeast Alaska, Washington inland waters, and the Oregon coast. In general, regional impacts include not only direct effects from harvesting and processing, but also indirect effects generated through tax payments and as income cycles through the regional economies.

The Alaska Peninsula and Aleutian Islands region is, in several respects, the center of the Alaska groundfish fishery, accounting for more than four times the volume of groundfish processed inshore than in the other Alaska regions combined during 1992-2001. Relative dependence on the groundfish fishery varies: four of Alaska's top five groundfish landing ports are in this region, but some communities have little, if any, direct involvement. Fish tax from groundfish is an important underpinning of the regional economy, and groundfish vessel owners, though few in number, are important contributors to the economies of local communities. Kodiak is the dominant region for groundfish in the GOA, but is also an important region for salmon, halibut, and other non-groundfish species. Groundfish accounts for roughly 40 to 45 percent of local processing and fish tax revenues. Participation in the groundfish fishery in southcentral and southeast Alaska is much more limited than in the Alaska Peninsula and Aleutian Islands and Kodiak Island regions. Both southcentral and southeast Alaska have significantly more diversified economies and relatively greater involvement in non-groundfish fisheries compared to the other two Alaska regions.

Regions in the Pacific Northwest also have important links to Alaska's groundfish fisheries. The Washington inland waters region as a whole, especially the greater Seattle area, is engaged in all aspects of the North Pacific groundfish fishery. While Washington is distant from the harvest areas, it is the organizational center of much of the industrial activity. The human components of the fishery-specific industry sectors based in or linked to Seattle are substantially engaged in or dependent on the groundfish fishery. In terms of vessel and processor ownership, involvement in the Alaska groundfish fishery is arguably greater for Seattle than for any other community. However, if the size and diversity of Seattle's overall economy are considered, the groundfish fishery may be less important or vital for Seattle than for the other communities considered in the Programmatic SEIS. The Oregon coast region has long had significant involvement in the fishery, from the development of joint ventures through the present catcher vessels that participate in a variety of fisheries across the Alaska regions.

In addition, six western Alaska Community Development Quota (CDQ) groups, representing 65 rural Alaskan villages, receive a share of the fisheries allocation to facilitate economic development in rural Alaska. The CDQ groups have provided up to 1,000 jobs annually for western Alaska residents, with annual wages of about $5-8 million; they have also used revenues to fund acquisition of vessels and seafood-related businesses, and to fund infrastructure improvements in western Alaska communities.

ES 5.0 How Are the Fisheries Managed?

The Magnuson-Stevens Act (MSA) established the primary legal framework for the management of the BSAI and GOA groundfish fisheries. FMPs are intended to satisfy the requirements of the MSA as well as other federal mandates including NEPA, the Endangered Species Act (ESA), the Marine Mammal Protection Act, and Executive Order (EO) 12898 on Environmental Justice. The MSA contains ten National Standards that serve as overarching policy goals for federal fisheries management. The NPFMC was established by the MSA to serve as a policy advisor to the Secretary of Commerce. Its many responsibilities include the preparation of FMPs and plan amendments for each fishery that requires fisheries conservation and management. The NPFMC employs a very public-oriented process. Its principal job is to make recommendations while attempting to balance sometimes conflicting policy objectives contained in the MSA with those objectives contained in other federal laws. Fishery issues, information, and public proposals are brought to the NPFMC. A system of scientific and industry experts review and advise the NPFMC on how best to manage the fisheries and address management problems that arise. For a more detailed overview of the MSA, other applicable federal laws, and the NPFMC process, see Appendix B.

Regulations specifically governing the groundfish fisheries in the EEZ off Alaska appear in the Code of Federal Regulations (CFR) in 50 CFR 679. FMPs, amendments to FMPs, and regulatory amendments are developed by the NPFMC, submitted to the Secretary of Commerce for review, and, if approved or partially approved, implemented by federal regulations. Once the regulations are put into effect, NOAA Fisheries has responsibility for the day-to-day management of the fisheries. Enforcement of the regulations is carried out jointly by NOAA Fisheries and the U.S. Coast Guard. In cases where groundfish are harvested and processed in both the EEZ and state waters, these fisheries are cooperatively managed by NOAA Fisheries and the Alaska Department of Fish & Game (ADF&G). For information on how these resources are managed, see Appendix B.

ES 5.1 What Are the Environmental Issues?

The first step in preparing an EIS is scoping. Scoping is designed to provide an opportunity for the public, other federal and state agencies, non-governmental organizations, and other interested groups to provide input on potential issues associated with the federal action. Through both the scoping process and a review of the public comments received on the first draft Programmatic SEIS, ten issues were mentioned frequently, suggesting that these issues are most important to the public (Section 1.5). These issues include:

- Effects on target groundfish species.
- Effects on prohibited species.
- Effects on forage fish species.
- Effects on other species.
- Effects on non-specified species.
- Effects on habitat.
- Effects on seabirds.
- Effects on marine mammals.
- Effects on social economics of the fishery.
- Effects on the marine ecosystem.

All of these important issues are addressed in this Programmatic SEIS and each alternative is evaluated as to its impacts on each of these issues. Therefore, while there will always be other issues that arise and need to be considered and acted upon, the ten most important issues identified through this NEPA process have been addressed by this Programmatic SEIS.

ES 5.2 How Do the Current Management Plans Address These Issues?

Over the last 25 years, fisheries regulations have been modified numerous times to address environmental and economic issues. Such actions include the establishment of:

- Bottom trawl closure areas in the GOA and BSAI based on historic king crab abundance to reduce bycatch and enhance the recovery of depressed crab stocks.
- A constraining cap on optimum yield in the Bering Sea and Aleutian Islands as a buffer against uncertainty.
- A domestic observer program for the purposes of collecting important fishery information.
- Overfishing definitions to protect target groundfish stocks, which reduce the fishing mortality rate when stocks are at low biomass levels.
- A moratorium on new entry into the groundfish fisheries.
- Specific allocations to inshore and offshore processing sectors to prevent preemption and provide economic stability to Alaska coastal communities.
- Closure areas around Steller sea lion rookeries to protect these marine mammals from adverse effects of commercial groundfish fishing.
- PSC limits to reduce bycatch.
- An individual fishing quota (IFQ) Program for the sablefish fishery.
- Allocations of Pacific cod among the various gear types to promote economic stability.
- Closed areas to protect sensitive marine habitat.

A more detailed summary of the actions can be found in Appendix B.

The NPFMC and NOAA Fisheries are not the only resource agencies that have taken action. The U.S. Fish and Wildlife Service (USFWS) conducts research and monitors walrus, short-tailed albatross, and other seabird populations off Alaska. The ADF&G actively monitors and manages all fishing within state waters and has taken numerous actions to protect nearshore habitats from trawling. The U.S. Congress has also prioritized research, expanded programs, and developed measures that have addressed problems including the phasing-out of foreign fishing, the overcapacity of the groundfish harvesting and processing sectors, and the potential adverse effects of groundfish fishing on Steller sea lions.

ES 6.0 What Are the Fisheries Management Alternatives?

This Programmatic SEIS examines four alternative policy statements, each presented in a standard framework that provides management flexibility and allows for adaptation as new information on the ecosystem and the fisheries is obtained. Analyzing environmental impacts of FMPs requires knowing what specific actions could be taken to implement them. Policies are, by definition, high-level, overall statements or plans embracing the general goals and procedures of a government body. Goals and objectives are often used to frame a policy, making it easier to understand, and provide specific directions for implementation through FMP amendments. Still, determining the ways in which a policy might affect the human environment is difficult to analyze without some indication of how it might be implemented.

Each alternative is comprised of three elements: a management approach statement that describes the goals, rationale and assumptions behind the alternative; a set of management objectives that complement and further refine the goals set forth in the management approach; and, except for Alternative 1(status quo), a pair of example FMP "bookends" that illustrate and frame the range of implementing management measures for that alternative. The management approach and objectives serve to define the direction the NPFMC and NOAA Fisheries wish to follow in the management of the fisheries. The example FMP bookends serve two purposes: first, they provide an additional level of analytical detail that will facilitate the comparison of the physical, biological and socioeconomic effects of the alternatives in relation to the environmental baseline (i.e., the condition of the environment and the fisheries in 2001 and 2002 considering past effects); and second, they provide the public with an illustration of the types of management measures the NPFMC and NOAA Fisheries envision they will use to achieve the goals of the alternative in 2004 and beyond. The PA identified in this document includes a policy statement accompanied by a set of management objectives and a set of example FMP bookends that illustrates a range of implementable management actions. This FMP framework structure serves to communicate to the public the intent of the NPFMC and NOAA Fisheries as to how they plan to pursue the policy objectives in the future. By providing, as part of the PA, a range of potential management measures (as illustrated by the example FMP bookends), the NPFMC and NOAA Fisheries retain management flexibility under the MSA to adaptively manage the fishery through FMP amendments.

At its April 2004 meeting, the NPFMC recommended a PA based on its review of the findings contained in the 2003 draft Programmatic SEIS and more than 13,400 public comments. The PA is based on the policy goals and objectives described under Alternative 3, with refinements incorporated from both Alternatives 1 and 4 as well as suggestions taken from public comments. NOAA Fisheries has reviewed the NPFMC recommendation, and has endorsed it as the Agency's PA. The NPFMC intends to submit to the Secretary of Commerce, the policy contained in the PA as an amendment to the policies in the current BSAI and GOA FMPs. For more information on the PA, see Section ES 8.0.

ES 6.1 Alternative 1: Continue Under the Current Risk-Averse Management Policy

Under this alternative, the groundfish fisheries would continue to be managed based upon the present risk-averse policy. Alternative 1(a) represents the policy language currently stated in the FMPs, dating from 1979 and 1985 for the GOA and BSAI FMPs, respectively. These policies, based on the best scientific information available, avoid irreversible or long-term adverse effects on fishery resources and the marine environment, while at the same time providing for optimum yield.

Alternative 1(b) is a substitute for the written policy language in the current FMPs and would include objectives that explicitly address the variety of concerns that are balanced by the NPFMC and NOAA Fisheries in current management considerations. The objectives of this alternative are summarized in Table ES-1. Alternative 1(b) encapsulates a risk-averse conservation and management program that is based on a conservative harvest strategy. This policy assumes that fishing does result in some adverse impacts to the environment and that, as these impacts become known, mitigation measures will be developed and appropriate FMP amendments will be implemented.

FMP 1 (Current BSAI and GOA Groundfish FMPs)

The Alternative 1(a) and 1(b) policies are both represented by FMP 1, which is the current FMP for the BSAI and the GOA and incorporates management measures approved by the NPFMC through the June 2002 meeting.

In the current FMPs, the TAC is determined annually based on a conservative harvest strategy that calculates the OFL and the acceptable biological catch (ABC) for each managed stock or stock complex. The current FMPs specify the OFL and maximum ABC (*max* ABC) by means of a six-tier system wherein the amount and quality of information available for a given stock or stock complex determine the formula that is used to define the rate of fishing mortality that would result in a long-term average yield at the OFL (F_{OFL} or *max* ABC [*max* F_{ABC}]) threshold for Tiers 1-5, and for Tier 6, where the fishing mortality rate is unknown, the OFL and *max* ABC is based on historical catches. Most stocks are currently managed under Tier 3, where *max* F_{ABC} equals $F_{40\%}$, the fishing mortality rate at which long-term average level of spawners per recruit, would be reduced to 40 percent of its level in the absence of any fishing. Precautionary adjustments are made in Tiers 1-3 by decreasing F_{OFL} and F_{ABC} linearly with biomass whenever biomass falls below a tier-specific reference level, but only Tier 1 stocks include an uncertainty variation in *max* ABC. The status of each stock in Tiers 1-3 is also examined annually with respect to the minimum stock size threshold (MSST), as defined in the National Standard Guidelines.

Optimum yield (OY) is specified in the current FMPs as a range that is aggregated across all stocks and does not vary with biomass. The current FMPs require the sum of the individual groundfish TACs to fall within the OY range. In the BSAI, the high end of the range, two million mt, acts as a cap on the TACs, as the aggregated ABCs regularly exceed this limit. In practice, although it is not required in the current FMPs, TACs are never set higher than the corresponding ABCs. Taking into account the ecosystem considerations of the food web, the FMPs also prohibit directed fishing for forage fish species.

Through amendments over the last twenty years, the current FMPs have built up a network of spatial and temporal closures, intended to protect resources of concern, as well as to minimize gear conflicts. In the BSAI, various areas around the Pribilof Islands and in Bristol Bay are closed year-round to trawling in order to protect red and blue king crab habitat, and chinook and chum salmon areas are closed seasonally. Also in the BSAI, waters within 12 nm of Walrus Islands are closed to groundfish fishing to minimize disturbance of walrus haulouts. In the BSAI and the GOA, Steller sea lion protection measures permanently close the area within 3 nm of rookeries to all fishing, as a no-transit zone. Additionally, they impose trawl prohibitions within 10 to 20 nm of all rookeries and haulouts, and prohibit fishing in Seguam Pass. In the GOA, trawling is prohibited in southeast Alaska west of 140° W. Also, a 2.5 nm^2 area designated as the Sitka Pinnacles Marine Reserve in the GOA is closed to groundfish fishing to protect habitat for rockfish and lingcod.

The current BSAI FMP prohibits directed fishing for pollock with non-pelagic trawl gear. There is no similar restriction on pollock trawling in the current GOA FMP. Directed fishing for sablefish with longline pot gear is prohibited in the GOA. Non-pelagic trawling is prohibited in the Bristol Bay Red King Crab Savings Area in the BSAI and in the Cook Inlet in the GOA. Additionally, various areas around Kodiak Island are closed to non-pelagic trawling either year-round or seasonally to protect crab stocks.

Groundfish fisheries in the BSAI and GOA are required to discard any incidental catch of halibut, salmon (or steelhead trout), crab, and herring. These species are known collectively as prohibited species. The FMPs currently set PSC limits on many of these species, with penalties ranging from closure of a particular zone or of the whole management area to a directed fishery or fisheries for a specified season or the remainder of the year. In the BSAI FMP, stairstep limits for trawl bycatch within specified zones are set for red king crab and *C. bairdi* crab. The catch limit varies based on stock abundance. The BSAI FMP also specifies an absolute trawl catch limit for chinook salmon and "other salmon" within specified zones. Once the apportioned PSC limit for a trawl fishery is reached within a zone, the fishery is prohibited from fishing within that zone. The BSAI FMP specifies a trawl catch limit for herring in the BSAI at 1 percent of annual biomass. Catch limits on *C. opilio* crab and halibut bycatch in the BSAI are framed in the FMP and established by regulation. The *C. opilio* catch limit applies to a specified zone and is based on an adjusted percentage of biomass that must fall within a certain range. The halibut catch limit is a BSAI-wide mt limit and is based on halibut mortality. In the GOA FMP, catch limits on halibut bycatch are authorized and set as part of the annual procedure for setting groundfish harvest levels. There are no other PSC limits set in the GOA.

Other bycatch reduction measures are required under FMP 1. The Improved Retention/Improved Utilization (IR/IU) program requires full retention, by vessels fishing for groundfish, of all incidentally caught pollock and Pacific cod fit for human consumption, as well as full utilization of the two species by inshore processors. A minimum utilization standard of 15 percent is set for all at-sea processors. The NPFMC has also adopted a policy to require full retention of demersal shelf rockfish by longline and jig vessels in the southeast Outside District of the GOA. A Vessel Incentive Program encourages bycatch reduction by setting bycatch reduction standards biannually. If a vessel fails to meet these standards, it can be penalized. Inseason bycatch management measures establish fishing seasons for bycatch management and give the NOAA Fisheries Alaska, Regional Administrator the authority to close areas with high bycatch.

Table ES-1. Comparative summary of the philosophy, assumptions, plan of action and goals of the policy statements. NOTE: Language taken from text of alternative policy statements.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Preferred Alternative (PA)
Philosophy	Management process will be adaptive to new information and reactive to new environmental issues.	Establishes a more aggressive harvest strategy, goal would be to maximize biological and economic yield from the resource.	Additional conservation and management measures will be taken as necessary to respond to social, economic or conservation needs, or if scientific evidence indicates that the fishery is negatively impacting the environment.	Extremely precautionary approach to managing fisheries under scientific uncertainty in which the burden of proof is shifted to the user of the resource.	Forward looking conservation measures that address differing levels of uncertainty; precautionary approach that applies judicious and responsible fisheries management practices, based on sound scientific research and analysis, proactively rather than reactively, to ensure the sustainability of fishery resources and associated ecosystems for the benefit of future as well as current generations.
Assumptions	Based on the assumption that fishing does produce some adverse impact to the environment.	Based on the assumption that fishing does not have an adverse impact on the environment except in specific cases as noted.	Recognizes need to balance many competing uses of marine resources and different social and economic goals for fishery management.	Based on the assumption that fishing does produce adverse impacts on the environment, but due to lack of information and uncertainty, we know little about these impacts.	Recognizes that potential changes in productivity may be caused by fluctuations in natural oceanographic conditions, fisheries, and other, non-fishing activities, and intends to continue to take appropriate measures to insure the continued sustainability of the managed species.
Plan of action	As adverse impacts become known, mitigation measures are developed and Fishery Management Plan (FMP) amendments are implemented; goals will be addressed through existing institutions and processes.		Will utilize and improve upon existing processes to involve a broad range of the public in decisionmaking.	Strategy will result in changes that will significantly curtail the groundfish fisheries until more is knows about impacts; once more is known, initial measures will be modified or relaxed.	Will utilize and improve upon existing open and transparent process to involve the public in decisionmaking; will review, modify, eliminate, or consider new issues as appropriate to best carry out the goals and objectives; objectives will be reviewed annually, and the Programmatic Supplemental Environmental Impact Statement (PSEIS) will be used as a planning document.

Table ES-1 (cont.). Comparative summary of the philosophy, assumptions, plan of action and goals of the policy statements.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Preferred Alternative (PA)
			Prevent overfishing		
Harvest strategy	• Conservative harvest levels for single species fisheries.		• Conservative harvest levels for multispecies and single species fisheries. • Evaluate F_{40} and implement improvements.	• Transition from single-species to ecosystem-oriented management of fishing activities. • Establish a program to maintain ecological relationships among exploited, dependent and related species as well as ecosystem processes that sustain them.	• Conservative harvest levels for multispecies and single species fisheries and specify optimal yield (OY). • Scientific review of F_{40} and adopt improvements as appropriate.
OY	• Specify OY as a range with the cap at 2 million (mill) metric tons (mt) in the Bering Sea and Aleutian Islands (BSAI), 0.8 mill mt in the Gulf of Alaska (GOA).	• Specify OY as a range. • Set OY cap at the sum of overfishing levels (OFLs) or acceptable biological catch (ABCs) for each species.	• Specify OY as a range or a formula.		• Specify OY as a range with the cap at 2 mill mt in BSAI (as stated in current law), 0.8 mill mt in GOA.
Other			• Improve biological information necessary to determine minimum stock size threshold (MSSTs) particularly for Tier 4 species.	• Close a percentage of known target stock spawning area.	• Improve the management of species through species categories
			Promote sustainable fisheries and communities[1]		
Benefit to the nation					• Provide for OY in terms of providing the greatest overall benefit to the nation with particular reference to food production.
Stability					• Avoid significant disruption of existing social and economic structures.

Table ES-1 (cont.). Comparative summary of the philosophy, assumptions, plan of action and goals of the policy statements.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Preferred Alternative (PA)
Promote sustainable fisheries and communities[1] (cont.)					
Equity					• Promote fair and equitable allocation of identified available resources.
Safety					• Promote increased safety at sea.
Preserve food web					
Ecosystem considerations	• Incorporate ecosystem considerations into fishery management decisions. • Consider the impact of fishing on predator-prey and other ecological relationships.	(none)	• Incorporate ecosystem considerations into fishery management decisions.	• Address the impact of fishing on predator-prey and other important ecological relationships. • Conserve native species and biological diversity.	• Incorporate ecosystem considerations into fishery management decisions as appropriate.
Fishing levels	• Limit harvest of forage species.		• Improve procedure to account for uncertainty and ecosystem factors in ABCs.	• Reduce ABCs/set highly precautionary fishing levels to account for uncertainty and ecological considerations.	• Improve procedure to account for uncertainty and ecosystem factors in ABCs. • Limit harvest of forage species.
Research			• Develop indices of ecosystem health as targets for management. • Initiate research program to identify the habitat needs of the significant food web.	• Develop and implement a fishery ecosystem plan.	• Develop indices of ecosystem health as targets for management.
Manage incidental catch, and reduce bycatch and waste[2]					
Level	• Current bycatch and incidental catch management program. • Require full utilization of target species.		• Continue and improve bycatch and incidental catch program. • Develop incentive programs for bycatch and incidental catch reduction. • Develop management measures that encourage gear or techniques that reduce discards.	• Reduce bycatch, incidental catch and prohibited species catch (PSC). • Phase out fisheries with >25% bycatch or incidental catch.	• Continue and improve bycatch and incidental catch program. • Develop incentive programs for bycatch reduction. • Develop management measures that encourage gear or techniques that reduce bycatch which includes economic discards. • Reduce waste to biologically and socially acceptable levels

Table ES-1 (cont.). Comparative summary of the philosophy, assumptions, plan of action and goals of the policy statements.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Preferred Alternative (PA)
Manage incidental catch, and reduce bycatch and waste[2] (cont.)					
Closures	• Manage bycatch and incidental catch through seasonal total allowable catch (TAC) distribution and geographic gear restrictions. • Respond to population and decline by area, gear and seasonal closures.	• Manage incidental catch and bycatch through gear closure areas.			• Manage bycatch and incidental catch through seasonal TAC distribution and geographic gear restrictions.
PSC	• Control PSC through limits.	• Monitor PSC bycatch and adjust or eliminate limits.		• Establish GOA PSC limits for salmon, crab and herring.	• Control PSC through limits or other appropriate measures.
TAC	• Account for bycatch mortality in TAC accounting.			• Include mortality in TAC accounting and improve accuracy of mortality including unobserved.	• Account for bycatch mortality in TAC accounting.
Non-target species			• Encourage research on population estimates for non-target species with a view to setting bycatch limits.	• Set stringent bycatch limits for vulnerable non-target species.	• Encourage research on population estimates for non-target species with a view to setting bycatch limits.
Avoid impacts to seabirds and marine mammals					
Seabirds	• Protect Endangered Species Act (ESA)-listed and other seabird species.	• Maintain protection measures for ESA-listed species.	• Protect ESA-listed and other seabirds. • Joint research program to establish population estimates for all seabird species.	• Set protection measures for all seabirds and develop methods to reduce the incidental take levels. • Joint research program to establish population estimates for all seabird species, and modify protection measures as appropriate.	• Protect ESA-listed and, if appropriate and practicable, other seabird species.

Table ES-1 (cont.). Comparative summary of the philosophy, assumptions, plan of action and goals of the policy statements.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Preferred Alternative (PA)
Avoid impacts to seabirds and marine mammals (cont.)					
Marine mammals	• Maintain protection measures to avoid jeopardy to ESA-listed Steller sea lions.	• Maintain protection measures to avoid jeopardy to ESA-listed Steller sea lions.	• Maintain or adjust protection measures for ESA-listed Steller sea lions. • Review status of other marine mammal and fishery interactions and develop appropriate measures.	• Increase Steller sea lion protection measures by further restricting gear in critical habitat and setting more conservative harvest levels for prey base species.	• Protect ESA-listed and, if appropriate and practicable, other marine mammal species • Maintain or adjust protection measures for ESA-listed Steller sea lions. • Review status of endangered and threatened marine mammal and fishery interactions and develop appropriate measures.
Reduce and avoid impacts to habitat					
Closures	• Close important habitat to all fishing in response to new scientific information. • Evaluate candidate areas for Marine Protected Areas (MPAs).	• Evaluate candidate areas for MPAs.	• Develop goals and criteria to evaluate the efficacy MPAs, consider implementation.	• Establish 20-50% of area as no-take marine reserves. • Prohibit trawling where fishery can be prosecuted with other gear types, and establish trawl closure areas.	• Review and evaluate efficacy of existing habitat protection measures for managed species. • Develop a MPA policy in coordination with national and state policies. • Develop goals and criteria to evaluate the efficacy MPAs, implement if and where appropriate.
Essential fish habitat (EFH)		• Identify EFH and determine appropriate habitat measures.	• Identify EFH and habitat areas of particular concern (HAPC).	• Protect habitat including EFH, HAPC, ESA critical habitat, etc.	• Identify EFH and HAPC pursuant to MSA rules. • Mitigate fishery impacts as necessary and practicable to continue the sustainability of managed species.
Research	• Implement research to evaluate impacts of trawl gear on habitat.	• Implement research to evaluate impacts of trawl gear on habitat.	• Implement research to evaluate impacts of all gear on habitat. • Develop regional baseline habitat. information and mapping.	• Manage adaptively, using large no take areas as experimental controls to facilitate learning.	• Encourage development of regional baseline habitat information and mapping.

Table ES-1 (cont.). Comparative summary of the philosophy, assumptions, plan of action and goals of the policy statements.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Preferred Alternative (PA)
Promote equitable and efficient use of fishery resources[3]					
	• Provide economic and community stability through maintaining allocation percentages.		• Provide economic and community stability through fair allocation of fishery resources.	• Consider non-consumptive values.	• Provide economic and community stability through fair allocation of fishery resources.
Excess capacity	• Reduce excess capacity, overcapitalization and the adverse effects of the race for fish.	• Maintain American Fisheries Act (AFA) and community development quota (CDQ) as authorized by the Magnuson-Stevens Fishery Conservation and Management Act (MSA).	• Maintain License Limitation Program (LLP) and reduce capacity and other adverse effects of the race for fish by extending rights-based management to some or all fisheries. • Periodically evaluate the effectiveness of rationalization.	• Reduce excess capacity, employ equitable allocative or cooperative programs to end the race for fish, reduce waste, increase safety and promote stability and benefits to communities.	• Maintain LLP and modify as necessary. • Decrease excess capacity and overcapitalization by eliminating latent licences and extending rights-based management to some or all fisheries. • Periodically evaluate the effectiveness of rationalization.
Efficiency					• Increase the efficient use of fishery resources taking into account the interest of harvesters, processors, and communities.
Increase Alaska native consultation					
Traditional knowledge	• Continue incorporating traditional knowledge into fisheries management.	• Continue incorporating traditional knowledge into fisheries management.	• Continue incorporating traditional knowledge into fisheries management, increase traditional knowledge data collection.	• Utilize traditional knowledge, including monitoring and data gathering, through co-management and cooperative research programs.	• Continue incorporating local and Traditional Knowledge into fisheries management, increase local and Traditional Knowledge data collection.
Consultation	• Continue Alaska Native consultation and participation in fisheries management.	• Continue Alaska Native consultation and participation in fisheries management.	• Increase Alaska Native consultation and participation in fisheries management.	• Increase participation of and consultation with Alaska Native subsistence users.	• Increase Alaska Native consultation and participation in fisheries management.

Table ES-1 (cont.). Comparative summary of the philosophy, assumptions, plan of action and goals of the policy statements.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Preferred Alternative (PA)
Improve data quality, monitoring and enforcement[4]					
Observer program	• Continue Observer Program for catch estimates.	• Consider repealing the Observer Program.	• Increase the utility of observer data. • Improve the Observer Program, including the funding mechanism.	• Increase the precision of observer data through increased coverage and enhanced sampling protocols, address the funding issue.	• Increase the utility of observer data. • Improve the Observer Program, including the funding mechanism.
Reporting	• Continue industry reporting, and efforts to improve economic impact assessments.	• Continue industry reporting, and efforts to improve economic impact assessments.	• Increase data and reporting requirements in order to improve economic impact assessments.		• Increase data and reporting requirements in order to improve economic impact costs and benefits.
Technology	• Increase quality of monitoring data through technology.		• Increase quality of monitoring data through technology.	• Improve enforcement and inseason management through technology.	• Increase quality of monitoring data through technology.
Research			• Establish a baseline ecosystem monitoring program. • Adopt recommended research plan in the PSEIS. • Cooperate with research institutions to identify research priorities.	• Establish a baseline monitoring program, use to improve the Fishery Ecosystem Plan. • Adopt recommended research plan in the PSEIS.	• Establish a baseline ecosystem monitoring program. • Cooperate with research institutions to identify research needs and develop programs.
Enforcement					• Promote enhanced enforceability. • Cooperate, consult, coordinate with federal and state agencies and organizations for conservation, sustainability, management and enforcement.

Notes: [1]This heading was added to the PA by the NPFMC
[2]In Alternatives 1 - 4, this heading is: Reduce and Avoid Bycatch
[3]In Alternatives 1 - 4, this heading is: Allocation
[4]In Alternatives 1 - 4, this heading is: Data Quality, Monitoring and Enforcement

"The Reasonable and Prudent Measures" adopted from the most recent USFWS Biological Opinion on the short-tailed albatross stipulate the use of certain seabird avoidance measures and require that the take of more than four short-tailed albatross within two years trigger consultation with the USFWS. Pending the results of the consultation, there is potential for the fisheries to close. To further reduce the possibility of the take of albatross impacting the fisheries, in 2001 the NPFMC adopted a policy to require all longline vessels to adopt more stringent seabird avoidance methods.

A License Limitation Program for groundfish vessels over 32 ft length overall (LOA) (with certain jig gear exceptions) and a moratorium on entry into the groundfish fisheries is in place for the BSAI and the GOA. An IFQ program is in place for sablefish in the BSAI and GOA, which includes provisions for community purchase of quota share. In the BSAI, the directed fishery for pollock is organized into cooperatives as authorized under the American Fisheries Act (AFA). A multi-species CDQ program apportions 7.5-10 percent of all BSAI groundfish quota to 65 eligible western Alaska communities.

FMP 1 monitors the groundfish fishing effort through federal and state reporting requirements and through the use of the North Pacific Groundfish Observer Program. All vessels between 60 ft and 125 ft LOA are required by regulation to have an observer on board 30 percent of the time; for vessels over 125 ft LOA this increases to 100 percent. For AFA and CDQ catcher boats greater than 60 ft LOA, one observer must be on board at all times, and for catcher processors and motherships, two observers must be on board at all times. The program also has observers at inshore processing plants. Additional monitoring tools are the reporting requirements for BSAI and GOA vessels that submit daily or weekly logbooks including information on the composition of catch and the locations of the hauls. The ADF&G also collects data from fish tickets at the point that catch is sold. Mandatory vessel monitoring systems for all directed Atka mackerel, pollock, and Pacific cod fishing verify vessel location.

ES 6.2 Alternative 2: Adopt a More Aggressive Harvest Management Policy

The Alternative 2 policy would maximize biological and economic yield from the resource while still preventing overfishing of the groundfish stocks. Such a management approach would, among other things, be based on the best scientific information available, take into account individual stock and ecosystem variability, and continue to work with other agencies in protecting threatened and endangered species. A more aggressive harvest strategy would be implemented based upon the concept that the present policy is overly conservative and that higher harvests can be taken without overfishing the target groundfish stocks. The objectives of this alternative are summarized in Table ES-1. This policy assumes that fishing at the recommended levels would have no adverse impact on the environment, except in specific cases that are known and mitigated.

Example FMP 2.1

Example FMP 2.1 illustrates a more aggressive harvest strategy than Alternative 1 by removing many of the existing constraints from the fisheries. As the policy is based on an assumption that the impacts of fishing on the environment are generally known and mitigated, the precautions currently built into the existing TAC-setting process will be alleviated. The buffer between the ABC level and the OFL is removed, and the maximum OY for the groundfish stocks in the BSAI is released from its two million mt cap and allowed to float as the sum of the OFLs for the BSAI groundfish stocks. Additionally, example FMP 2.1 removes the precautionary element of the current FMPs that decreases F_{ABC} linearly with biomass when the biomass falls below a specific reference level.

Example FMP 2.1 also removes physical constraints from the fisheries by repealing the various closure areas currently in place. The fishery would be returned to an open-access scenario, where time and area closures, gear restrictions, and PSC restrictions are repealed. The potential impact of the groundfish fisheries on Steller sea lions, however, means that the current mitigation including a suite of protection measures that constrain fishing around rookeries and haulouts, and protect Steller sea lion prey species (pollock, Pacific cod and Atka mackerel) when at low biomass levels, would remain in place. This is required by the ESA to avoid jeopardy and adverse modification of population levels. The same applies to the impact of groundfish fishing on short-tailed albatross, with the consequent take limits remaining in effect.

The federally-mandated effort limitation program for the directed BSAI pollock fishery enacted under the AFA, with its accompanying CDQ allocation, would remain in place and the CDQ program, mandated by the MSA, would be modified to allocate only a percentage of the BSAI TAC for pollock to the CDQ program. All other effort limitation programs such as the sablefish IFQ program would be repealed. Reporting requirements would remain in place, in order to keep track of the impact of the fisheries, but the Observer Program, except as federally mandated by the AFA, would be repealed as would vessel monitoring system requirements.

Example FMP 2.2

A more moderate illustration of Alternative 2, example FMP 2.2, also represents a more aggressive harvest strategy than Alternative 1. In this case, the mechanisms for setting ABC and TAC remain the same as in the current FMPs (see FMP 1 for further detail), but the existing regulatory-capped maximum OY of two million mt in the BSAI would be removed in favor of a maximum OY equaling the sum of individual groundfish ABCs in the BSAI. Additionally, bycatch reduction incentives and bycatch restrictions would be repealed, other than those related to PSC limits or IR/IU. Under the assumption that fishing does not have an impact on the environment other than what is generally known and mitigated, the NPFMC's more stringent seabird avoidance measures recommended in 2001 would be repealed, leaving only the mitigation measures recommended by USFWS to avoid jeopardy or adverse modification for short-tailed albatross. Closure areas in example FMP 2.2 mirror those in FMP 1.

ES 6.3 Alternative 3: Adopt a More Precautionary Management Policy

This policy would seek to accelerate the existing precautionary management measures through community or rights-based management, ecosystem-based management principles and, where appropriate and practicable, increased habitat protection and additional bycatch constraints. Under this approach, additional conservation and management measures would be taken as necessary to respond to social, economic or conservation needs, or if scientific evidence indicated that the fishery was negatively impacting the environment. The objectives of this alternative are summarized in Table ES-1. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management.

Example FMP 3.1

Example FMP 3.1 illustrates a management approach that accelerates precautionary management measures by increasing conservation-oriented constraints on the fisheries where necessary, formalizing precautionary practices in the FMPs, and initiating scientific review of existing practices as a necessary precursor to the decision of how best to incorporate adequate precautions.

Example FMP 3.1 implements changes to the TAC-setting process following a comprehensive review. Precautionary practices such as setting TAC less than or equal to the ABC, and specifying MSSTs for Tiers 1-3 in accordance with National Standard guidelines, would be formalized in the FMP. Sharks and skates would be removed from the other species management category and given their own TACs. Criteria to do the same for other target stocks would also be developed. Efforts to develop ecosystem indicators to be used in TAC-setting, as per ecosystem management principles, would be accelerated.

In order to balance the needs of social and economic stability with habitat protection and resource conservation, a review would be conducted of the existing system of closure areas in the BSAI and the GOA, while evaluating them against a Marine Protected Area (MPA) methodology to be developed as part of this alternative. The NPFMC and NOAA Fisheries would also seek to initiate joint consultation and research with USFWS to develop fishing methods that reduce incidental take of threatened and endangered species. To mitigate adverse impacts of fisheries management decisions on fishing communities, and to comply with other national directives, formal procedures would be implemented to encourage increased participation of Alaska Natives in fishery management.

Example FMP 3.1 recognizes that the anticipated community or rights-based management programs may address bycatch reduction objectives (a review of bycatch rates under existing such programs is initiated), but in the meantime a moderate reduction of PSC limits will be initiated as an intermediary step. PSC limits for crab, herring and salmon would be authorized in the GOA, in addition to the halibut PSC limits authorized under the current GOA FMP. Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through improvements in the Observer Program and third party verification of economic data.

Example FMP 3.2

Example FMP 3.2 implements the acceleration of existing precautionary measures on a more rapid timeline than example FMP 3.1. Rather than reviewing existing practices prior to incorporating increased precaution, this bookend implements changes to many aspects of the FMPs concurrently with the initiation of scientific research efforts necessary to bring management measures in line with a precautionary policy.

Example FMP 3.2 significantly accelerates precautionary management by incorporating an uncertainty correction into the estimation of ABC for all species. Additionally, OY would be specified separately for each stock or stock complex rather than for the groundfish complex as a whole (i.e., OY would be set as a formula rather than as a range, eliminating the BSAI two million mt OY cap), and would be set equal to the respective stock or stock complex's TAC. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. Example FMP 3.2 would also incorporate stock-specific biological reference points in the tier system where scientifically justifiable. This could result in Tier 3 rockfish stocks, for example, being capped at $F_{60\%}$ rather than $F_{40\%}$. In implementing this bookend, criteria would be developed for specifying MSSTs for Tiers 4-6, along with a list of priority candidate stocks; and the development of criteria for removing some stocks from the other species and non-specified species management categories would minimally result in sharks and skates being given their own TACs.

Example FMP 3.2 also reexamines the existing closure system in the BSAI and the GOA. The bookend sets a guideline of 0-20 percent of the EEZ (3 to 200 nm) to be closed as an MPA.. The objective of these measures is to provide greater protection to a full range of marine habitats within the 1,000-m bathymetric line. The guideline aims to provide greater protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species, while at the same time respecting traditional fishing grounds and maintaining open area access for coastal communities. Additionally, the bookend would extend the existing bottom-trawl ban on pollock to the GOA.

Additional conservation benefits would be realized in example FMP 3.2 through the comprehensive rationalization of all fisheries (except those already part of a cooperative or IFQ program.) In adopting rationalization programs such as cooperative-style programs with built-in community protections, habitat and bycatch concerns would also be addressed by reducing concentrated effort in the fisheries. To increase precaution regarding bycatch, PSC limits would be significantly reduced (and set for all prohibited species in the GOA), but would not be expected to act as a proportionate restraint on the fisheries due to the incentives for bycatch reduction under cooperatives, or other bycatch incentive programs implemented as necessary under this bookend.

In accordance with ecosystem principles, the NPFMC and NOAA Fisheries would seek to initiate joint consultation and research with USFWS to develop fishing methods that reduce incidental take of all seabird species. Formal procedures would also be implemented to increase consultation with and representation of Alaska Natives in fishery management.

Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through increase of coverage and improvements to the Observer Program, as well as an increase in the use of vessel monitoring systems and the range of economic data collected from industry.

ES 6.4 Alternative 4: Adopt a Highly Precautionary Management Policy

This policy represents an extremely precautionary approach to managing fisheries under scientific uncertainty. It shifts the burden of proof to the users of the resource and the NPFMC and NOAA Fisheries to demonstrate that the intended use would not have a detrimental effect on the environment. It would involve a strict interpretation of the precautionary principle. Management decisions would involve and be responsive to the public, but would decrease emphasis on industry and community concerns in favor of ecosystem processes and principles. The objectives of this alternative are summarized in Table ES-1. This policy assumes that fishing does produce adverse impacts on the environment, but due to a lack of information and uncertainty, characterization of these impacts is difficult. The initial restrictive and precautionary conservation and management measures would be modified or relaxed when additional, reliable scientific information becomes available.

Example FMP 4.1

Example FMP 4.1 illustrates an FMP where current levels of fishing are reduced and other precautionary restrictions are implemented until scientific research shows that the fisheries have no adverse effect on the sustainability of the resource and its environment.

Accordingly, example FMP 4.1 would substantially reduce the potential of the fisheries to adversely impact the environment. A modified TAC-setting process would create a more substantial buffer between ABC and the OFL by setting the fishing mortality rate at $F_{75\%}$ for all Steller sea lion prey species (pollock, Pacific cod and Atka mackerel) and for rockfish (as long-lived, slow-growing species). Also, the *max* F_{ABC} for each stock or stock complex in Tiers 1-5 would be adjusted downward based on the lower bound of a confidence interval surrounding the survey biomass estimate. OY would be specified separately for each stock or stock complex rather than for the groundfish complex as a whole (i.e., OY would be set as a formula rather than as a range, eliminating the BSAI two million mt OY cap), and would be set equal to the respective stock or stock complex TAC. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. For species managed as members of a stock complex, rather than setting TAC as the aggregate of the individual members' ABCs, the *max* ABC value for each component stock would be determined and the TAC set equal to the lowest value. Where sufficient biological information is available, such as with EBS pollock, TAC would be distributed on a smaller spatial scale. MSSTs would be determined for all tiers.

To further mitigate the possibility of the fisheries having a detrimental biological and ecosystem impact, 20-50 percent of the EEZ would be designated as No-Take Marine Reserves (i.e., no commercial fishing) covering the full range of marine habitats within the 1,000-m bathymetric line. As part of this area in the Aleutian Islands, a Special Management Area would be established to protect coral and other living bottom habitat. The closed area would include spawning reserve areas for intensively fished species. Under example FMP 4.1, comprehensive trawl exclusion zones would be set to protect all Steller sea lion critical habitat, and trawling would be restricted to those fisheries that cannot be prosecuted with other gear types (i.e., the flatfish fisheries).

In an effort to reduce waste and the risk of adverse impact to the environment, existing PSC limits would be halved under this bookend, as would bycatch (discard) and incidental catch rates. IR/IU would be extended to all target species. Stringent PSC limits would be set for salmon, crab and herring in the GOA, and as information becomes available, bycatch limits would also be set for non-target species. Protection measures would be set for all seabird species.

Because this policy alternative necessitates greater research and data-gathering efforts, example FMP 4.1 would expand observer coverage to 100 percent for all vessels over 60 ft LOA and require 30 percent observer coverage on vessels presently exempted from observer coverage (i.e., vessels under 60 ft LOA). Vessel monitoring systems would be made mandatory for all groundfish vessels, as would motion-compensated scales for weighing all catches at sea or at shore-based processors. In addition, cooperative research and data-gathering programs would be initiated to expand the use of Traditional Knowledge in fisheries management.

Example FMP 4.2

Example FMP 4.2 expands the precautionary principles of Alternative 4 by temporarily suspending all fishing until the fisheries can be shown to have no adverse effect on the resource and its environment. The Agency would conduct an environmental review of each groundfish fishery. Until such a review is completed and a fishery certified, the TAC for all species in that fishery would be set at zero. All areas of the EEZ would be closed to all fishing (i.e. commercial, recreational, and subsistence); bycatch and incidental catch, as well as the take of seabirds and marine mammals, would then necessarily be reduced to zero in the short-term. It is estimated that for some fisheries, an environmental review could take as long as two years.

Scientific research and data-gathering efforts would continue under FMP 4.2. Each groundfish fishery would be reviewed to determine whether it results in significant adverse biological and environmental impacts, and if it does, whether those impacts can be mitigated by fishery-specific mitigation measures. If the Agency concludes that the fishery poses no significant threat to the environment, NOAA Fisheries would certify that fishery and authorize fishing to resume under fishery-specific regulations. If a fishery is found by this review to produce significantly adverse environmental effects, and measures cannot be designed to mitigate those effects, that fishery would not be certified and would remain closed until more scientific information is known, or new ways are found to mitigate the effects of fishing.

ES 7.0 Possible Effects of Fishery Management Alternatives

In order to determine the effects of the alternatives, a two-dimensional analytical framework has been developed that defines a range of implementing management measures for each alternative. The framework consists of a set of FMP components (including the TAC-setting process, bycatch and incidental catch restrictions, gear restrictions, etc.) and a set of example FMPs (summarized in the prior section) that include management measures that address each FMP component. Each FMP component focuses on a particular set of policy objectives and is evaluated qualitatively to provide the reader with a general sense of the environmental consequences associated with various management tools and their potential applications in relative isolation of other FMP components, when possible (see Section 4.3 and Appendix F). Each example FMP is then examined as a whole (e.g. a combination of rows), to provide an understanding of how the various components work together to accomplish a number of policy objectives simultaneously (Sections 4.5 to 4.9). Except for Alternative 1, each alternative contains a pair of example FMPs as "bookends" to illustrate and frame the range of that alternative's management measures. Alternatives 1(a) and 1(b), representing status quo, contain just one FMP; the existing management regime in place for the BSAI and GOA, including NPFMC-approved (but not necessarily implemented yet) measures through June 2002. The intention is that the FMP framework structure will represent a range of management measures that address each FMP component and are likely to be implemented under a chosen alternative.

Each of the two dimensions of the framework (the FMP components and the example FMPs) has been analyzed, either qualitatively or quantitatively. Section 4.3 provides a summary of the Qualitative Analysis papers written for each FMP component. Each paper provides background on the choice of management measures used to address that FMP component and describes the range of management measures that are implemented under each example FMP. Additionally, the papers provide a preliminary assessment of the potential impacts of implementing the management measures in a static environment; cumulative or synergistic impacts among FMP components are not analyzed (for the full text of the papers, see Appendix F).

Following this two dimensional analysis, the results of the analysis of each individual FMP are synthesized as a method for assigning environmental benefits and adverse effects to each policy alternative (Section 4.10). We continue this synthesis by incorporating a policy assessment comparing each alternative against the MSA National Standards and other key environmental laws and policy recommendations (Section 4.11.1). And, finally, we present our overall findings of our analysis for each alternative (Section 4.11.2).

Analysis of these alternative regimes is intended to illustrate the types of environmental effects that can be anticipated should specific fisheries management actions be pursued in the future. Many potential combinations of management actions could comprise an FMP. Reliance on Agency experts and public comments received during the preparation of this Programmatic SEIS led to the development of these example FMPs for analytical purposes; they are not intended to represent all possible combinations of actions. As a planning document, this Programmatic SEIS provides the decision-makers and the public with a broad range of potential policy objectives and management actions. The direct, indirect, and cumulative effects analyzed in this Programmatic SEIS illustrate, to the best of our ability, the environmental consequences and risks associated with each policy alternative. However, this Programmatic SEIS does not prevent the NPFMC or NOAA Fisheries from taking other management actions necessary to achieve its policy objectives and to protect the ecosystem. In such cases, future FMP amendments will explore all reasonable alternatives to address the stated problem, and thus accompanying NEPA analyses will fully evaluate the specific proposed action and its environmental impacts. To the extent that such future actions fall within the range of FMP bookends selected as part of the PA, those future actions can tier from the Programmatic SEIS and by doing so, the analysis can be streamlined. In the event a different management tool is designed, or a new environmental issue arises not previously discussed in the Programmatic SEIS, then future NEPA actions will likely require more detailed analysis and discussion.

ES 7.1 Analytical Approach to Evaluating Alternatives

The analytical approach for simulating current groundfish management in the North Pacific EEZ involves considering interactions among a large number of species (including target, non-target, and prohibited), areas, and gear types. To evaluate the consequences of alternative management regimes selected in this Programmatic SEIS, computer modeling was used to predict the likely outcome of management decisions using data on historical catch of different species by gear types and areas, stock assessment surveys, research studies, and industry reported statistics. Management of the Alaska groundfish fisheries is complex given the large numbers of species, areas, and gear types. The managers schedule fisheries openings and closures to maximize catch subject to catch limits and other constraints. These management actions are based on expectations about the array of species likely to be captured by different gear types and the cumulative effect that each fishery has on the allowable catch of each individual target species and other species groups. The groundfish population abundance for each alternative regime was forecast for a five-year period beginning from 2003. Ten and twenty year projections were also predicted, although the confidence intervals surrounding these longer-view projections make them highly questionable.

This approach provides a reasonable representation of the current fisheries management practice for dealing with the multi-species nature of catch in target fisheries and for evaluating the different policy alternatives and their associated FMP bookends on the human environment. In addition to the multi-species model, agency analysts also used other models as tools to evaluate the potential impacts of the policies on habitat, the economics of the fisheries, and the effects on fishing communities. All of these models are still in early stages of development and therefore cannot accurately predict all effects with absolute certainty. Thus, analysts must qualify their findings and often rely on the scientific literature and the professional opinion of fishery experts in their respective fields to perform qualitative assessments. More detailed information on the analytical approach used by the Agency analysts in preparing this Programmatic SEIS can be found in Section 4.1.

ES 7.2 Summary of Environmental Consequences and the Comparison of Alternatives

This section contains a summary of the environmental consequences of each of the alternatives. Table ES-2 presents the information summarized below in table format, and uses a color key to indicate the direction of effect associated with each policy alternative. The intent of the summary below, and Table ES-2, is to provide a broad, policy-level understanding of the general impacts of the alternatives. The analysis deals with effects at the population or fishery level, rather than calling out impacts to individual components (a more detailed analysis of the example FMP bookends presented in Sections 4.5 - 4.9 provides a basis for the policy-level analysis). Where the impacts within a policy goal are substantially different under an example FMP for major components, the color key in the table is split in half and two colors are assigned.

The colors used in Table ES-2 are red, yellow, light green, and dark green. Red indicates an adverse effect or may include adverse conclusions that are based on assumptions. Yellow indicates a high potential for adverse impacts if any of the assumptions used to manage the resource are wrong. Light green indicates a potential beneficial impact, or that the assumptions used to manage the resource incorporate some precaution. Dark green indicates a beneficial effect, or the assumptions used to manage the resource incorporate a high level of precaution against uncertainty.

ES 7.2.1 Summary of Alternative 1

The key policy elements that predominantly influence the impacts under Alternative 1 are: the current harvest strategy that incorporates automatic stock rebuilding (ensuring the sustainability of target stocks); incidental catch and bycatch controls; the existing system of closure areas (to protect a variety of species from groundfish fishery interactions); the objective to reduce the adverse effects of the race-for-fish (resulting in gradual implementation of rationalization); and reporting and monitoring requirements (increasing the accuracy of catch accounting).

Alternative 1 is successful at preventing overfishing of target stocks and thus meeting the goal of ensuring the sustainability of the fisheries. Alternative 1 also includes automatic stock rebuilding provisions which have proven to be effective. A weakness of this alternative is that there is no incentive to research fishery impacts on Tier 4-6 stocks in order to change their management status. It is also possible under this alternative to overharvest a vulnerable member of a stock complex.

This alternative is partially successful in achieving the goal of preserving the food web through its protection measures for dominant target species, forage species, and ESA-listed species. However, it will likely make slow, incremental progress in protecting other food web components. This policy is likely effective in protecting food web components that are more well-studied than others and those that are at critical population thresholds, but it is uncertain whether sufficient protection is provided to other food web components for which less complete information is available.

The bycatch management program under Alternative 1 is effective at limiting incidental catch of non-target species and reducing bycatch through incentive programs and monitoring. The weaknesses of the alternative are that bycatch is often reported as a complex rather than as individual species, and that observers are not present to monitor catch on vessels less than 60 ft LOA, which may result in inaccurate estimates of bycatch. This alternative may therefore not provide adequate protection for non-target species.

Alternative 1 is effective at providing protection to listed seabirds and marine mammals as a result of its explicit objectives for ESA-listed species. Although not an explicit policy goal, some protection may also be provided to non-listed seabirds through reduced incidental take as a result of implementing additional seabird protection measures.

Table ES-2. Comparison of policy-level impacts of the alternatives.

	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**	Preferred Alternative
NOTE: The implication of a split color rating is that major components within the category will undergo a different impact under the alternative in question. To the extent possible, the rationale is explained in the bullets beneath.					
What is the impact of the policy on the sustainability of target stocks (preventing overfishing)?	• Successful at preventing overfishing of target stocks, ensures sustainable fishery. • No incentive to research those stocks on which impacts of fishing are unknown; possible to overharvest a vulnerable member of a stock complex.	• Maximizes economic yield while preventing overfishing of target stocks, but not effective at preventing stocks from becoming overfished. • Increases the chance of unintentionally overfishing a stock.	• Prevents overfishing of target stocks through precautionary harvest policies. • Acceleration of efforts to identify methods for reducing the number of stocks where the status relative to an overfished condition is unknown.	• Establishes a very conservative harvest policy which is likely to prevent stocks from becoming overfished. • Protects most vulnerable species of a complex, but the resulting management would be difficult to implement.	• Prevents overfishing of target stocks through precautionary harvest policies. • Acceleration of efforts to improve the current harvest strategy.
What is the impact of the policy on the sustainability of fisheries and communities?	• Continues to provide economic and community stability within the current system while adapting management programs when the need arises. • Some fisheries and communities are stressed due to negative effects of the race for fish.	• Long-term sustainability of fisheries and communities may be problematic if scenarios depicted in 2.1 are implemented; in the short-run fisheries and communities will likely see improved economic conditions. • If less aggressive actions are pursued, likely to be no better or worse than Alternative 1.	• Rationalization of fisheries holds the promise of improved fishery and community sustainability. • Extensive area closures associated with more aggressive ecosystem-based management may reduce small-boat and Alaska community involvement in fisheries.	• Extensive total allowable catch (TAC) reductions and area closures reduce viability of fisheries and fishery dependent communities. • Some fisheries may survive if assumptions of impacts are correct.	• Rationalization of fisheries holds the promise of improved fishery and community sustainability. • Incorporation of community protection elements into rationalization and ecosystem-based management programs are likely to ensure coastal community stability.
What is the impact of the policy on the stability of the food web and community structures (preserving the food web)?	• Likely effective in protecting food web components that are more well-studied than others and those that are at critical population thresholds. • Uncertain whether sufficient protection is provided to others for which less-complete information is available.	• High potential to create adverse food web impacts through its lack of precaution for many food web components, which leaves no room for uncertainty.	• Many improvements provide additional protection against uncertainty in order to achieve the goal of preserving the food web. • If implemented, this strategy is likely to provide protection to a broad range of food web components.	• Very successful in meeting the goal of preserving the food web, by providing large buffers against scientific uncertainty about ecosystem impacts. • Achieves protection of virtually all food web components and thus ecosystem function.	• Many improvements provide additional protection against uncertainty in order to achieve the goal of preserving the food web. • If implemented, this strategy is likely to provide protection to a broad range of food web components.
What is the impact of the policy on bycatch (discards) and incidental catch?	• Effective at limiting incidental catch of non-target species and reducing of bycatch. • Insufficient reporting of individual species catch, and catch in shallow water environments.	• May not be consistent with the goal of reducing and avoiding bycatch through developing practical measures that minimize bycatch.	• Likely successful at reducing prohibited species catch. • Reductions likely to be achieved through incentives for more efficient use of fishery resources under cooperatives, comprehensive rationalization of fisheries or other bycatch incentive programs.	• Bycatch and incidental catch reduction policies are effective. • Achieved through extreme reductions in target groundfish catch and strong bycatch and incidental catch limits.	• Likely successful at reducing prohibited species catch. • Reductions likely to be achieved through incentives for more efficient use of fishery resources under cooperatives, comprehensive rationalization of fisheries or other bycatch incentive programs.
What is the impact of the policy on seabird and marine mammal interactions?	• Effective at providing protection to Endangered Species Act (ESA)-listed seabirds and marine mammals. • No objectives for protecting non-listed species.	• Retains protection measures for ESA-listed species, but does not go beyond ESA-required measures. • High potential to increase fishery interactions with seabirds and marine mammals which may result in adverse impacts to those species.	• Goal of minimizing human-caused threats to protected species is largely met. • Likely to provide increased protection to marine mammals and seabirds.	• Very successful at avoiding impacts to seabirds and marine mammals. • Specific objectives to protect all seabirds from fishing interactions, and extend protection measures for Steller sea lion critical habitat and prey base.	• Effective at providing protection to ESA-listed seabirds and marine mammals. • May provide increased protection to seabirds and marine mammals if appropriate and practicable.

Key:

- Adverse impact; may include adverse conclusions that are based on assumptions.
- High potential for adverse impacts if any assumptions used to manage the resource are wrong.
- Potentially beneficial impact; assumptions used to manage the resource incorporate some precaution.
- Beneficial impact; assumptions used to manage the resource incorporate a high level of precaution.

Table ES-2 (cont.). Comparison of policy-level impacts of the alternatives.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	PA
What is the impact of the policy on protecting marine habitat?	• Likely effective in protecting habitat components that are more well studied than others; uncertain whether sufficient protection provided to habitat components for which there is less complete information. • Concerns exist with continued reduction of long-lived slow growing benthic habitat species and reduced levels of benthic organisms in areas of high fishing intensity.	• Increased impacts to habitat because of less precautionary management measures. • Potential changes may result in adverse impacts that may be hard to reverse, especially for long-lived, slow recovering living habitats.	• Potential to reduce and avoid future impacts to habitat by careful placement of closures. • A careful strategy can minimize geographic redistribution and increases in effort, and thus reduce chances of unintended consequences.	• Combination of highly precautionary measures associated with increasing marine reserves and other closure areas will likely achieve protection of, and avoidance of impacts to, habitat. • A careful strategy can minimize geographic redistribution and increases in effort, and thus reduce chances of unintended consequences.	• Potential to reduce and avoid future impacts to habitat by careful placement of closures. • A careful strategy can minimize geographic redistribution and increases in effort, and thus reduce chances of unintended consequences.
What is the impact of the policy on the value of marine resources (commercial and non-commercial)?	• Continues to generate substantial producer and consumer benefits in the United States (U.S.), while adapting management programs when the need arises. • Continues policies that have generated environmental concerns tending to keep recreation, tourism and non-market values low.	• Potential to increase allowable catches is expected to significantly increase revenues, but would also increase operating costs. • Non-market, recreational, and tourism values are expected to decline because of the reduced emphasis on these benefits.	• Increased social and economic benefits through the elimination of the race-for-fish while also emphasizing the long-term economic value of the fishery. • Promotes ecosystem based management and is likely to increase non-commercial values assigned to the ecosystem.	• Results in substantial reductions in allowable catches and could also result in the closure of large portions of traditional fishing areas, could jeopardize the continued viability of coastal communities. • Goals of incorporating and enhancing non-consumptive use values are met.	• Increased social and economic benefits through the elimination of the race-for-fish while also emphasizing the long-term economic value of the fishery. • Considers ecosystem-based management and is unlikely to decrease non-commercial values assigned to the ecosystem.
What is the impact of the policy on Alaska Native participation in fishery management, and their traditional ways of life?	• Alaska Native consultation and participation in fishery management, and subsistence, would continue to comply with federal law.	• Alaska Native consultation and participation in fishery management, and subsistence, would continue to comply with federal law. • Increased fishing effort would result in increased economic benefits to fishery participants (particularly community development quota [CDQ]), but potentially increased salmon bycatch.	• Increase current participation and consultation in fishery management by expanding informal and formal consultation and traditional knowledge (TK) data collection. • Rationalization and additional area closures may benefit subsistence by reducing salmon bycatch.	• Directly involves Alaska Natives in fishery management through the development of co-management or cooperative research programs. • Other goals, that greatly reduce or eliminate commercial fishing, would adversely impact Native communities.	• Increase current participation and consultation in fishery management by expanding informal and formal consultation and local and Traditional Knowledge data collection. • Rationalization and additional area closures may benefit subsistence by reducing salmon bycatch.
What is the impact of the policy on data quality, monitoring, research, and enforcement requirements?	• Data collection program will continue to meet minimum acceptable standards. • Aspects of the program, such as non-random coverage in the 30% component of the fleet, could be improved.	• Maintains a minimum level of data collection to meet conservation requirements. • Consideration to repeal the Observer Program may compromise management on the best science available.	• Likely to be effective at reducing uncertainty through data collection measures, such as improved observer catch monitoring data of target and non-target species, and expanded economic reporting data.	• Expands research and monitoring programs to fill critical data gaps that may result in the modification of restrictive conservation and management measures. • Expansion of observer program coverage would result in more complete fishery data, particularly on vessels <125 ft length overall (LOA).	• Likely to be effective at reducing uncertainty through improved data collection and monitoring, promotes research to fill data gaps. • Explicitly promotes enforceability.

Key:

- Adverse impact; may include adverse conclusions that are based on assumptions.
- High potential for adverse impacts if any assumptions used to manage the resource are wrong.
- Potentially beneficial impact; assumptions used to manage the resource incorporate some precaution.
- Beneficial impact; assumptions used to manage the resource incorporate a high level of precaution.

This alternative emphasizes incremental implementation of habitat protection measures as scientific information becomes available. As a result, impacts to habitat may be alleviated, albeit slowly. This strategy is likely effective in protecting habitat components that are better-studied than others, but it is uncertain whether sufficient protection will be provided to habitat components for which there is less complete information. Cumulatively, continued adverse impacts result from historical impacts that have potentially caused long-term and possibly irreversible loss of living habitat, especially to long-lived, slow-growing species that are slow to recover.

Alternative 1 is expected to continue to provide economic and community stability within the current management system while adapting management programs when the need arises. The alternative could eliminate the race-for-fish and, by doing so, would increase net revenues to producers and provide benefits to consumers, but would create fewer, although possibly higher paying, fishery related jobs. Non-market, recreation, and tourism values could decrease in the short-term before the transition to rights-based systems is completed.

The goals and policies for Alaska Native consultation and participation in fishery management would continue at the current levels and comply with relevant EOs and other federal law. Traditional Knowledge in fishery management would continue to be incorporated in environmental documents as available and appropriate. Subsistence uses would continue consistent with federal law.

This policy will result in a data collection program that will continue to meet minimum acceptable standards for scientific management of the fisheries. Although aspects of the catch collection program could be improved, such as non-random coverage in the 30 percent component of the fleet, current practices do provide useful data for fishery management while remaining mindful of the cost burden on industry of the monitoring program.

ES 7.2.2 Summary of Alternative 2

The key policy elements that predominantly influence the impacts under Alternative 2 are: the re-setting of the OY cap to the sum of OFL or the sum of ABCs (resulting in increased yield); the absence of an objective to eliminate the race-for-fish (resulting in increased effort); the absence of objectives to maintain existing closure areas (resulting in potentially adverse impacts to areas that have been closed to fishing); and the consideration to repeal the Observer Program (resulting in less monitoring and research data.)

The impacts analysis of Alternative 2 is hampered to a certain extent by the fact that controls and restrictions on the fishery are removed under this alternative. It is more difficult to predict the impact of removing rather than imposing restrictions; consequently, the uncertainty about predicted projections of the fishery and the environment could result in an increased risk to the human environment under this alternative.

Alternative 2 would maximize economic yield while preventing overfishing of target stocks, but is not effective at preventing stocks from becoming overfished. The weaknesses of this alternative are that it increases the chance of unintentionally overfishing a stock and catch estimates may be uncertain under this alternative if the Observer Program is repealed. Also, as in Alternative 1, there is no incentive to change the management status of stocks where the impact of fishing is unknown, and it is still possible to overharvest vulnerable members of a managed stock complex.

There is a high potential to create adverse food web impacts under Alternative 2 due to its lack of precaution, which leaves no room for uncertainty. The lack of catch monitoring results in the potential for adverse food web impacts to go undetected until dramatic food web changes are seen. This alternative provides less precautionary management to many components of the food web.

Alternative 2, as illustrated in example FMP 2.1, would not be consistent with the objective of monitoring PSC, as repeal of the Observer Program would negatively impact catch monitoring. Alternative 2 policies, as illustrated by example FMP 2.2, would be less severe. As in Alternative 1, additional weaknesses of the alternative are that bycatch is often reported as a complex rather than as individual species, and the absence of observer monitoring of catch on vessels less than 60 ft LOA may result in inaccurate estimates of bycatch. Therefore Alternative 2 may not provide adequate protection for non-target species.

Alternative 2 retains seabird and marine mammal protection measures for ESA-listed species, but does not go beyond ESA-required protection measures. Additionally, other goals and objectives under this alternative remove management measures currently in place in the baseline. The more aggressive harvesting policy, the relaxation of area closures, and the possible repeal of the Observer Program create a high potential to increase fishery interactions with seabirds and marine mammals that may result in adverse impacts to those species.

The alternative could result in increased impacts to habitat because of less precautionary management measures. Possible elimination of current closed areas and increases in TAC have the potential to result in adverse impacts to habitat that could be hard to reverse, especially for long-lived, slow recovering, living habitats. The policy goal of developing practical measures to minimize adverse effects to EFH could be difficult to achieve if such irreversible impacts occur.

Alternative 2 has the potential to increase allowable catches to maximum biological levels and could eliminate the cushion between ABC levels and levels that result in OFLs. This alternative is expected to significantly increase revenues but would also increase operating costs with the elimination of the LLP and IFQ programs. While fishery production is maximized, product quality and the health and safety of participants suffer. Of particular importance may be the amount of variability in harvests, which could increase significantly and therefore make it much more difficult to make long-term business and infrastructure decisions. Finally, non-market, recreation, and tourism values that accrue to the ecosystem could be reduced substantially.

As in Alternative 1, the goals and policies for Alaska Native consultation and participation in fishery management under Alternative 2 would continue at the current levels and comply with relevant EOs and other federal law. Traditional Knowledge in fishery management would continue to be incorporated in environmental documents as available and appropriate. Subsistence uses would continue consistent with federal law. Other goals and objectives in Alternative 2 would affect Alaska Natives by the increase in economic benefits accruing to participants in the fishery, particularly the CDQ pollock fishery. The increased fishing effort under this alternative may, however, result in increased salmon bycatch, which could have adverse effects on salmon fisheries particularly in the western Alaska Yukon-Kuskokwim river system.

Alternative 2 objectives maintain a minimum level of data collection to meet conservation requirements. The consideration to repeal the Observer Program may compromise management of the best science available as a result of reduced accuracy and breadth of fishery data. Because the presumed risk of adversely impacting the environment is assumed to be low in this alternative, the costs to industry of funding the Observer Program to gather fishery data may not be considered necessary.

ES 7.2.3 Summary of Alternative 3

The key policy elements that predominantly influence the impacts under Alternative 3 are: the emphasis on rationalizing the fisheries (resulting in increased efficiency and flexibility); the incorporation of ecosystem considerations (increasing the uncertainty buffers in management accounting); and the likelihood of additional closure areas (which may result in a variety of impacts, depending how the closures are situated).

Predictions about the impacts under this alternative are difficult due to the uncertainty involved in defining ecosystem management and predicting the impacts of protecting areas. Increased emphasis on relatively less abundant species, through protection measures and increased monitoring, indicates a tendency towards ecosystem management but as the implications of such management are uncertain, the tendency is to tread cautiously while accelerating research and data-gathering. The large potential gain in flexibility from rationalization has the potential to create ecosystem benefits.

Alternative 3 prevents overfishing of target stocks and reduces the likelihood that stocks will become overfished, through precautionary harvest policies and imposition of rebuilding regulations when stocks fall below the level capable of producing maximum sustainable yield (MSY). This alternative would formally define criteria for determining the status of stocks relative to an overfished condition in order to better satisfy the requirements of the National Standard 1 guidelines. Efforts would be accelerated to identify methods for reducing the number of stocks where the status relative to an overfished condition is unknown.

This alternative is successful in making many improvements relative to the baseline in achieving the goal of preserving the food web. The emphasis of this alternative is not only on using the best scientific information available to determine catch levels but also on providing additional protection against uncertainty by designation of MPAs and marine reserves. If these improvements are implemented, this strategy is likely to provide protection to a broad range of food web components.

The bycatch and incidental catch reduction policies in Alternative 3 are consistent with accelerating precautionary management measures through additional bycatch constraints and monitoring. Bycatch reduction objectives and reductions in incidental catch are likely to be achieved without a major cost to industry due to the incentives for more efficient use of fishery resources under cooperatives, comprehensive rationalization of fisheries, or other bycatch incentive programs implemented under this alternative.

The goal of minimizing human-caused threats to protected species is largely met in this alternative by actively adjusting protection measures, actively reviewing the status of marine mammal fishery interactions, and through research. This approach, which may provide additional conservation measures in response to scientific evidence, is likely to provide increased protection to marine mammals and seabirds.

This alternative has a potential to reduce and avoid impacts to habitat by careful placement of closures. Placement of closures in lightly fished areas or areas not fished at all could result in avoidance of future habitat impacts if fisheries were to move effort into surrounding areas. Placement of closures in heavily fished areas can mitigate impacts, reduce unintended consequences, and achieve overall benefits to habitat if closures do not encompass entire habitat types or areas of fishing intensity. In the short-term, information from the Observer Program could be used to locate such closures. In the long-term, scientific information gained from this policy can potentially lead to modification of the placement of MPAs and help meet the policy objective to assess the necessary and appropriate habitat protection measures. Cumulatively, the alternative results in a split impact rating, as the adverse condition of the habitat baseline is coupled with continued damage and mortality to living habitat; however, the alternative has strong potential to mitigate these adverse impacts.

Alternative 3 promotes increased social and economic benefits through the elimination of the race-for-fish while also emphasizing the long-term economic value of the fishery through the promotion of rights-based allocations to individuals, sectors, and communities. In addition, this alternative promotes ecosystem-based management and is likely to increase non-market, recreational, and tourism values assigned to the ecosystem. It is not possible to determine the long-term effect on overall benefits (commercial and non-market values combined) because it is not known whether the fishing sectors, even with rights-based allocations, will be able to adapt to the changes resulting from the increased emphasis on ecosystem tools and, in particular, the additional number and significance of closed areas.

The goals and policies for Alaska Native consultation and participation in fishery management under Alternative 3 would increase current levels by expanding informal and formal consultation between the NPFMC and NOAA Fisheries and Alaska Native participants and tribal governments. Traditional Knowledge would be more formally incorporated in fishery management and additional data would be collected. Other goals and objectives in Alternative 3, such as reductions in PSC limits, may benefit subsistence salmon use by reducing bycatch levels in the groundfish fisheries.

Through data collection measures that will result in reducing uncertainty, Alternative 3 is likely to be effective in achieving the goal of accelerating the use of precautionary management measures. The objectives to improve the Observer Program and observer data will increase the quality of fishery data by implementing increased flexibility of, and potentially expanding, observer coverage. Additionally, the expanded economic data and potential for independent verification would allow for more accurate and credible economic impact assessments. A funding source would, however, need to be identified to implement improvements to these programs.

ES 7.2.4 Summary of Alternative 4

The key policy element that influences impacts under Alternative 4 is the shift of the burden of proof to the user of the resource to demonstrate that the intended use will not have a detrimental effect on the environment. Such a formal policy would raise the standard of justification required for fishery management actions. Key management objectives that implement this approach are: reduce the ABCs, and in turn the TACs, or consider temporarily suspending the fisheries to account for uncertainty; institute extensive closure areas (resulting in the closure of traditional fishing areas and an increased emphasis on non-consumptive values); phase out fisheries with greater than 25 percent incidental catch and bycatch rates; develop a

Fisheries Ecosystem Plan; and increase data collection and monitoring (in order to fill in data gaps and adjust restrictive measures as appropriate).

Predictions about the impacts under this alternative are difficult due to the uncertainty involved in defining ecosystem management and predicting the impacts of protecting areas. The emphasis is on instituting protective measures, particularly focusing on less abundant or economically valuable species, while at the same time imposing extensive monitoring and data-gathering to increase understanding of fishery impacts.

Alternative 4 establishes a very conservative harvest policy which is likely to prevent overfishing of target stocks and reduce the chance that stocks would become overfished. Constraints to commercial harvest coupled with systems of closed areas would effectively reduce impacts from the race for fish and therefore from spatial and temporal concentration of catch. Catch monitoring would also increase under this alternative, resulting in more complete fisheries data. As with Alternative 3, this alternative would define criteria for determining the status of all managed stocks relative to an overfished condition in order to better satisfy the requirements of the National Standard 1 Guidelines. In the long term, this alternative would protect the most vulnerable species of the complex, but the resulting management of many stocks with low biomass would be difficult to implement.

This alternative is very successful in meeting the goal of preserving the food web, by providing large buffers against scientific uncertainty about ecosystem impacts resulting from fishing. The assumption that the present level of scientific information is insufficient to manage fisheries without excessive risk to the ecosystem results in the implementation of highly precautionary measures. This strategy provides improvements over the baseline and achieves protection of virtually all food web components and thus ecosystem functions. Although the alternative is successful in producing a food web that is less influenced by fishing activity, predictions about the abundance changes of individual food web components that might result are uncertain due to the difficulty in accurately predicting predator-prey relationships.

The bycatch and incidental catch reduction policies under Alternative 4 are effective. Reduced bycatch and incidental catch would be achieved through extreme reductions in target groundfish catch and strong bycatch and incidental catch limits.

Alternative 4 is very successful at avoiding impacts to seabirds and marine mammals through its specific objectives to protect all seabirds from fishing interactions, and extending protection measures for Steller sea lion critical habitat and prey base. This increased level of protection provides a substantial buffer against uncertainty with regards to protection of marine mammals and seabirds.

The emphasis of the Alternative 4 policy on habitat provides large buffers against scientific uncertainty about the impacts of fishing on habitat. The combination of highly precautionary measures associated with increasing marine reserves and other closure areas will likely achieve protection and avoidance of impacts to habitat. Cumulatively, the alternative has a split rating, as the existing adverse condition of the baseline includes damage to slow-growing species unlikely to recover within the time period predicted in this analysis, while providing strong protection for habitat and potential for mitigation.

The Alternative 4 goals of incorporating and enhancing non-consumptive use values are met but at the expense of commercial value and potentially the continued viability of coastal communities. The precautionary policies in Alternative 4 could result in substantial reductions in allowable catch and could also result in the closure of large portions of traditional fishing areas. The alternative is likely to result in a substantial increase in the non-market values of the ecosystem, but may also result in a substantial decrease in efficiency, net revenues, and the number of participants in the fisheries.

Alternative 4 would directly involve Alaska Natives in fishery management through the development of co-management or cooperative research programs. Consultation and participation objectives would focus on subsistence uses and cultural values of living marine resources. However, other goals and objectives in Alternative 4, that greatly reduce or eliminate commercial fishing, would adversely impact Native communities, including CDQ communities, through the loss of employment, economic activity, and community revenues.

Alternative 4 expands research and monitoring programs to obtain information necessary to fulfill the requirements of this alternative. The policy objectives are successful in increasing fisheries data by expanding the Observer Program to full coverage for vessels over 60 ft LOA, and instituting 30 percent coverage on smaller boats. Additionally, the requirements to improve the accuracy of data through technological means such as at-sea scales and VMS will improve monitoring and enforcement under this alternative.

Because of these described effects, NOAA Fisheries has identified Alternative 4 as the environmentally preferable alternative since it would result in the least impact to the physical and biological environment. NEPA requires the Agency to identify such an alternative from among those analyzed fully in the Programmatic SEIS. NEPA does not require the Agency to select the environmentally preferable alternative as its PA. Should it choose not to do so, the Agency must explain why it chose a different alternative as its PA in its Record of Decision.

ES 8.0 The Preferred Alternative and Summary of its Environmental Consequences

The PA for the management policy to govern the BSAI and GOA groundfish fisheries was recommended by the NPFMC after careful consideration of public comments and the analyses of the alternatives in the PSEIS. NOAA Fisheries received more than 13,400 comments during the review period on the revised 2003 Draft Programmatic SEIS, which are synthesized and responded to in Appendix G. The analyses in the PSEIS are based on the best scientific information available. The PA is based on the policy goals and objectives described under Alternative 3, with refinements incorporated from both Alternatives 1 and 4 as well as suggestions taken from public comments. NOAA Fisheries has reviewed the NPFMC recommendation, and has endorsed it as the Agency's PA.

The management approach and the objectives in the PA reflect a conservative, precautionary approach to ecosystem-based fisheries management, and communicate a policy direction for the future. The PA is a realistic and responsible approach that addresses and complies with the various goals, objectives and requirements of the MSA and other applicable law. The policy elements contained in the PA are consistent with, and also achieve a reasonable balance between the competing interests reflected in, the National Standards. The PA continues the commitment by the NPFMC and NOAA Fisheries' to prevent overfishing and, to the extent practicable, protect seabirds and marine mammals and reduce bycatch and habitat impacts. The PA incorporates ecosystem-based management principles into a management approach that recognizes the need to both promote sustainable fisheries and protect fishery-dependent communities. It also retains the strong role of science in fishery management, and fosters a transparent and effective regulatory process where all stakeholders have a meaningful role. The PA is an adaptive management policy which will guide and inform fisheries management decisions made by the NPFMC and NOAA Fisheries. The adaptive nature of the PA also gives the NPFMC and NOAA Fisheries the flexibility to modify policy elements in response to new information or changing circumstances in order to continue to adequately manage the fisheries.

ES 8.1 The North Pacific Fishery Management Council's Recommended Preferred Alternative

The management policy of the PA is included below. The objectives of the PA are also summarized in Table ES-1.

Management Approach

The productivity of the North Pacific ecosystem is acknowledged to be among the highest in the world. For the past 25 years, the NPFMC management approach has incorporated forward looking conservation measures that address differing levels of uncertainty. This management approach has, in recent years, been labeled the p precautionary approach. The NPFMC's precautionary approach is about applying judicious and responsible fisheries management practices, based on sound scientific research and analysis, proactively rather than reactively, to ensure the sustainability of fishery resources and associated ecosystems for the benefit of future as well as current generations. Recognizing that potential changes in productivity may be caused by fluctuations in natural oceanographic conditions, fisheries, and other, non-fishing, activities, the NPFMC intends to continue to take appropriate measures to insure the continued sustainability of the managed species. It will carry out this objective by considering reasonable, adaptive management measures as described in the MSA and in conformance with the National Standards, the Endangered Species Act, the National Environmental Policy Act and other applicable law. This management approach takes into account the National Academy of Science's recommendations on Sustainable Fisheries Policy.

As part of its policy, the NPFMC intends to consider and adopt, as appropriate, measures that accelerate the NPFMC's precautionary, adaptive management approach through community or rights-based management, ecosystem-based management principles that protect managed species from overfishing, and where appropriate and practicable, increase habitat protection and bycatch constraints. All management measures will be based on the best scientific information available. Given this intent, the fishery management goal is to provide sound conservation of the living marine resources; provide socially and economically viable fisheries and fishing communities; minimize human-caused threats to protected species; maintain a healthy marine resource habitat; and incorporate ecosystem-based considerations into management decisions.
This management approach recognizes the need to balance many competing uses of marine resources and different social and economic goals for sustainable fishery management including protection of the long-term health of the resource and the optimization of yield. This policy will utilize and improve upon the NPFMC's existing open and transparent process to involve the public in decision-making.

Adaptive management requires regular and periodic review. Objectives identified in this policy statement will be reviewed annually by the NPFMC. The NPFMC will also review, modify, eliminate or consider new issues as appropriate to best carry out the goals and objectives of this management policy. To meet the goals of this overall management approach, the NPFMC and NOAA Fisheries will use the PSEIS as a planning document. To help focus its consideration of potential management measures, it will use the following objectives as guideposts to be re-evaluated as amendments to the FMP are considered over the life of the PSEIS.

Prevent Overfishing:

1. Adopt conservative harvest levels for multi-species and single species fisheries and specify optimum yield.

2. Continue to use existing optimum yield cap for BSAI (as stated in current law) and GOA groundfish fisheries.

3. Provide for adaptive management by continuing to specify optimum yield as a range.

4. Initiate a scientific review of the adequacy of F40 and adopt improvements as appropriate.

5. Continue to improve the management of species through species categories.

Promote Sustainable Fisheries and Communities:

6. Promote conservation while providing for optimum yield in terms of providing the greatest overall benefit to the nation with particular reference to food production, and sustainable opportunities for recreational, subsistence and commercial fishing participants and fishing communities.

7. Promote management measures that, while meeting conservation objectives, are also designed to avoid significant disruption of existing social and economic structures.

8. Promote fair and equitable allocation of identified available resources in a manner such that no particular sector, group or entity acquires an excessive share of the privileges.

9. Promote increased safety at sea.

Preserve Food Web:

10. Develop indices of ecosystem health as targets for management.

11. Improve the procedure to adjust ABCs as necessary to account for uncertainty and ecosystem factors.

12. Continue to protect the integrity of the food web through limits on harvest of forage species.

13. Incorporate ecosystem-based considerations into fishery management decisions as appropriate.

Manage Incidental Catch and Reduce Bycatch and Waste:

14. Continue and improve current incidental catch and bycatch management program.

15. Develop incentive programs for bycatch reduction including the development of mechanisms to facilitate the formation of bycatch pools, VBAs, or other bycatch incentive systems.

16. Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits as information becomes available.

17. Continue program to reduce discards by developing management measures that encourage the use of gear and fishing techniques that reduce bycatch which includes economic discards.

18. Continue to manage incidental catch and bycatch through seasonal distribution of TAC and geographical gear restrictions.

19. Continue to account for bycatch mortality in TAC accounting and improve the accuracy of mortality assessments for target, PSC bycatch, and non-commercial species.

20. Control the bycatch of prohibited species through PSC limits or other appropriate measures.

21. Reduce waste to biologically and socially acceptable levels.

Avoid Impacts to Seabirds and Marine Mammals:

22. Continue to cooperate with USFWS to protect ESA-listed species, and if appropriate and practicable, other seabird species.

23. Maintain or adjust current protection measures as appropriate to avoid jeopardy to ESA-listed Steller sea lions.

24. Encourage programs to review status of endangered or threatened marine mammal stocks and fishing interactions and develop fishery management measures as appropriate.

25. Continue to cooperate with NOAA Fisheries and USFWS to protect ESA-listed marine mammal species, and if appropriate and practicable, other marine mammal species.

Reduce and Avoid Impacts to Habitat:

26. Review and evaluate efficacy of existing habitat protection measures for managed species.

27. Identify and designate EFH and HAPC pursuant toMSA rules, and mitigate fishery impacts as necessary and practicable to continue the sustainability of managed species.

28. Develop a Marine Protected Area policy in coordination with national and state policies.

29. Encourage development of a research program to identify regional baseline habitat information and mapping, subject to funding and staff availability.

30. Develop goals, objectives and criteria to evaluate the efficacy and suitable design of marine protected areas and no-take marine reserves as tools to maintain abundance, diversity, and productivity. Implement marine protected areas if and where appropriate.

Promote Equitable and Efficient Use of Fishery Resources:

31. Provide economic and community stability to harvesting and processing sectors through fair allocation of fishery resources.

32. Maintain LLP program and modify as necessary, and further decrease excess fishing capacity and overcapitalization by eliminating latent licences and extending programs such as community or rights-based management to some or all groundfish fisheries.

33. Provide for adaptive management by periodically evaluating the effectiveness of rationalization programs and the allocation of access rights based on performance.

34. Develop management measures that, when practicable, consider the efficient use of fishery resources taking into account the interest of harvesters, processors, and communities.

Increase Alaska Native Consultation:

35. Continue to incorporate local and Traditional Knowledge in fishery management.

36. Consider ways to enhance collection of local and Traditional Knowledge from communities, and incorporate such knowledge in fishery management where appropriate.

37. Increase Alaska Native participation and consultation in fishery management.

Improve Data Quality, Monitoring and Enforcement:

38. Increase the utility of groundfish fishery observer data for the conservation and management of living marine resources.

39. Improve groundfish Observer Program, and consider ways to address the disproportionate costs associated with the current funding mechanism.

40. Improve community and regional economic impact costs and benefits through increased data reporting requirements.

41. Increase the quality of monitoring and enforcement data through improved technological means.

42. Encourage a coordinated, long-term ecosystem monitoring program to collect baseline information and compile existing information from a variety of ongoing research initiatives, subject to funding and staff availability.

43. Cooperate with research institutions such as the NPRB in identifying research needs to address pressing fishery issues.

44. Promote enhanced enforceability.

45. Continue to cooperate and coordinate management and enforcement programs with the ADF&G, and Alaska Fish and Wildlife Protection, the USCG, NOAA Fisheries Enforcement, IPHC, federal agencies, and other organizations to meet conservation requirements; promote economically healthy and sustainable fisheries and fishing communities; and maximize efficiencies in management and enforcement programs through continued consultation, coordination, and cooperation.

ES 8.2 Example FMP Bookends for the Preferred Alternative

The example FMP bookends PA.1 and PA.2 serve to illustrate management concepts and future actions that logically flow from the PA management policy and provide sufficient detail to allow for focused analysis of their environmental consequences. The example FMP bookends are described below.

Example FMP PA.1

Example FMP PA.1 illustrates a conservative management approach that continues current risk-averse practices, increases conservation-oriented constraints on the fisheries as appropriate, formalizes precautionary practices in the FMPs, and initiates scientific review of existing practices in order to assess and improve fishery management.

FMP PA.1 builds on the existing conservative procedure for determining ABC, annual quotas, and the existing suite of closed areas (Figure ES-2). The example FMP implements changes to the TAC-setting process following a comprehensive review. Precautionary practices such as setting TAC less than or equal to the ABC, and specifying MSSTs for Tiers 1-3 in accordance with National Standard Guidelines, would be formalized in the FMP. The NPFMC and NOAA Fisheries would continue to use and improve harvest control rules to maintain a spawning stock biomass with the potential to produce sustained yields on a continuing basis, and to distribute allocations by area, season, and gear as appropriate. Efforts to develop ecosystem indicators to be used in TAC-setting, as per ecosystem management principles, would be continued.

In order to balance the needs of social and economic stability with habitat protection and resource conservation, the NPFMC and NOAA Fisheries would develop a Marine Protected Area (MPA) efficacy methodology, including the development of definitions, program goals, objectives, and criteria for establishing MPAs. Additionally, the existing habitat and bycatch area restrictions would be maintained. Measures are also retained to protect ESA-listed species. To minimize bycatch, a moderate reduction of PSC limits in the BSAI will be initiated, and PSC limits or other appropriate measures for protection of crab, herring and salmon would be authorized in the GOA. Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through improvements in the Observer Program and existing reporting requirements.

Existing programs addressing excess capacity and overcapitalization are maintained under this example FMP, with continued development of rights-based management to be undertaken as needed. In order to mitigate adverse impacts of fisheries management decisions on fishing communities, and to comply with other national directives, procedures to encourage increased participation of Alaska Natives in fishery management, would be pursued.

Example FMP PA.2

FMP PA.2 accelerates adaptive precautionary management by increasing conservation measures that provide a buffer against uncertainty, instituting research and review of existing measures, and expanding data collection and monitoring programs.

FMP PA.2 significantly accelerates precautionary management by incorporating an uncertainty correction into the estimation of ABC for all species. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. The calculation of the OY caps would be periodically reviewed to determine their relevancy to current environmental conditions and stock levels. Example FMP PA.2 would also develop and implement criteria for using key ecosystem indicators in TAC-setting, and other precautionary practices such as developing appropriate harvest strategies for rockfish stocks. In implementing this bookend, data would be collected and analysis undertaken to allow the specification of MSSTs for Figure ES-2 (FMP PA.1 map) priority stocks in Tiers 4-5. The development of criteria to manage target and non-target species consistently, and for removing some stocks from the other species and non-specified species management categories, would initially consider breaking sharks out of the other species category for TAC-setting and management purposes in the BSAI, as well as consider breaking sharks and skates out of the other species category in the GOA.

FMP PA.2 also reexamines area restrictions in the BSAI and the GOA by reviewing the existing system of closure areas in the BSAI and the GOA (Figure ES-3 and Section 4.2.3), and evaluating them in conjunction with developing MPAs. PA.2 considers adopting MPAs, with a guideline of 0 to 20 percent of the EEZ (3 to 200 nm) to be closed. The objective of these measures is to provide greater protection to a full range of marine habitats within the 1,000-m bathymetric line (Figure ES-3). This area would incorporate an Aleutian Islands management area to protect coral and living bottom habitat, and also any modification to the 2002 Steller sea lion closures. The closed area may also mitigate adverse effects that occur due to fishing. The guideline aims to provide greater protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species, while at the same time respecting traditional fishing grounds and maintaining open area access for coastal communities. Additionally, the bookend would extend the existing BSAI bottom-trawl ban on pollock to the GOA.

To increase precaution regarding bycatch, existing PSC limits would be reduced, and limits would be set for all prohibited species in the GOA, with appropriate in-season closure areas. The achievement of these bycatch reductions is expected to be realized through the comprehensive rationalization of all fisheries (except those already part of a cooperative or IFQ program), which reduces concentrated effort in the fisheries, or through bycatch incentive programs implemented in this example FMP.

In accordance with ecosystem principles, the NPFMC and NOAA Fisheries would seek to cooperate with USFWS to develop fishing methods that reduce incidental take of all seabird and marine mammal species in the longline and trawl fisheries. Procedures would also be pursued to increase consultation with and representation of Alaska Natives in fishery management by incorporating local and Traditional Knowledge. Increases in observer coverage and improvements to the observer data that is collected would enhance effective monitoring and timely reaction to change in the environment and the fisheries. Additionally, the bookend explores programs that would expand the mandatory economic data collected from industry while protecting confidentiality.

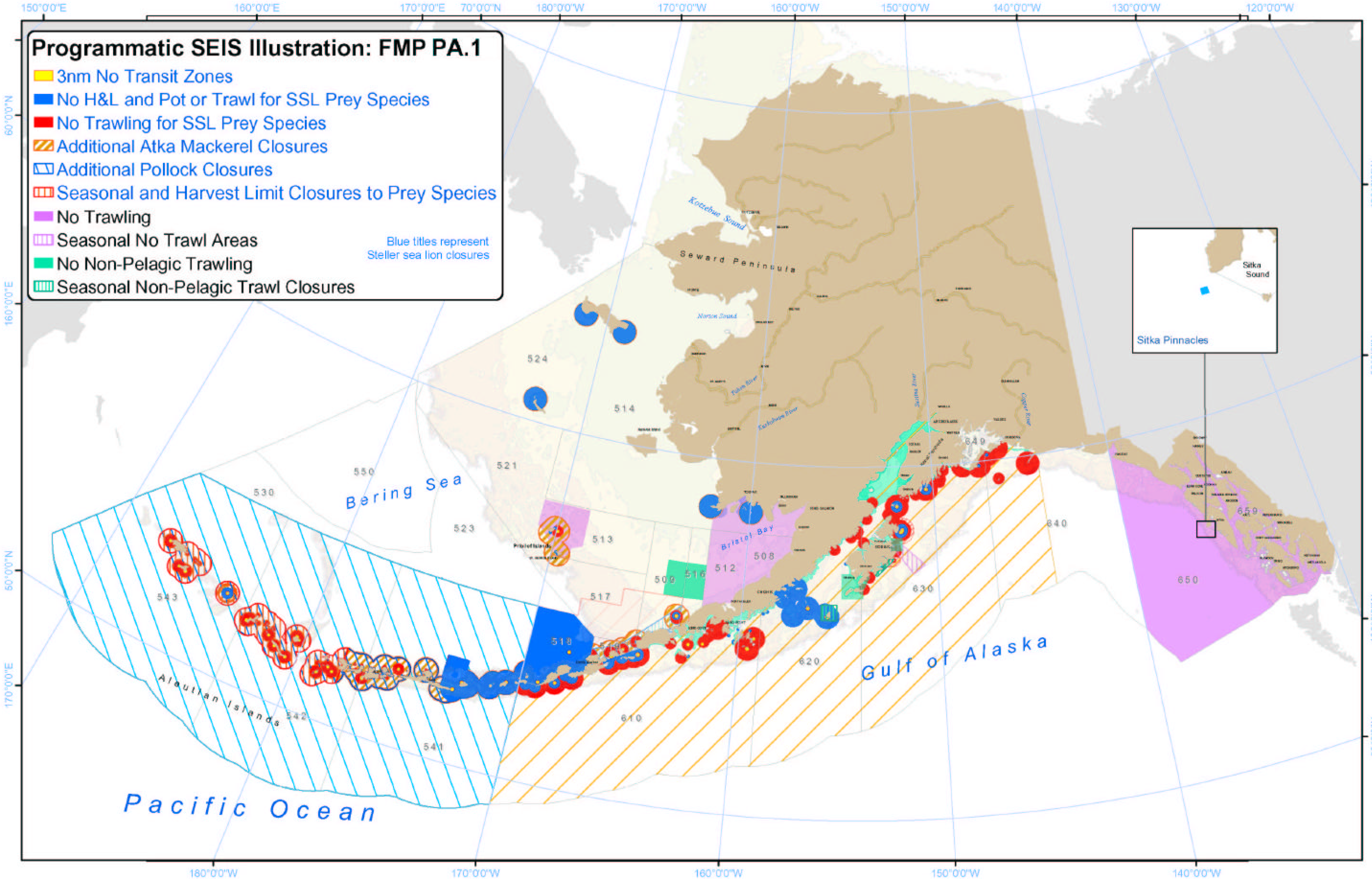

Figure ES-2. Programmatic Supplemental Environmental Impact Statement illustration of closure areas included in Preferred Alternative FMP PA.1.

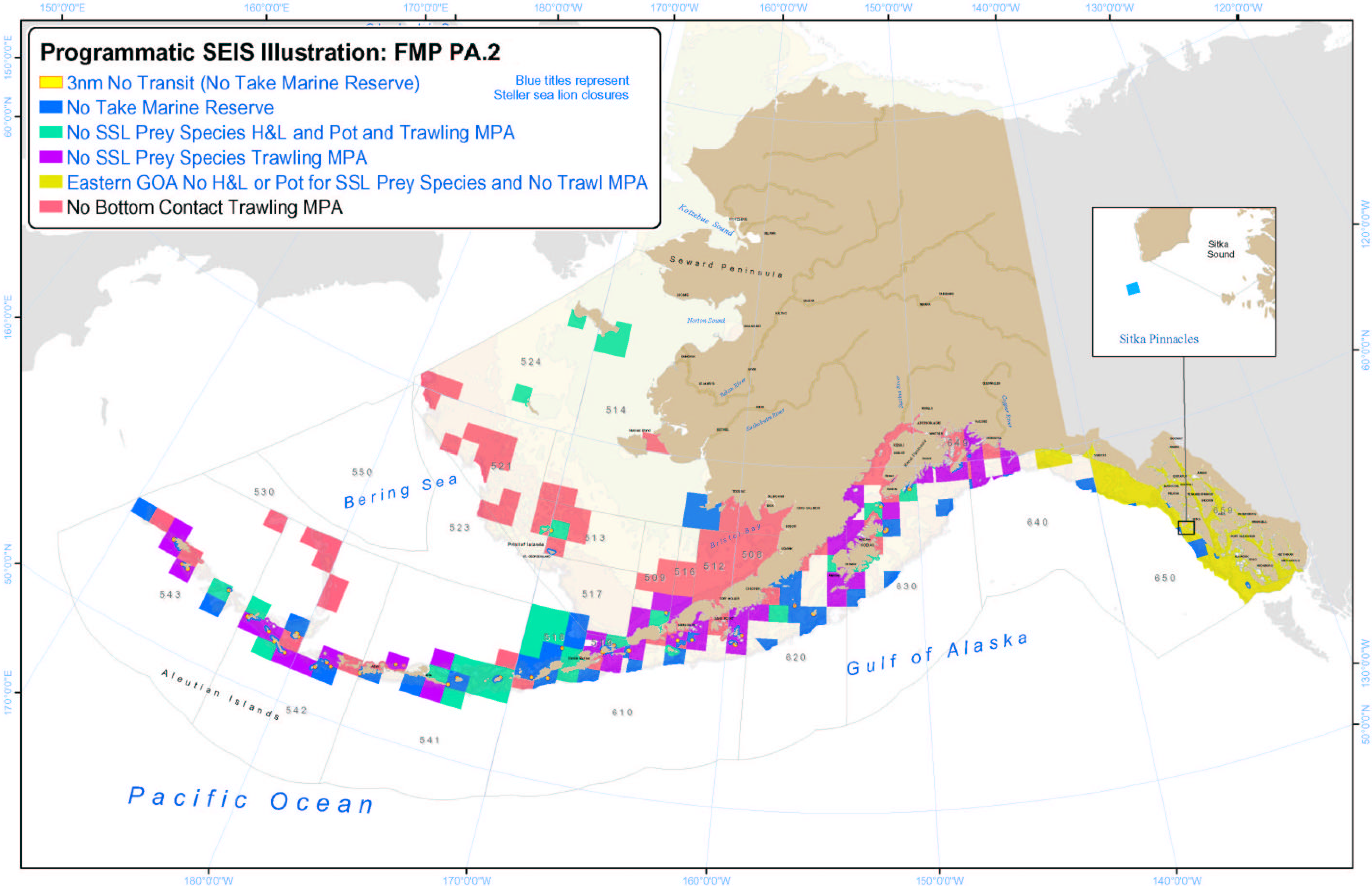

Figure ES-3. Programmatic Supplemental Environmental Impact Statement illustration of closure areas included in Preferred Alternative FMP PA.2.

ES 8.3 Summary of Environmental Consequences of the Preferred Alternative

This section contains a summary of the environmental consequences of the PA at the policy-level. Table ES-2 presents the information summarized below in table format, and uses a color key to indicate the direction of the effects associated with each alternative. The intent of the summary, and Table ES-2, is to provide a broad, policy-level understanding of the general impacts of the alternatives, including the PA. The analysis deals with effects at the population or fishery level, rather than calling out impacts to individual components (a more detailed analysis of the example FMP bookends provides the basis for this policy-level analysis). For more information on the structure of the table and the color key, see the description in Section ES 7.2.

The key policy elements that predominantly influence the impacts under the PA are: the emphasis on rationalizing the fisheries (resulting in increased efficiency and flexibility); the incorporation of ecosystem considerations (increasing the uncertainty buffers in management accounting); and the likelihood of additional closure areas (which may result in a variety of impacts, depending how the closures are situated).

Predictions about the impacts under the PA are difficult due to the uncertainty involved in defining ecosystem management and predicting the impacts of protecting areas. Increased emphasis on relatively less abundant species, through protection measures and increased monitoring, indicates a tendency towards ecosystem management but as the implications of such management are uncertain, the tendency is to tread cautiously while accelerating research and data-gathering. The potential increased flexibility gained by from rationalizing the fisheries may prove beneficial for the ecosystem.

The PA prevents overfishing of target stocks and reduces the likelihood that stocks will become overfished, through precautionary harvest policies, and imposition of rebuilding regulations when stocks fall below the level capable of producing MSY. Efforts would be accelerated to improve the current harvest strategy, including additional procedures to incorporate uncertainty and develop spawning stock biomass estimates, in particular for Tiers 4-5 (PA.2).

The goal of promoting sustainable fisheries and communities under the PA is likely to be successful. The precautionary adjustments made to quota management decrease the risk of inadvertently overfishing managed species. Additionally, the transition to rights-based management under this alternative will promote the objectives to increase efficiency, stability, and safety in the long-term.

As a whole, through its goal to accelerate precautionary management measures through ecosystem-based principles, and its objectives to develop indices of ecosystem health and to take ecosystem factors into account in ABC-setting, the PA is successful in making many improvements beyond the status quo in achieving the goal of preserving the food web. The emphasis in this alternative is on using the best scientific information available to determine catch levels, but also on providing additional protection against uncertainty by designation of MPAs and reserves. If these improvements are implemented, this strategy is likely to provide protection to a broad range of food web components.

The bycatch and incidental catch reduction policies in the PA are consistent with minimizing human-caused threats to protected species and accelerating precaution through additional bycatch constraints, such as reduced PSC limits. Bycatch reduction objectives and reductions in incidental catch are likely to be achieved without a major cost to industry due to the incentives for more efficient use of fishery resources under cooperatives, comprehensive rationalization of fisheries, or other bycatch incentive programs implemented under this alternative.

The goal of minimizing human-caused threats to protected species and if appropriate and practicable, other seabird and marine mammal species, is largely met in the PA by actively adjusting seabird and marine mammal protection measures, and by conducting periodic review of endangered and threatened marine mammal fishery interactions. This approach, which may provide additional conservation measures in response to scientific evidence, is likely to maintain protection to ESA-listed marine mammals and seabirds, and may increase protection for other seabirds and marine mammals.

This alternative has the potential to reduce and avoid impacts to habitat by careful placement of closures. Placement of closures in lightly fished or not fished areas will provide mitigation and result in avoidance of future habitat impacts if fisheries were to move effort into surrounding areas. Closures in heavily fished areas should be small to minimize displaced efforts and reduce chances of unintended consequences. To achieve overall benefits, closures should not encompass entire habitat types or areas of fishing intensity. In the short term, information from the Observer Program could be used to locate such closures. In the long term, scientific information gained from this policy can potentially lead to modification of the placement of MPAs and help meet the policy objective to assess the necessary and appropriate habitat protection measures.

The PA promotes increased social and economic benefits through the elimination of the race-for-fish while also emphasizing the long-term economic value of the fishery through the promotion of rights-based allocations to individuals, sectors, and communities. In addition, this alternative promotes ecosystem-based management and is likely to increase non-market, recreational, and tourism values assigned to the ecosystem. It is not possible to determine the long-term effect on overall ecosystem value (commercial and non-market values combined) because it is not known whether the fishing sectors, even with rights-based allocations, will be able to adapt to the changes resulting from the increased emphasis on ecosystem tools and, in particular, the potential addition to the number and significance of closed areas.

The goals and policies for Alaska Native consultation and participation in fishery management under the PA would increase current levels by expanding informal and formal consultation between the NPFMC and NOAA Fisheries and Alaska Native participants and tribal governments. Local and Traditional Knowledge would be more formally incorporated in fishery management and additional data would be collected. Other goals and objectives in the PA, such as reductions in PSC limits, may benefit subsistence salmon use by reducing bycatch levels in the groundfish fisheries.

Through data collection measures that will result in reducing uncertainty, the PA is likely to be effective in achieving the goal of accelerating the use of precautionary management measures. The objectives to improve the Observer Program and observer data will increase the quality of fishery data by implementing increased flexibility of, and potentially expanding, observer coverage. Additionally, the expanded economic data and potential for independent verification would allow for more accurate and credible assessments of economic impacts while protecting confidentiality of data. A funding source would, however, need to be identified to implement improvements to these programs. The alternative also emphasizes the importance of enforcement concerns in fishery management.

ES 9.0 Overall Conclusions

This Programmatic SEIS represents a broad but comprehensive review of the Alaska groundfish fisheries and its environmental consequences. Due to its large geographic, biological, and regulatory scope, it is necessarily a large document containing many findings and conclusions on numerous issues. This section of the summary however, brings forward thirteen overall conclusions that the Agency wanted to highlight in this Programmatic SEIS of the Alaska groundfish fisheries.

1. The more precautionary you become, the lower the risk of causing adverse effects on the physical/biological environment. This comes with at least a short-term cost to socioeconomic sectors of the environment including fishermen, processors, and coastal communities, although some of this cost could be offset by long-term sustainability of the ecosystem, albeit at lower harvests than today.

2. As TAC is reduced, other FMP components currently used by the NPFMC and NOAA Fisheries become less important and may no longer be necessary. For example, at reduced TAC levels, bycatch of prohibited species and non-target species is decreased. Impacts to the benthic habitat are also decreased. Managers may no longer need to specify PSC limits if the measures themselves no longer constrain the groundfish fisheries because the estimated bycatch is now below threshold. Similarly, with reduced TAC levels, it may no longer be necessary to spend time developing a complex web of spatial closures since the impacts of the fisheries on benthic habitat would likely decrease and such spatial closures may be unwarranted. As a result, the corresponding FMP may be very simplistic compared to today's FMPs.

3. At the policy level, all alternatives have been designed to take into account the requirements of applicable laws, including the MSA, MMPA, and ESA. Some MSA National Standards for socioeconomic resources could realize increased risk as the policy becomes more precautionary with regard to potential physical and biological impacts. Such costs may not be desirable when there is considerable uncertainty regarding the benefits gained by such policies. Similarly, should the NPFMC recommend a more aggressive harvest policy, the risk of overfishing stocks (especially those where there is very little information) increases even though we choose to remain within OFL of target groundfish species.

4. The realities of conducting fishery research often center around funding. It is usually difficult to obtain research funding when you most need it or for all the topics that warrant study. As a result, fishery research has trade-offs—if you investigate some species, others may not be studied. Even if all the required/requested research was funded, it would be difficult to fully implement a large comprehensive program due to the limited number of fishery scientists currently available to do the work.

5. Considerable uncertainty is associated with management of any fishery and these uncertainties continue under all of the alternatives.

6. Under Alternative 2, most controls over the fishery are removed. As a result, it is difficult to predict how the fishery, stocks, and other resources will react to such a shift in management policies. Risk to the human environment increases as a result of uncertainty.

7. Adaptive management often results in unexpected consequences (e.g., the "bulge theory" when you change the fishery in one way to address a specific problem, another problem often develops somewhere else).

8. A large biomass or increased biomass does not necessarily translate to a stable or increased level of sustainability. Spawner recruit relationships and other features of the population suggest that sustainability of a resource (and a fishery dependent on that resource) is dependent on more variables than just size of the population.

9. The "race-for-fish" is less than optimal in terms of the allocation of fishery resources. Lessons learned from past experience has proven that a rationalized fishery provides greater benefits to the nation than an open access fishery.

10. Currently, questions exists on whether fishermen can achieve their TACs when displaced from traditional fishing grounds. This is an area of great uncertainty and it means that predictions of future catches under different closed area scenarios may be incorrect.

11. Closed areas designed as no-take reserves or a form of MPA should be based on the best available science and the NPFMC and NOAA Fisheries should work closely with public stakeholders and coastal communities in seeking the best areas for protection that provide the greatest benefits to habitat while minimizing adverse social and economic consequences.

12. Careful placement of small closures within heavily fished areas can potentially mitigate some habitat impacts and help avoid unintended consequences of displaced effort. The size of the closures, if closures are determined to be necessary, will depend on a number of factors including the distribution of the valued habitat-type, frequency and intensity of impacts, research needs, and enforcement considerations. Such closures could promote scientific understanding of the effects of fishing on habitat and help determine the efficacy of MPAs.

13. A policy is a statement of goals and objectives that provides direction based on values of the people. It should be referred to frequently to ensure that decisions are consistent with the policy. Periodic review and, if necessary, revision of the policy is prudent.

ES 10.0 Some Frequently Asked Questions about the Alaska Groundfish Fisheries and this Programmatic Supplemental Environmental Impact Statement

1. What is the proposed action and how does it meet that purpose and need?

The proposed action is the continued authorization and management of the Alaska groundfish fisheries. We accomplish this by having the NPFMC and NOAA Fisheries review their past management policies and practices and consider updating these policies and practices to better reflect the future direction of the fisheries. Assuming a change is necessary, an FMP amendment will replace the current policy language with a revised policy statement. The policy statement is defined as the management approach statement and its accompanying policy objectives.

2. Is the current policy for managing the Alaska groundfish fisheries conservative and risk-averse?

Yes. Formally, there are mechanisms built into the harvest policy which minimize the likelihood of inadvertently fishing at non-sustainable fishing mortality rates. Furthermore, there are extra measures of protection that limit the overall harvest including an overall cap on the amount of quota that can be specified in a given year, seasonal and area closures, and bycatch limits. Also, the quota management system has a high level of monitoring through the observer program which tracks target and non-target species catch. Monitoring in-season catch levels allows for fishery closures to ensure that allowable species-specific catch levels (which are always specified as being below the OFL) are not exceeded.

3. Can the current management policy statement in the BSAI and GOA groundfish FMPs be improved?

We believe so. The BSAI and GOA policy statements currently in the groundfish FMPs reflect a period in history when foreign dominated fisheries occurred off Alaska. Both national and regional policy emphasis was to encourage the development and expansion of domestic groundfish fisheries. This policy goal was accomplished by the mid-1980s. Since then, other issues have risen to the forefront of the NPFMC and NOAA Fisheries. These include increased environmental awareness, the identification of bycatch, waste, and fishery allocation problems, as well as concerns over the decline of Steller sea lions and the general health of the fisheries due to overcapacity.

4. Must the NPFMC and NOAA Fisheries select the alternative that is the most protective of the physical and biological environment?

No. The NPFMC and NOAA Fisheries are free to choose any of the alternatives as long as they clearly explain the rationale for their decision. NEPA does not require a decision-maker to choose the environmentally PA. MSA requires that NPFMC and NOAA Fisheries balance conservation with needs to harvest OY from the resource. MSA requires that the NPFMC and NOAA Fisheries consider human needs as well as fishery and ecosystem needs. As long as the PA is explained, and its potential environmental consequences identified, the decision-maker is free to select any of the alternatives.

5. What actions are contained in the preferred alternative?

The PA contains two elements: 1) the policy statement and accompanying policy goals and objectives; and 2) the FMP framework, which is a range of management measures defined by two example FMP bookends. In addition to the PA, a schedule for implementation of the selected policy will also be developed by the NPFMC and will serve to illustrate the prioritization of the PA's objectives and to provide the public with a general timeline under which they can reasonably expect certain actions to occur. This timeline will be updated regularly as new issues arise and as certain initiatives and amendments are completed.

6. What is the purpose of the FMP framework and the bookends? Can the NPFMC or NOAA Fisheries go outside the bookends?

The FMP framework, comprised of two example FMPs is provided to illustrate a range of potential actions and a range of environmental consequences associated with the adopted policy statement. The FMP framework will not be included in the plan but used to better communicate to the public the NPFMC and NOAA Fisheries' intentions and overall policy direction. The FMP framework identifies a number of management tools and example applications to provide the public with the likely types of actions and measures the NPFMC and NOAA Fisheries will pursue in order to achieve the selected policy objectives. The FMP framework is provided in the Programmatic SEIS and ROD to illustrate the NPFMC's and NOAA Fisheries' commitment to implementing its policy. The NEPA advantage that we want to gain with this Programmatic SEIS, is more timely and focused preparation of NEPA documents that will analyze the effects of future plan amendment proposals and their alternatives, and ensure they are consistent with a stated policy direction. Providing an FMP framework and illustrating a range of actions and environmental consequences illustrates for the public that fishery managers require flexibility in their management program and must have the ability to adapt to changing environmental conditions or new scientific information. In the event the NPFMC and NOAA Fisheries find that a future plan amendment would fall outside the range of FMP bookends, then follow-up NEPA analyses will need to be broader in scope and will likely require more time to prepare. This was CEQ's goal in developing the Programmatic EIS concept. A Programmatic EIS would allow follow-up tiering as a way to improve efficiency in government processes.

7. **Once a preferred alternative is adopted and a Final Programmatic SEIS released, what happens next?**

   After a minimum of 30 days, NOAA Fisheries will issue its Record of Decision document. This document brings the NEPA process for the Programmatic SEIS to a close. If a new or updated policy is selected, it will contain the Agency's decision and its justification for the decision. The Record of Decision will also contain, in addition to the policy statement, an FMP framework and a set of FMP bookends that will serve to illustrate for the public the NPFMC's and NOAA Fisheries' intentions for implementing the selected policy.

8. **Is the NPFMC committing to the implementation of specific bookend measures when it adopts the preferred alternative in the Programmatic SEIS?**

   No. The example FMPs only serve to illustrate a range of actions that the NPFMC and NOAA Fisheries have defined as their best illustration of the types of actions they intend to consider in applying its policy. The Programmatic SEIS action itself does not force the NPFMC or NOAA Fisheries to take the exact actions specified in the example FMPs. The example FMPs only illustrate a range of likely management measures from which the NPFMC and NOAA Fisheries may choose to enable implementation of the selected alternative. By design, the NPFMC and NOAA Fisheries attempted to make the example FMPs different in order to capture a meaningful range of future actions. Over time, the NPFMC will initiate FMP amendments and consider alternatives for specific actions. All of these future amendments will require analysis to satisfy NEPA, MSA, Regulatory Flexibility Act, and other applicable federal law. To the extent that the proposed actions fall within the range defined in the PA, the subsequent NEPA analysis can be tiered from this Programmatic SEIS and made more focused, thereby streamlining the regulatory process.

9. **What specific management measures will be set in motion for implementation by the adoption of the preferred alternative?**

   None. With the NPFMC's final recommendation of a PA, an FMP amendment will be submitted by the NPFMC to the Secretary and reviewed under Section 304 of the MSA. If approved, the amendment would replace the old policy with a new policy statement. Specific regulations implementing that policy are not planned to be submitted with the new policy statement. However, the NPFMC and NOAA Fisheries will modify, over a reasonable time frame, the current suite of management measures to better meet the goals and objectives of the new policy statement. If they so choose, the NPFMC and the Agency may simultaneously include in the ROD proposed regulatory changes to management measures with the adoption of the PA. It is not anticipated that this will occur, however, and it is not required. The policy statement will set the stage for future actions. These future actions will most often be accompanied by fishing regulations.

10. What is the baseline that you used as a reference point for analyzing the impacts of the alternatives?

For this revised 2003 Draft Programmatic SEIS, we used 2001 and 2002 data to develop the environmental baseline. NEPA requires that the affected environment and environmental baseline be defined (see Chapter 3). Our "snapshot" of the environment is the condition that existed in 2001 and 2002, to the extent that it can be described. For the socioeconomic and seabirds analyses in Chapter 4, 2001 data were used because 2002 were not available prior to the release of the 2003 Draft PSEIS. The regulatory baseline was the BSAI and GOA FMPs in effect following the June 2002 NPFMC meeting. The baseline characterization of current conditions is more, however, than simply a snapshot through time. It takes into account past human actions and natural events that have influenced resources in various ways, leading, for example, to population declines or increases, or changes in distribution. This baseline condition was then used as the reference point when analyzing the changes that could occur if one of the alternatives, or its example FMPs were approved. More detailed description of the baseline is included in Section 3.1.4. If the alternative resulted in no significant change to the baseline, it was concluded that the alternative or its example FMP resulted in insignificant changes to the environment. In instances where potential significant impacts could occur, we identify those impacts as being either conditionally significant, or significant (beneficial or adverse).

11. Why isn't there always a difference between Alternatives 1, 2, 3, 4 and the preferred alternative for some effects?

Sometimes the alternatives result in similar impacts on a particular resource. A Programmatic EIS is a big picture environmental assessment and the geographic scale and scope of analysis is very broad. For example, the analysis of population-level impacts to the current baseline for herring resulted in the same findings for all the alternatives. All alternatives resulted in insignificant impacts on herring mortality, reproductive success, prey availability, and herring habitat. All alternatives are different in terms of predicted bycatch of herring in the groundfish fisheries, which can result in serious allocation issues, but at the population level, none of these alternatives were determined to pose a serious threat to sustainability of herring populations.

12. What FMP components have the greatest influence on the total effects of a FMP?

The analysis contained in this Programmatic SEIS has revealed that three FMP components are the principle drivers behind an FMP and that the environmental consequences for the plan as a whole are influenced most by these FMP components. For every example FMP, the most influential components affecting the outcome and overall ratings were TAC-setting (how much fish, target and bycatch, is allowed), resource and community allocation (who can fish), and spatial closures (where can they fish). All other FMP components, while important for successful management of the fisheries, were found to have relatively minor influence on the overall rating of the FMP.

13. What is the difference between "overfished" and "overfishing"?

Overfishing is the act of fishing at a higher rate than that defined as the overfishing rate. In Alaska, groundfish overfishing rates are specified as the rate that would be expected to produce the MSY. Groundfish fishing at a higher rate would constitute overfishing.

Overfished means a stock has been fished to a point where the population is below a population size threshold (commonly taken to be about one-half of the target stock size or B_{MSY}) necessary to produce the MSY on a continuing basis.

14. Will any of the alternatives result in overfishing?

No. All of the alternatives prevent overfishing by design, although the risks of overfishing do vary among alternatives, with Alternative 2 posing the highest risk and Alternative 4 the lowest risk.

15. Is it true that fishing on a stock (Bering Sea pollock for example) can actually be beneficial to the population as a whole?

If the term "beneficial" means surplus production, then yes, fishing can improve a stock's ability to increase surplus production. If a stock is at its carrying capacity, then surplus production is zero. Principles of fisheries science tell us that by reducing the size of the population, the population turnover increases and over time will produce a surplus beyond what the stock needs to sustain its population.

16. Is there uncertainty and risk to the environment as a result of authorizing the groundfish fisheries in the BSAI and GOA?

Yes there is. We do not know the full effects of commercial fishing on the environment, nor do we understand the effects of fishing on the ecosystem and its processes. We have a choice as both managers and stewards of marine resources, and as a society. We can either move forward, cautiously and carefully in our management of fisheries, or we can reduce our harvests and perhaps even suspend some or all groundfish fisheries until we know more about our environment and the effects of fishing upon that environment.

17. How is uncertainty addressed across the alternatives?

Uncertainty is accounted for through regular development of stock assessment analyses. That is, as part of the regular review of stock assessments, robustness to model assumptions is continually evaluated. While this evaluation is objective, the risks of overfishing are treated differently than the risk of under exploiting stocks. These risks are presented annually to the NPFMC before they recommend ABC levels to NOAA Fisheries. For example, model alternatives that resulted in higher ABC's for Greenland turbot in the BSAI were rejected in 2002 over concerns about the change in recruitment pattern observed on the Eastern Bering Sea shelf from resource survey data. In this case, the more conservative model alternative was selected even though the fit to the data was better for the models that were less conservative.

More formal inclusion of risk-averse policies that relate to the uncertainties both in the observation error and in recruitment variability are taken into account under Alternative 3. These allow for a constant level of risk for all stocks. A different adjustment to the maximum permissible ABC level is used for Alternative 4 (based on the lower 90 percent confidence interval). This adjustment is more ad-hoc in that it fails to have a constant level of risk-aversion for all stocks.

18. Are there environmental trade-offs in groundfish fisheries management?

Yes. NEPA defines the human environment as being comprised of the natural and physical environments and the relationship of people with those environments. This Programmatic SEIS shows that with already established fisheries, continued use of fishery resources comes at a cost to the physical and natural environment. The challenge for society that falls on to the NPFMC and NOAA Fisheries is to balance environmental protection with resource use in a manner that achieves the best combination of benefits to the human environment as a whole.

19. How are these trade-offs considered and balanced?

The MSA, ESA, MMPA, and other applicable federal law, provide standards, objectives, and requirements with which the NPFMC and the Agency must comply. Balancing all of these values and mandates forces decision-makers to identify the action that achieves as many of these requirements as possible and violate none of them. Both the MSA and NEPA specify that a public process will be undertaken when making decisions so that the process is transparent and the public have the opportunity to be informed and to participate.

20. What are the cumulative effects of groundfish fishing over the last 25 years?

Over the last 25 years, management of the groundfish fishery has undergone a transition from a primarily foreign fishery, through a brief period of joint venture, to a completely domestic fishery. Areas fished, the nature and efficiency of gear types, utilization of catch, and rates of bycatch have changed significantly. The diversity of groundfish species fished, and the volume of catch increased through the early 1990's, and has since remained stable. The value of catch has continued to increase over time. Communities that participate in or support groundfish fishing have experienced cumulative beneficial effects, particularly in proportion to other state and federal fisheries. Alaska Natives that participate in the groundfish fisheries have experienced cumulative beneficial effects for themselves and their communities. There appear to be no adverse cumulative effects of groundfish fishing on target species. Management of the fishery has become more precautionary over time and developed extensive scientific knowledge regarding target species. Human activities over time have resulted in cumulative conditionally adverse effects on various components of the ecosystem including changes in species diversity, such as whales and harbor seals, western Alaska salmon, king and Tanner crab, and some types of benthic habitat. However, there is still uncertainty regarding the contribution of the domestic groundfish fishery to past cumulative effects on the North Pacific ecosystem. As more research has become available on other management issues such as ecosystem effects, fisheries management has incorporated measures to account for them, including temporal and spatial closures, and changes in fishing techniques and gear.

21. **Do the current management policy and FMPs incorporate ecosystem-based management principles?**

    Ecosystem-based management principles include the recognition that our ability to predict ecosystem behavior is limited and that diversity is important to ecosystem functioning. The current policy and FMPs incorporate ecosystem-based management principles primarily through management strategies that incorporate uncertainty, take into account the needs of other species, and those that promote participation, fairness, and equity in policy and management. Protection measures for dominant target species, ESA-listed species, prohibited species, and forage species ensure the protection of food web components that are more well-studied than others and those that are at critical population thresholds, but may not provide sufficient protection to others with less-complete information.

22. **What alternative best incorporates ecosystem-based management principles?**

    The ecosystem-based management principles recommended by the NOAA Fisheries ecosystem advisory panel and the National Resource Council include the recognition that our ability to predict ecosystem behavior is limited and that diversity is important to ecosystem functioning. Management policies that achieve those principles are policies that incorporate uncertainty, take the needs of other species into account, and promote participation, fairness, and equity in policy and management. Although Alternative 4 policies are strong in incorporating uncertainty and taking the needs of other species into account, these do so at the expense of fishers and communities dependent on these resources. Alternative 3 and the PA appear to provide the best balance of policies that take uncertainty and the needs of other species into account while still allowing participation and equity in its regulation of humans.

23. **Do the policy alternatives comply with MSA National Standards, MMPA, and ESA?**

    The policy alternatives have been designed to take into account the requirements of all applicable federal statutes and executive orders including the MSA, MMPA, ESA, NEPA, and RFA. However, analysis has shown that Alternatives 1 and 2 may not satisfy the MSA requirement that MSSTs be specified in the FMP or the National Standard Guidelines for determining whether a stock is currently overfished or approaching an overfished definition. Under Alternatives 1 and 2, MSSTs are operationally taken into account in the management of the fisheries, but MSSTs are specified in the Stock Assessment and Fishing Evaluation documents and not the FMPs.

    Alternative 2 may satisfy ESA at the policy level, but analysis of FMP 2.1 could result in the increase in harvest levels of prey species and the reopening of a number of closed areas. Such a FMP bookend may not comply with ESA without additional Steller sea lion protection measures. In addition, depending on the application of the policies, goals, and objectives in Alternative 2, bycatch measures may not necessarily satisfy the requirements of National Standard 9, which requires that bycatch and/or bycatch mortality be minimized.

24. Do any of the policy alternatives result in fisheries harvests on Steller sea lion prey species that could adversely effect their recovery?

Yes, the Alternative 2 policy. Under FMP 2.1, the combined harvest of all three key Steller sea lion prey species were determined to likely have a population-level effect on Steller sea lions and were found to be significantly adverse. The fishing mortality rate (F) over the next 5 years of EBS and GOA pollock is expected to increase by an average of 140 percent and 100 percent, respectively, relative to the comparative baseline of 2002. Although F of EBS pollock under baseline conditions has been qualified as being "artificially low" because TAC was capped by the OY, the EBS pollock F is expected to increase by 140 percent under FMP 2.1 relative to the comparative baseline (Baseline F = .22, 5 year average F from projections; under FMP 2.1 = .44). This projected increase in the harvest of this key prey species, relative to the comparative baseline, is expected to have significant adverse effects on Steller sea lion populations.

For other key species under FMP 2.1, the BSAI and GOA Pacific cod fishing mortality rate is expected to increase by 79 percent and 64 percent, respectively, and changes in AI Atka mackerel harvest are expected to increase by 124 percent, relative to the baseline. All of these increases are considered to be significantly adverse to Steller sea lion populations.

The combined harvest of Steller sea lion prey species under FMP 2.1 meets the criteria defined for a significant adverse determination for prey availability of Steller sea lions.

Under FMP 2.2, F of EBS pollock is expected to increase by an average 69 percent and the GOA pollock will decrease by 13 percent. BSAI and GOA Pacific cod fishing mortality rate is expected to increase by 28 percent and 19 percent, respectively. Changes in AI Atka mackerel harvest are expected to increase an average of 64 percent under FMP 2.2 relative to the baseline. The combined harvest of Steller sea lion prey species under FMP 2.2 is therefore expected to result in either insignificant or significantly adverse effects to Steller sea lions for individual prey species and is rated significant adverse, overall.

25. Could any of the policy alternatives result in fisheries harvests on forage fish species that could adversely effect the recovery of short-tailed albatross?

Under FMP 2.1, the ban on directed forage fish fisheries would be repealed. If a market developed so that substantial amounts of capelin and other forage fish were harvested (along with expected bycatch of squid and other pelagic invertebrates), there would be a potential for localized depletions of prey used by short-tailed albatross. However, since short-tailed albatross primarily feed on squid and forage over vast areas of ocean, the potential effects of localized depletions of forage fish are considered minimal for this species. In addition, since the near extinction of short-tailed albatross was caused by commercial hunting rather than habitat degradation, the carrying capacity of the environment, which once supported millions of these birds, should not limit their population recovery for a long time.

26. **Do any of the alternatives result in spatial or temporal concentrations of the catch? Could this concentration adversely impact Steller sea lions, seabirds, or EFH?**

It's possible. Under Alternative 1, the groundfish trawl fishery is compressed in time and fishing occurs in areas of historically high catch rates. Whether such spatial or temporal concentrations of catch significantly harm the stocks or the environment is unknown. Our analysis of the spatial and temporal closure schemes illustrated by example FMPs 3.2 and 4.1 indicate that fishing effort would be relocated to areas where little is known about the availability of the target species. The effects of such relocation of effort on bycatch and benthic habitat are also unknown. Due to this uncertainty, the risk of causing unintentional impacts by the closures is high. Past experience has shown that bycatch of certain species could increase if the fishing fleet is forced to operate in areas it would not normally fish. It is presumed that the fishing fleet currently deploys to those open areas where the catch-per-unit-effort (CPUE) for target species is the highest. Naturally, in instances where CPUE is high for target species, bycatch rates for non-targets species or prohibited species should be low in comparison. Since the entire GOA and BSAI are not fished continuously, we expect that there are seasonal differences in stock availability and catch rates across the continental shelf. Experimental fishing or test fishing would provide some insight as to whether the target species, and their respective TACs, could be harvested in the open areas illustrated by these FMPs.

Effects of fishing on benthic habitat is currently a major topic of research. Whether redistributed effort results in adverse impacts to benthic habitat can not be determined at this time. What can be answered is that the closure scheme illustrated by example FMP 3.2 and 4.1 do result in a greater separation of the commercial fishery from Steller sea lion haulouts and rookeries as well as known seabird colony sites. What is unknown is whether such separation provides any real benefits to these marine mammals and seabirds.

27. **How does the current gear specific closure scheme compare to past years? Are we being more protective of the environment now?**

Overall, it appears that more of the EEZ or fishable area is being afforded protection today than back in the late-1970s and early-1980s. More restrictions exist today on groundfish trawling compared to 1980. However, there are fewer area restrictions on fixed gear fisheries compared to 1980. As stated in this Programmatic SEIS, it is important to realize that benthic habitat is only fully protected from fishing impacts if a closure applies to all gear types and is in effect all year. Little area in the BSAI or GOA has been designated that meets this criteria. Partial closures that permit some bottom trawling to occur negates the benefits that accrue to that benthic habitat by restricting only certain fisheries. For example, the current closures surrounding Steller sea lion rookeries and haulout sites, apply only to those fisheries that target Steller sea lion prey (e.g. pollock, Pacific cod, and Atka mackerel). Trawl fisheries targeting flatfish are permitted within these closed areas. Concerns exists that such trawl impacts on certain types of benthic habitat may require a recovery period that is not satisfied by restricting only the pollock, cod, and mackerel fisheries. Little difference between the 1980 regime and the 2002 regime exist in terms of the amount of area that is fully protected from fishing. Alternatives 3 and 4 could increase the amount of area that is fully protected from fishing by 3 to 11 percent for the EEZ, or by 8 to 29 percent for the defined fishable area. Unfortunately, there is no information to conclusively show whether fishing impacts on the benthic environment are adverse and whether meaningful benefits to the environment would accrue as a result of a modified closure scheme.

28. Can any of the TACs be fully achieved in the more precautionary or extremely precautionary policy alternatives?

Maybe. It is uncertain whether the current TACs could be taken if the fishing fleet were not permitted to fish in areas where they currently operate. Current catch levels are unlikely to be possible under Alternative 4. This is primarily because the TACs will be set much lower as a precautionary measure until scientific information is collected that would support an increase in harvest levels. This alternative would also emphasize the use of no-take marine reserves where all commercial fishing would be prohibited. The combination of reduced TACs with closures of large areas would make achieving the current TAC level difficult.

29. Will any of the alternative closure schemes prevent TACs from being achieved? If so, why?

Alternatives 3 and 4 include management measures that lead to the creation of MPAs, or areas closed to particular gear types. It is possible that areas could be created that would preclude the attainment of TACs of certain species. Whether or not the closures will actually prevent achievement of the TACs depends on the TAC levels, on the location of the specific areas created, and on the level of abundance of the species outside the closed areas. To the extent that a closed area comprises the majority of the range of a particular species, then it is less likely the TAC for that species can be attained. If TACs are reduced significantly, as could happen under Alternative 4, then, even if a closure encompasses a large portion of the natural range of a species, it may still be possible to harvest the lower TAC.

30. What alternative best mitigates the effects of fishing on EFH?

It is difficult to say. The use of closures as a management tool is probably the most effective habitat protection measure. However, with so little information currently available on the different habitat types in the BSAI and GOA, and the affect of fishing on those habitats, it is difficult at this time to determine whether benefits of a closed area outweighs the social and economic cost. Alternatives 1, 3, and 4 all have the potential of providing protection to EFH. However, it is difficult to determine if all the current areas being closed or restricted provide measurable benefits to EFH. Similarly, while our analysis of Alternatives 3 and 4 indicate that they both have the potential of increasing protection to EFH, example FMPs 3.2 and 4.1 may not provide all the benefits to EFH as originally believed and therefore they highlight the importance of making sure that the areas closed are based on the best available science.

31. Are closures good for habitat?

They can be if they are established in the right place. However, if a closure is established in an area of historically high catches, the displaced effort will relocate and it could lead to higher levels of habitat disturbance in other areas which may negate the habitat benefits of the closure.

32. What is the impact of fishing offal and discards on seabirds?

Scavenging of fishery wastes can influence seabird population trends in either direction. Processing wastes may not be adequate foods for successfully rearing chicks but abundant scavenging during winter may improve survival of immature birds and increase populations of the large, competitive gull species. On the other hand, if populations of the larger gull species increase, local populations of other species (such as kittiwakes and murres) may be reduced through increased competition for nest sites and predation pressure on their young. Sudden withdrawal of discards might cause the predatory species to increase pressure on other species long before the predator populations decline to previous levels. Research on seabird populations in the North Sea has documented numerous instances of potential relationships between offal and discards and changes in breeding populations. However, no data are available on how important these supplemental food sources might be for various seabird species in Alaska or whether there are regional differences in offal use by seabirds.

33. What is the economic value of the Alaska groundfish fisheries to the Pacific Northwest and Alaska?

The socioeconomic data currently available to NOAA Fisheries does not include data on production costs. Without information on harvesting and processing costs it is not possible to determine whether businesses are profitable, much less the magnitude of the profit or how it has been affected by regulatory changes. However, economic theory would suggest that average costs are less than or equal to gross revenues. In 2001, total revenues from processing and harvesting groundfish were estimated to have exceeded $1.5 billion. The fishery supports thousands of regional jobs in both the fishing and support service industries. Revenues generated by commercial groundfish fishing are used by federal, state, and community governments to finance valued infrastructure and community services, and as such are important parts of the Alaska and Pacific Northwest economies. Measures to collect additional socioeconomic data needed to fully answer this question are included in the PA and in Alternatives 1, 3 and 4.

34. What happened to supply and demand? In example FMP 2.1 the amount of catch increases significantly but you assume there are no changes in prices. Similarly the amount of catch decreases significantly under example FMP 4.1 but again it does not appear that prices change. Shouldn't prices change as a function of supply and demand?

The analysis does not attempt to measure any price changes that may result from regulation of the groundfish fisheries. Evidence from the market for groundfish suggests that most groundfish products are shipped to foreign markets and markets in the "lower-48," where they compete with other seafood products and other sources of animal protein. As a result of the presence of a large number of substitutes for Alaska groundfish products, the demand curve for these products is relatively elastic. In other words, prices for groundfish products are unlikely to be significantly influenced by changes in groundfish harvests in Alaska. The absence of a price change would have a negative impact on participants in groundfish fisheries because little, if any, of their loss from harvest declines will be compensated for by a price rise.

35. Why do we prohibit harvesters that use specific gear types from retaining halibut and salmon, regardless of whether the fish are alive or dead? Can't we give the fish that would be discarded to food banks?

The purpose of PSC limits is to eliminate or substantially reduce the incentive for vessels to harvest certain non-groundfish species that are harvested in other domestic fisheries. At the same time, these restrictions recognize that some level of incidental catch of prohibited species can not be avoided without eliminating many groundfish fisheries. Amendment 28 to the BSAI FMP and Amendment 29 to the GOA FMP authorize a voluntary donation program for fish taken as bycatch in the groundfish trawl fisheries off Alaska. The seafood is distributed to economically disadvantaged individuals by tax-exempt organizations through a distributor authorized by NOAA Fisheries. Currently, the authorized distributor is Northwest Food Strategies (NFS), a 501 (c) 3 non-profit organization. NFS accesses seafood products for distribution to the America's Second Harvest network of 200 food banks and food-rescue organizations. Since it's inception in 1994, NFS has grown into the leading supplier of seafood to hunger-relief organizations in the country. The fish voluntarily donated by the groundfish fishing industry to NFS are salmon and halibut that are part of the groundfish fishery PSC. The salmon and halibut retained and donated under the NOAA Fisheries Prohibited Species Donation Program represent a small but significant portion of the seafood distributed by NFS. It is estimated that catcher processor companies donate one million seafood meals annually to provide hunger relief.

36. I live in Sandpoint, Alaska and I don't see anything in the Programmatic SEIS about the importance of groundfish to my community nor is there anything on the impact of the alternatives on my community. Will this shortcoming be addressed?

Because of the geographic scope of the Alaska groundfish fisheries, much of the social impact assessment information in the main body of the document is provided at the regional level. Community differences are highlighted in each discussion area, but much more detail on Sand Point itself and other fishing communities may be found in the *Interim Updates of Sector and Community Profiles*, on the NPFMC website at www.fakr.noaa.gov/npfmc. This document, incorporated by reference into the Programmatic SEIS, contains a detailed groundfish oriented profile of many of the fishery dependent communities including Sand Point. The profiles describe community engagement in, and dependence upon, the groundfish fishery. In terms of impacts of the alternatives to the community of Sand Point, quantitative information cannot be provided at the community level due to data confidentiality restrictions. However, the discussion of impacts to the Alaska Peninsula and Aleutian Islands region as a whole are applicable to Sand Point, and provide information on the nature, direction, and magnitude of the impacts that would be felt in the community.

37. I run a fuel supply business operating in Dutch Harbor and Bellingham, how can I tell what the impacts of the Programmatic SEIS will be on me?

As noted in the Chapter 4, the impact to support service sector businesses are likely to be somewhat different than the impacts to direct fishery sector businesses, depending on the specific alternative chosen. Both direct and support sector business activity is assumed to remain near to or exceed existing conditions levels under Alternatives 1 and 2, and both direct and support sectors are expected to decline under Alternative 4. Assuming your business varies with the volume of fishery activity in the region, you may be able to roughly gauge increases or decreases in demand by looking at the overall percentage change in regional indicators under those alternatives. Under Alternative 3, however, the outcomes for direct and support sectors may vary. As discussed in Chapter 4, support sector businesses (and some coastal communities that have large support sectors) that derive benefits from seasonal peaks (and the economic inefficiencies) of current race-for-fish fisheries could experience adverse impacts under rationalization conditions, at least in the short term during a transition to a lower if more stable level of employment.

Unalaska/Dutch Harbor has a relatively well developed support service sector that supports all major fishing industry segments, and this sector derives marked benefits from the current economic inefficiency within the fishery. It is relatively expensive to provide services in the community, but under conditions where it is important to minimize down time during a fishing season, services that cost more in Unalaska/Dutch Harbor than some other places (but are available on a more timely basis) are often deemed well worth the trade-off by fishery participants. Under a rationalized fishery, cost considerations become relatively more important (as the relative cost of time away from the fishing grounds decreases), giving service purchasers more options (to the possible detriment of providers in relatively remote locations). How your particular business changes as a result of fishery management changes depends, of course, to a large extent on the adaptability of the business to changed circumstances, which in turn depends on the relative economics of your business compared to other local providers of the same service.

38. In several of the alternatives, the concept of "rights-based management" appears. What is rights-based management?

A "rights-based management" approach to controlling harvesting and processing capacity in fisheries relies on incentive adjusting methods, such as the allocation of shares of the TAC to specific individuals or groups. With secure "rights" to specific quantities of fish, there is no incentive for fishermen to invest in ever more elaborate vessels or equipment—or, to be more precise, to select anything but the least cost combination and deployment of fishing inputs. In other words, rights-based management systems (in which rights are freely transferable) are "self-rationalizing" systems. Redundant capital is removed from the fishery as more efficient operations purchase the rights of less efficient operations. In economic theory, the less efficient operations, having sold their rights to participate, will exit the fishery and shift their labor and capital to some underutilized fishery or into an entirely different segment of the economy. The result is a net gain to society in the form of a reduction in costs and an increase in production. For more information on rights-based management in the groundfish fisheries, please see the QA paper on overcapacity in Appendix F-8.

39. Does "rights-based management" give an exclusive right to some individuals while keeping out others? Why are we giving away the public resource?

The MSA refers to an IFQ as an exclusive "fishing privilege," rather than a right. In specific reference to authorizing IFQs or other limited access systems, the MSA states that such an authorization, "(A) shall be considered a permit for the purposes of sections 307, 308 and 309; (B) may be revoked or limited at any time in accordance with this Act; (C) shall not confer any right of compensation to the holder of such IFQ or other such limited access system authorization if it is revoked or limited; and (D) shall not create, or be construed to create, any right, title, or interest in or to any fish before the fish is harvested" [Sec. 303(d)(3) 16 USC 1853(d)].

40. Won't "rights-based management" result in windfall gains (or the appearance of windfall gains) to permit holders from the reallocation of a public asset to private holdings?

First, it is important to recognize that our nation's fishery resources are given away at no charge when fisheries are managed through open access. Nevertheless, a potential and frequently anticipated effect of rights-based management is the provision of an apparent windfall profit (i.e., the ability to sell quota shares for which they did not have to pay) to the initial permit holders. Anyone receiving quota shares without explicit payment receives an increase in tangible wealth. The increased value of this wealth due to the efficiencies of the rationalization program is often seen as the source of windfall profits. Various mechanisms, such as the auctioning of quota shares or making them taxable, have been suggested to reduce or eliminate windfall profits and to recover for the nation the fair market value for private use of the natural resource. However, the MSA explicitly prohibits such mechanisms (as Sec. 304 (d) has been interpreted by NOAA Fisheries). There are differing viewpoints as to whether the MSA should be modified to allow an auction system or the imposition of taxes and, if so, how such authority should be utilized. Currently the sablefish IFQ cost-recovery program is authorized to collect up to two percent of the ex-vessel value of sablefish to pay for the costs of administering the program. Additionally, specific measures in PA and Alternative 3 would include a cost recovery program, and it is conceivable that if rights-based management measures were to be approved under Alternative 1, they would also include cost-recovery mechanisms.

41. Why not let the race for fish continue? If boats and processors can't make it, then they'll go out of business-that's the American way?

The "race for fish," in which each fisherman is motivated to be the first to capture fish, is undesirable because it usually leads to excess harvesting and processing capacity. The problems of excess capacity have been summarized by Kirkley and Squires (1999): *[Excess capacity] generates intense pressure to continue harvesting past the point of sustainability in order to keep as much of the fleet working as possible. With revenues spread among many vessels operating under little or no profits, reductions in fleet size become politically and socially more difficult. Vessels are more vulnerable to changes in the resource base and regulations when they are only marginally viable because of excess capacity. Excess capacity encourages inefficient allocation and constitutes a major waste of economic resources. Overcapitalization and excessive use of variable inputs follow. Excess capacity also complicates the fishery management process, particularly in open access, frequently leading to detailed and comprehensive regulation. Excess capacity substantially reinforces the increasing tendency for* *management decisions to become primarily allocation decisions, i.e. decisions about the gainers and losers of wealth and profits (or losses) from alternative management choices over an overfished or even declining resource stock.* For more information on the effects of the race for fish and the problem of excess capacity in the groundfish fisheries, please see the Qualitative Analysis paper on overcapacity (Appendix F-8).

42. What is the difference between bycatch, incidental catch, and discards?

The terms "bycatch" and "incidental catch" are often used interchangeably by fishermen and the public when referring to the catch of groundfish or other species that is taken incidentally when targeting other fish species and thrown away. However, legally, the two terms mean different things. The term "incidental catch" is defined by federal regulations (50 CFR 679.2) and refers to that catch that is taken while targeting some other species but is retained and used (e.g., cod taken in a pollock fishery). "Bycatch" is defined by the MSA as the portion of the catch that is not used and discarded. This discarded incidental catch may include regulatory discards defined by the MSA as fish harvested but are required by regulation to be discarded whenever caught (e.g., in Alaska these species are called "prohibited species"); and fish species that are undesirable and have no market, such as sculpins and skates. The MSA further defines economic discards as fish which are targeted in a fishery but are not retained because they are of an undesirable sex, size, or of poor quality.

43. Why does the analysis indicate that right-based management will lead to reductions in bycatch and incidental catches? What evidence exists that leads to this conclusion?

With a rights-based management program, as evaluated in the example FMP bookend 3.2, it is assumed that individual fishing vessels would be held accountable for their total catch of target species, prohibited species, and the non-specified species. For the target and prohibited species categories, each fishing vessel would receive species specific allocations which it could either use directly in its own fishing activities or transfer to another fishing operation. For the non-specified species category, there would not be allocations to individual fishing operations; however, the catch of these species would be counted against a fishing operation's total allocation of target species. Therefore, there would be an opportunity cost borne by the fishing operation for its catch of each of these three types of species. This management scenario would provide each fishing operation with an increased incentive to develop a fishing strategy that will decrease catch of species which would not be retained.

In addition, rights-based management will tend to decrease the cost of developing and using fishing strategies that decrease discards. This is the result of eliminating the "race for fish" as the allocation mechanism. The race for fish increases the opportunity cost of using fishing strategies that decrease the rate at which a vessel can harvest fish. For example, the time lost searching for areas with lower bycatch rates may be prohibitive in the very short season that can occur due to the "race for fish" style season. As experienced in the Alaska sablefish and halibut IFQ fisheries, elimination of the "race for fish" will result in an increase of the length of time a fishing vessel has to profitably retain catch that would otherwise be discarded.

One other benefit of rights-based management: fishermen are given better business "signals" from this type of management program; therefore, they tend to make better decisions that are more appropriate from society's perspective. This is the result of internalizing what had been external costs and benefits (i.e., costs and benefits that do not accrue to the fishing operation as a result of the fishing strategy it selects). The specifics of the rights-based system will determine the types of externalities that are addressed and the extent to which they are internalized. Such externalities are the source of a variety of fishery management problems, including excessive levels of discards. Therefore, example FMP 3.2 is expected to decrease discards by at least partially internalizing what are currently the external costs and benefits of decreasing discards.

44. Our community is completely dependent on the fishing and processing industry, however the regional impact analysis for the region I live in has lower income and employment multipliers than other regions that are less dependent on fishing. Are your multipliers correct?

The income and employment multipliers used in the regional effects analysis in this Programmatic SEIS are based on the most current information available from IMPLAN®, an input-output analysis software program that is generally regarded to provide accurate results. The multipliers indicate the additional income and employment that will be generated when industries produce and export their product outside the region. Multipliers will be higher in regions that produce a wide variety of potential inputs to the industry in question. If, for example, the fishing industry in a region purchased all of it vessels and engines from a local manufacturer the multiplier for the fishing industry would account for the additional jobs created in the vessel and engine manufacturing sectors. If instead, the industry purchases its vessels and engines from outside the region, jobs and income in some other region are affected rather than in the region itself. From this perspective, the more dependent a region is on a single industry, the lower its multipliers. Thus, the multipliers in Aleutian Islands are lower than the multipliers for southcentral Alaska.

45. How are environmental benefits such as viewing sea lions accounted for and compared to the benefits from the commercial harvesting and processing of fish?

The economic analysis contained in this Programmatic SEIS discusses the full range of benefits that the BSAI and GOA marine ecosystems and species associated with them (including sea lions) provide to the American public. Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. While there are difficulties in estimating the value the public places on protecting ecological conditions, the analysis provides a qualitative discussion of possible benefits provided by the BSAI and GOA marine ecosystems. In addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing. Furthermore, some people may not directly interact with the BSAI and GOA marine ecosystems and the various species associated with them but derive satisfaction from knowing that the structure and function of these ecosystems are protected. For more information on the range of benefits these marine ecosystems provide, please see Section 3.9.7.

46. **In your assessment of non-market, recreational and tourism values, you indicate that the effects of FMP 1 are insignificant. I don't consider myself an environmentalist, but I am concerned about the effects of fishing on the endangered stock of Steller sea lions. If fishing has a negative effect on Steller sea lions how can the rating of FMP 1 be insignificant?**

    The significance ratings for each example FMP studied in this Programmatic SEIS are based on the question of whether there will be a significant change to the baseline at the population level as a result of the FMP. It does not mean that the NPFMC or the Agency is satisfied with the current state of the environmental baseline. For example, FMP 1 would continue the current suite of Steller sea lion protection measures to avoid jeopardy and adverse modification to their critical habitat. We have determined that FMP 1 would not significantly change the current management of the fisheries and so there would be no predicted beneficial or adverse change to the recovery plan currently in place. It is predicted that measures contained in example FMPs 3 and 4 would more likely result in changes believed positive to the recovery of Steller sea lions and so these FMPs received a conditionally significant beneficial rating.

47. **I operate a small 58 ft trawler. Although I favor the rationalization measures in Alternative 3, the closures that are also included are likely to make it impossible for me to operate. The impact analysis seems to underestimate the impacts of these closures. How come, and is there any way these shortcomings can be addressed?**

    Data necessary to make reliable quantitative projections of the impacts of closed areas were unavailable for use in the Programmatic SEIS. The illustrated closures used in this Programmatic SEIS are examples and only used for purposes of analysis. Adoption of a PA will not necessarily lead to implementation of these closures. The Programmatic SEIS analysis uses the illustrations to provide insight into the likely effects of closures. These effects can be used to highlight concerns and shape management policy. At such time in the future that specific closed areas are proposed following adoption of a PA, it is hoped that improved habitat data will allow for reliable quantitative estimates to be developed. Estimates of the percentage of catch by species that occurred in the proposed closed areas during the baseline period are shown in the habitat analysis of the alternatives. It is assumed that catch that is foregone in closed areas will be available to fishermen in areas that remain open because fish are mobile and generally widely dispersed. Our analysis shows that if this is true, smaller vessels could be affected to a greater degree compared to large vessels if the proposed closed areas are close to shore where small vessels often are forced to operate due to safety concerns.

48. **Can any of the policy alternatives adversely impact subsistence?**

    Yes. Groundfish fisheries managed under Alternative 2 could produce adverse indirect and cumulative effects on subsistence salmon harvests by increasing the bycatch of chinook and chum salmon in the BSAI, and by increasing the likelihood for fishery disturbance and competition for prey with Steller sea lions, a marine mammal used for subsistence. Alternatives 3 and 4, and the PA while potentially providing direct benefits to subsistence users by reducing salmon bycatch and reducing disturbance to Steller sea lions, are not enough to overcome the cumulative adverse effects of both human and natural events on Yukon-Kuskokwim River salmon stocks.

49. Do any of the alternatives adversely impact minority populations?

Yes, there are three potential effects of the groundfish fisheries on minority populations: adverse effects on Alaska Natives related to subsistence harvests; adverse affects on CDQ groups and other Alaska Natives participating in the groundfish fishery; and adverse effects on other minority populations participating in the groundfish fishery. Alternatives 2 and 4 appear to produce the most significant adverse effects on minority populations in Alaska. Alternative 2 will have potential adverse effects on subsistence harvests by Alaskan Natives of salmon (increasing salmon bycatch) and Steller sea lion (increasing disturbance and competition for prey). Alternative 4 , which could significantly reduce groundfish TACs will have adverse effects on Alaska Natives participating in groundfish fisheries and Alaska Native communities that are economically dependent on those fisheries by reducing or eliminating their participation on the groundfish fishery. The alternative would also have adverse effects on minority populations employed in fish processing as a result of reduced groundfish TACs.

50. Of the policy alternatives, which are most dependent on new research and scientific information?

All of the policy alternatives require some level of research and monitoring. However, Alternatives 3 and 4 and the PA each require increased levels of research and monitoring, beyond the current program, to fully achieve their respective policy goals and objectives. A description of ongoing, planned and recommendations for future research is provided in Chapter 5 of this Programmatic SEIS.

ES 11.0 Areas of Controversy and Issues to be Resolved

This Final Programmatic SEIS completes NOAA Fisheries' comprehensive review of the Alaska groundfish fisheries, its management regime, and its impact on the marine environment. It is the work product of countless meetings, scientific analysis, and thousands of public comments. NOAA Fisheries has attempted in every way, to listen, document, and consider all points of view and all sources of scientific information as well as local and Traditional Knowledge. The PA moves fishery management toward a more formalized ecosystem-based approach to management of the Alaska groundfish fisheries that is more precautionary when faced with uncertainty, as well as balanced, using the MSA National Standards as a guide, in ensuring sustainable fisheries for generations to come. Still, issues and controversy remain.

Section ES 5.1 (and Section 1.5 in the Final PSEIS) provides a list of ten issues that were identified as being the most important. These issues focus on the effects of commercial groundfish fishing on various components of the marine ecosystem. Each of these issues were addressed to the best of our ability in this Programmatic SEIS. However, it is clear that there is lack of consensus on our findings.

Throughout this document we have mentioned that our understanding of these issues and potential fishery-caused effects is made very difficult due to our lack of knowledge of how the marine ecosystem works and all of its internal processes. We have made few findings where we can conclude in a definitive manner, that the effects of fishing on a resource or ecosystem component is adverse (or beneficial). In many cases, we had to rely on qualitative analysis and the professional judgement of fishery scientists in reaching a finding. Until more environmental data are collected and until a number of information gaps are filled, analysts will always face controversy and differing opinions on these issues.

Two issues overlay all the environmental issues analyzed and still remain to be resolved. The first issue centers on the concept of environmental risk and uncertainty. How should managers respond to situations where the environmental impact of a proposed action is not known and where there is a great deal of uncertainty, both in the data collected as well as in our ability to predict future outcomes? How should managers apply the precautionary principle when making management decisions? The PA would reduce the risk of environmental harm by adopting measures that would mitigate against adverse impacts. Such measures would be monitored and if new data indicate they are not working as intended, the NPFMC and NOAA Fisheries would adapt the management regime accordingly. Controversy among various stakeholders is anticipated over the measures to be employed. We expect that the analysis of those proposed measures will be thorough and based on the best scientific information available. It is doubtful that a broad consensus among stakeholders can be reached on this issue until more environmental data are available.

The second issue focuses on the term ecosystem-based management. What does this truly mean? This issue is currently receiving national attention and scientific debate. How should resource managers apply ecosystem-based management principles? We have attempted, through this Programmatic SEIS, to inform the public on this subject. We anticipate that over the next few years, the American public will come to understand this concept more fully and we will begin to finds ways to incorporate this concept into our fishery management plans. The PA sets the stage for this debate and commits to its implementation once it is better defined and analyzed. NOAA Fisheries encourages the public to be full participants in the MSA-

NPFMC process by staying involved. This is accomplished by volunteering to serve on working groups and committees, by developing new ideas and management proposals consistent with the FMPs new policy goals and objectives, and by sharing in the responsibility for how these resources are to be managed.

ES 12.0 What Are the Next Steps in the Programmatic Supplemental Environmental Impact Statement Process?

This executive summary is a snapshot of the contents of the final Alaska Groundfish Fisheries Programmatic SEIS. Following release of the final PSEIS to the public in June 2004, the Agency will make its decision concerning the reauthorization of the Alaska groundfish fisheries. NOAA Fisheries will issue its Record of Decision no later than September 1, 2004. This decision document will conclude the NEPA process on the proposed action. For updates on the Programmatic SEIS and to obtain a copy of the Record of Decision, visit the NOAA Fisheries website at www.fakr.noaa.gov.

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Alaska Groundfish Fisheries
Final Programmatic SEIS

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ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code
ABC	Acceptable Biological Catch
ACC	Alaska Coastal Current
AD	Automatic Differentiation
ADCED	Alaska Department of Community and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AEB	Aleutians East Borough
AFA	American Fisheries Act
AFSC	Alaska Fisheries Science Center
AKAPAI	Alaska Peninsula and Aleutian Islands
AKKO	Alaska Kodiak Region
AKR	Alaska Region
AKSC	Southcentral Alaska
AKSE	Southeast Alaska
ANCSA	Alaska Native Claims Settlement Act
ANHSC	Alaska Native Harbor Seal Commission
AP	Advisory Panel
APA	Administrative Procedure Act
APAI-SP	Alaska Peninsula and Aleutian Islands Shore Plant
APEC	Asia Pacific Economic Cooperation
APICDA	Aleutian Pribilof Island Community Development Association
A-R-S-O	Atka Mackerel-Rockfish-Sablefish and Other Groundfish Species
AYK	Arctic-Yukon-Kuskokwim
B	Biomass Proxy Value
BBEDC	Bristol Bay Economic Development Corporation
BiOp	Biological Opinion
BRD	Biological Research Division
BSAI	Bering Sea and Aleutian Islands
BSP	Bering Sea Pollock
BSP-SP	Bering Sea Pollock Shore Plant
BTLC	Bird Treatment and Learning Center
CS-	Conditionally Significant Adverse
CS+	Conditionally Significant Beneficial
CAFF	Conservation of Arctic Flora and Fauna
CAR	Comment Analysis Report
CBSFA	Central Bering Sea Fishermen's Association
CCAMLR	Convention for the Conservation of Antarctic Marine Living Resources
CDQ	Community Development Quota
CEQ	Council on Environmental Quality
CFEC	Commercial Fisheries Entry Commission
CFIVSA	Commercial Fishing Industry Vessel Safety Act
CFR	Code of Federal Regulations
CFZ	Contiguous Fishing Zone

ACRONYMS AND ABBREVIATIONS (Cont.)

CG	Central Gulf of Alaska
CH	Critical Habitat
CIMMC	Cook Inlet Marine Mammal Commission
cm	Centimeter
cm/sec	Centimeters per Second
CMSA	Consolidated Metropolitan Statistical Area
COAR	Commercial Operations Annual Report
CP	Catcher Processor
CPUE	Catch-Per-Unit-Effort
CV	Catcher Vessel
CVM	Contingent Valuation Method
CVRF	Coastal Villages Region Fund
CWT	Coded Wire Tag
CZMA	Coastal Zone Management Act
°C	Degrees Celsius
DAH	Domestic Annual Harvest
DAP	Domestic Annual Processing
DCED	Alaska Department of Community and Economic Development
DCPL	Daily Cumulative Production Logbook
DDT	*Para*-dichlorodiphenyltrichloroethane
DFA	Directed Fishing Allowance
DNA	Deoxyribonucleic Acid
DOC	Department of Commerce
DPS	Distinct Population Segment
DSR	Demersal Shelf Rockfish
E	East
EA	Environmental Assessment
EAI	Eastern Aleutian Islands
EA/RIR	Environmental Assessment and Regulatory Impact Review
EBS	Eastern Bering Sea
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EFP	Exempted Fishing Permit
EG	Eastern Gulf of Alaska
EIS	Environmental Impact Statement
EIT	Echo-Integrated-Trawl
EJ	Environmental Justice
ENSO	El Niño - Southern Oscillation
EO	Executive Order
EPA	Environmental Protection Agency
EPAP	Ecosystem Principles Advisory Panel
EPIRB	Emergency Position Indicating Radio Beacons
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
EVOS	*Exxon Valdez* Oil Spill
F	Fishing Mortality Rate
FAO	Food and Agriculture Organization

ACRONYMS AND ABBREVIATIONS (Cont.)

FEIS	Final Environmental Impact Statement
FEP	Fisheries Ecosystem Plan
FGCV	Fixed Gear Catcher Vessel
FIM	Fisheries Industry Model
FLAT	Flatfish
FLP	Floating Inshore Processor
FMP	Fishery Management Plan
FMU	Fisheries Management Unit
FOCI	Fisheries Oceanography Coordinated Investigation
FPA	Federal Power Act
FR	Federal Register
FRFA	Final Regulatory Flexibility Analysis
ft	Feet/Foot
FT-CP	Fillet Trawl Catcher Processor
FTE	Full-Time Equivalent
FWCA	Fish and Wildlife Coordination Act
FY	Fiscal Year
G&H	Gut-and-Head
GEF	Global Environmental Facility
GFOP	Groundfish Observer Program
GHL	Guideline Harvest Level
GLM	Generalized Linear Model
GOA	Gulf of Alaska
H&L	Hook-and-Line
HACCP	Hazard Analysis and Critical Control Point
HAPC	Habitat Area of Particular Concern
HT-CP	Head-and-Gut Trawl Catcher Processor
HMAP	Halibut Mortality Avoidance Program
I	Insignificant
IAI	Impact Assessment, Incorporated
ID	Identification
IFQ	Individual Fishing Quota
IMALF	Incidental Mortality of Albatross in Longline Fisheries
INPFC	International North Pacific Fisheries Commission
IPHC	International Pacific Halibut Commission
IRFA	Initial Regulatory Flexibility Analysis
IR/IU	Improved Retention/Improved Utilization
ISO	International Organization for Standardization
ISWG	Interagency Seabird Working Group
IUNC	International Union for Conservation of Nature
IWC	International Whaling Commission
JV	Joint Venture
JVP	Joint Venture Processor
kg	Kilogram
KIB	Kodiak Island Borough
km	Kilometer

ACRONYMS AND ABBREVIATIONS (Cont.)

km^2	Square Kilometers
K-SP	Kodiak Shore Plant
L-CP	Longline Catcher Processor
LCV	Longline Catcher Vessel
LL	Lower Limit
LLP	License Limitation Program
LOA	Length Overall
LP	Linear Programming Constrained Optimization Algorithm
m	Meter
MARPOL	International Convention for the Prevention of Pollution from Ships
mb	Millibar
MCA	Marine Conservation Alliance
mi^2	Square Miles
µM	Micrometer
M	Mortality
mm	Millimeter
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
MRA	Maximum Retainable Amount
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSST	Minimum Stock Size Threshold
MSY	Maximum Sustainable Yield
mt	Metric Ton
N	North
NAS SF	National Academy of Sciences Policy Recommendations for Sustainable Fisheries
NEPA	National Environmental Policy Act
NFS	Northwest Food Strategies
NFWF	National Fish and Wildlife Foundation
NIOSH	National Institute for Occupational Safety and Health
nm	Nautical Mile
nm^2	Square Nautical Miles
NMFS	National Marine Fisheries Service
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Marine Fisheries Service
NORPAC	NOAA Fisheries Observer Database
NPAFC	North Pacific Anadromous Fish Commission
NPFMC	North Pacific Fishery Management Council
NPFVOA	North Pacific Fishing Vessel Owner's Association
NPI	North Pacific Index
NPO	North Pacific Ocean
NPOA	National Plan of Action
NPRB	North Pacific Research Board
NRC	National Research Council
NS&T	National Status and Trends Program
NSEDC	Norton Sound Economic Development Corporation

ACRONYMS AND ABBREVIATIONS (Cont.)

NSG	National Standard Guidelines
NTE	Not To Exceed
OCSEAP	Outer Continental Shelf Environmental Assessment Program
OFL	Overfishing Level
OMB	Office of Management and Budget
OPA	Oil Pollution Act
ORCO	Oregon Coast
OSCURS	Ocean Surface Current Simulations
OY	Optimum Yield
PA	Preferred Alternative
PBR	Potential Biological Removal
PCB	Polychlorinated Biphenyl
PCC	Pollock Conservation Cooperative
PCOD	Pacific Cod
P-CP	Pot Catcher Processor
PCV	Pot Catcher Vessel
PFMC	Pacific Fishery Management Council
PICES	North Pacific Marine Science Organization
PLCK	Pollock
POP	Pacific Ocean Perch
PRA	Paperwork Reduction Act
PRD	Protected Resources Division
PRR	Product Recovery Rate
PSC	Prohibited Species Catch
PSG	Pacific Seabird Group
PSMFC	Pacific States Marine Fisheries Commission
PSR	Pelagic Shelf Rockfish
psu	Practical Salinity Unit
PWS	Prince William Sound
QA	Qualitative Analysis
RACE	Resource Assessment and Conservation Engineering
RD	Regional Direction
RFA	Regulatory Flexibility Act
RFMC	Regional Fishery Management Council
RIR	Regulatory Impact Review
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RPN	Relative Population Number
RPW	Relative Population Weight
R/V	Research Vessel
S-	Significantly Adverse
S+	Significantly Beneficial
SAFE	Stock Assessment and Fishery Evaluation
SC-SP	Southcentral Alaska Shore Plant
SEBSCC	Southeast Bering Sea Carrying Capacity
SEIS	Supplemental Environmental Impact Statement

ACRONYMS AND ABBREVIATIONS (Cont.)

SEO	Southeast Outside
SE-SP	Southeast Alaska Shore Plant
SFA	Sustainable Fisheries Act
SIAWG	Seabird Inter-Agency Working Group
SoC	Secretary of Commerce
SP	Shore Plant
SPELR	Shoreside Processor Electronic Logbook Report
SPR	Spawning Biomass Per-Recruit
SSC	Scientific and Statistical Committee
SSL	Steller Sea Lion
ST-CP	Surimi Trawl Catcher Processor
STWG	Seabird Technical Working Group
TAC	Total Allowable Catch
TALFF	Total Allowable Level of Foreign Fishing
TCV	Trawl Catcher Vessel
U	Unknown
UL	Upper Limit
U.S.	United States
USGS	U.S. Geological Survey
U.S.S.R.	Union of Soviet Socialist Republics (Soviet Union)
USC	United States Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS/BRD	U.S. Geological Survey/Biological Resource Division
VDE	Voluntary Dockside Examination
VIP	Vessel Incentive Program
VMP	Vessel Monitoring Program
VMS	Vessel Monitoring System
W	West
WAIW	Washington Inland Waters
WG	Western Gulf of Alaska
WPR	Weekly Production Report
WSGP	Washington Sea Grant Program
YDFDA	Yukon Delta Fisheries Development Association

GLOSSARY

abiotic: not living.

acceptable biological catch (ABC): the range of allowable catch for a species or species group set by a scientific calculation of the sustainable harvest level of a fishery; a target reference point that management aims to achieve.

advection: horizontal or vertical movement of a mass of fluid, i.e. air or ocean current.

advisory panel (AP): a group of people appointed by a fisheries management agency to review information and give advice. Members are usually not scientists, but most are familiar with the fishing industry or a particular fishery.

alcids: small birds that fly with rapid wing beats and use their wings to swim underwater.

Alaska Coastal Current: a persistent flow of buoyant water circumscribing the inner shelf of the Gulf of Alaska shelf over 2000 km from its origin in the southeastern Gulf of Alaska to where it enters the Bering Sea in the southwestern gulf.

Alaska Current: the shallow, highly variable, eastern limb of the counterclockwise-flowing subpolar gyre in the North Pacific

Alaska Stream: the steady, swift current that flows westward approximately 150 km from the coast and reaches to the ocean floor.

albedo: the fraction of light radiation that is reflected by a body, as the moon or a cloud.

alkanes: any of numerous saturated, non-aromatic hydrocarbons; any of a series of open-chain hydrocarbons such as methane and butane.

American Fisheries Act (AFA): enacted 1998, this act requires the determination of whether vessels of 100 feet or greater in registered length comply with the new ownership, control and financing requirements imposed, thereby demonstrating eligibility to receive a fishing endorsement.

amphipods: small crustaceans with flat bodies.

GLOSSARY (Cont.)

anadromous: fish that migrate from saltwater to fresh water to spawn.

anal fin: the fin that lies behind the anus, usually on the back half of the fish.

annelids: long, segmented invertebrates that have a coelom. (e.g., earthworms, various marine worms, and leeches).

anomalous: inconsistent with or deviating from what is usual, normal, or expected.

anoxic: oxygen deficient.

anthropogenic: of or relating to the study of the origins and development of human beings.

anthozoans: sessile marine coelenterates including solitary and colonial polyps; the medusoid phase is entirely suppressed.

apex feeders: those who feed at the top of the food chain.

appendicularia: free-swimming tadpole-shaped tunicate resembling larvae of other tunicates.

aromatic hydrocarbons: a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances.

arthropods: invertebrate animals such as crabs that have segmented bodies and jointed appendages, and an exoskeleton.

austral winter: winter in the southern hemisphere.

avian: pertaining to or characteristic of birds.

avifauna: the birds of a region or environment.

B: see *biomass*.

B_0: biomass at the starting point of a population at its original or pristine level.

B_{MSY}: the average biomass that would be achieved if fishing continued at a constant fishing mortality rate resulting in the maximum sustainable yield.

barnacle: a marine crustacean with feathery appendages for gathering food, free-swimming as larvae but permanently fixed (as to rocks, boat hulls, etc.) as an adult.

baroclinic: a state in which water surfaces of equal density are influenced by those of equal pressure.

barotropic: a water state in which surfaces of pressure and density coincide at all levels; depth-independent circulation due to changes in surface elevation.

basal metabolic rate: the rate at which heat is given off by an organism at complete rest.

bathyal: refers to organisms or phenomena at depths between 200 & 4000 meters, on the sea bottom; often coincident with the continental slope.

Bathylagidae: Family of fishes in the Class: Actinopterygii; distribution includes the Atlantic, Indian and Pacific Oceans. Physical characteristics include: Adipose fin may be present or absent.

bathylagids: deep-sea smelts.

bathymetric: water depth measurement.

benthic: portion of the marine environment inhabited by marine organisms that live permanently in or on the bottom.

benthic substrate: the base on which an organism lives.

benthypelagic: suspended in the water column near the bottom.

benthos: organisms that live on or in the bottom of a body of water.

Bering Sea Gyre: a barotropic, counterclockwise gyre of the Aleutian Basin.

Bering Slope Current: a counter-clockwise flow with an eastern boundary current at the shelf edge

biennial: occurring every second year.

bioaccumulation: an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment.

biogenic: produced by living organisms.

biomarker: a distinctive usually biochemical indicator of a biological or geochemical process or event.

biomass (*B*): amount of living matter per unit of water surface or volume expressed in unit weight .

biota: all the plant and animal life of a particular region.

biotic: living or related to living units.

biphenyls: a white crystalline hydrocarbon used especially as a heat-transfer medium ($C_6H_5 \cdot C_6H_5$.)

bivalve: having a shell composed of two valves.

boreal: of or located in northern regions.

brash ice: floating ice found between the year's first ice floes and made up of fragments from other ice forms.

bryozoan: one of a phylum of minute, mostly colonial aquatic animals, with body walls often hardened by calcium carbonate and growing attached to aquatic plants, rocks and other firm surfaces.

butyltins: organic tin compounds in either single, double, or triple forms and used to inhibit the growth of unwanted organism such as bacteria, algae, and barnacles.

bycatch: harvested species other than that for which the fishing gear was set. Also called *incidental catch*, bycatch is sometimes kept for sale (does not include fish released alive under a recreational catch-and-release program).

C: degrees Celsius.

calanoid (e.g., copepod): large copepod easily recognized by its longer-than-body antennae.

California Current: the eastern limb of the clockwise flowing subtropical gyre in the North Pacific.

cannibalistic: the eating of the flesh of an animal by another animal of the same kind.

caprellid: a species of amphipods commonly known as skeleton shrimp.

carapace: a bony case or shield covering the back or part of the back of an animal as a turtle or crab.

caridean: a group belonging to the crustaceans, commonly known as shrimp.

carrion: dead flesh that is unfit for food.

cartilaginous: composed of cartilage.

catch: the total number or poundage of fish captured from an area over some period of time, including fish that are caught but released or discarded instead of being landed.

catch per unit of effort (CPUE): the quantity of fish caught with one standard unit of fishing effort; e.g. the combination of gear type, gear size, and length of time gear is used. Also used as a measurement of relative abundance for a particular fish.

caudal: at the hind or tail end of the body.

GLOSSARY (Cont.)

caudal fin: the terminal fin, or tail, of a fish.

caveat: an explanation to prevent misinterpretation.

central Pacific Gyre: this gyre is bordered by the southern flowing, cold water California current which runs into the western moving, warm water North Equatorial Current. The North Equatorial Current moves north with the Philippines Current and then northeast into the Kuroshio Current. West winds push the North Pacific current east where it divides at the North American continental plate to form the Alaska Current to the north (part of the North Pacific gyre) and the California Current to the south. This is a clockwise moving gyre.

cessation: end, cease, stop.

cetaceans: aquatic, mostly marine, mammals including whales, dolphins, porpoises, and others that have a torpedo shaped, nearly hairless body, paddle-shaped forelimbs, no hind limbs, one or two nares opening externally at the top of the head, and a flat tail for locomotion.

chaetognath: small free-swimming marine worms with movable curved chaetae on either side of the mouth.

chlordane: a highly chlorinated viscous volatile liquid insecticide ($C_{10}H_6Cl_8$).

chrysene: one of the polycyclic aromatic hydrocarbon compounds formed when gasoline, garbage, or any animal or plant material burns. Usually found in smoke and soot, this chemical combines with dust particles in the air and is carried into water and soil and onto crops.

circumpolar: constantly visible above the horizon.

cladoceran: minute chiefly freshwater branchiopod crustaceans that includes the water fleas.

coastal lowland: a narrow strip of relatively low ground between the sea and the cliffs leading to the plateau with a climate wetter than that of the plateau; with fewer temperature extremes it is more subject to fog.

GLOSSARY (Cont.)

coastal runoff: land-based pollution, i.e., chemicals and other contaminants that make their way into coastal waters.

coccolithophorid: the unicellular marine plant plankton with a calcareous skeleton that form the base of the food chain.

community development quota (CDQ): a federal fisheries program that involves coalitions of communities who have formed six regional organizations. The program allocates a portion of the Bering Sea and Aleutian Island harvest amounts to groups.

concomitant: accompanying, especially in a subordinate or incidental way.

congener: a member of the same taxonomic genus as another plant or animal; something resembling another in nature or action.

continental shelf: a shallow submarine plain of varying width forming a border to a continent and typically ending in a steep slope to the ocean floor.

continental slope: the usually steep slope from a continental shelf to the ocean floor.

control rule: describes a variable over which management has some direct control as a function of some other variable(s) related to the status of the stock.

copepods: a group of small crustaceans, some free-swimming and some parasitic on fish gills or skin.

cottid: member of the family Cottidae, which includes sculpin and bullhead.

covariance: the expected value of the product of the deviations of two random variables from their respective means.

crangonid shrimp: commonly called bay shrimp; there are three species in the Family Crangonidae.

GLOSSARY (Cont.)

critical habitat: a specific area that is necessary for preservation of a threatened or endangered species that may require special protection or management.

crustacean: a group of freshwater and saltwater animals having no backbone, with jointed legs and a hard shell made of chitin.

ctenophore: marine animals superficially resembling jellyfishes but having biradial symmetry and swimming by means of eight meridional bands of transverse ciliated plates.

cumacea: an order of marine crustacea, mostly of small size.

cycloalkanes: alkanes in which at least one of the continuous carbon chains is linked back on to itself in the form of a ring.

davit: a crane that projects over the side of a ship or hatchway and is used for boats, anchors, or cargo.

decapod: crustaceans with five pairs of thoracic appendages one or more of which are modified into pincers, with stalked eyes, and with the head and thorax fused into a cephalothorax and covered by a carapace; cephalopod mollusks with 10 arms.

deep water basin: a collection of water so deep that surface waves are little affected by the ocean bottom; generally characterized as water deeper than one-half the surface wavelength.

demersal: living near the bottom of a water body.

density-dependent mortality: increased risk of death associated with increased population density.

denticulate: fine toothed or serrated.

depredation: to lay waste; to plunder.

depth strata: (also known as depth zone) any of one of the four oceanic environments: the littoral, neritic, bathyal and abyssal zones.

GLOSSARY (Cont.)

detritus: loose material (organic particles) resulting from disintegration.

diatoms: minute planktonic unicellular or colonial algae with silicified skeletons.

dibenzothiophenes: a polynuclear aromatic hydrocarbon; an environmental hazard.

dinoflagellate: chiefly marine phytoplanktonic, usually solitary unicellular flagellates that include luminescent forms and forms that cause red tide.

diurnal: having a daily cycle; occurring in the daytime.

domestic annual harvest (DAH): the domestic annual fishing capacity, modified by other factors (such as economic factors), which will determine estimates of what fishing fleets will harvest.

domestic annual processing (DAP): the amount that will be domestically processed, based not only on physical capacity but on a demonstrated intent and the effects of domestic harvesting, markets, and other fisheries.

donut hole: an area which encompasses approximately 48,000 square miles and comprises 19 percent of the Aleutian Basin or 10 percent of the entire Bering Sea area where the stocks being fished are suspected to straddle or move back and forth across the open area and an area of regulated national jurisdiction.

dorsal: the back of the body.

dorsal fin rays: cartilaginous structures within the dorsal fin.

downwelling: a circulation pattern in which warmer surface waters move down in the water column.

echinoderms: marine animals including starfishes, sea urchins, and related forms.

Echiuroid worm: marine worms that have sensitive but non-retractable proboscis above the mouth.

ecosystem: the community of living creatures occurring in an environment.

El Niño Southern Oscillation: an interannual disturbance of the climate system characterized by a periodic weakening of the tradewinds and warming of the surface layers in the equatorial Pacific Ocean every 4 to 7 years.

embayment: a small bay or semi-enclosed coastal water body whose opening to a larger water body is restricted.

endemic: native to a particular country; characteristic of or prevalent in a particular environment.

endocrine system: the system of glands/organs capable of secreting hormones which provide communication in the body

epibenthic: living on the surface of bottom sediments in a water body.

epifauna: invertebrates living on to of the sediment of the seafloor.

epipelagic: the zone of the ocean into which enough light penetrates for photosynthesis.

errantiate: form of the word "errant" meaning to move or wander, usually an irregular motion.

escarpment: a long cliff or steep slope separating two comparatively level or more gently sloping surfaces and resulting from erosion or faulting.

estuary(ies): a water passage where the tide meets a river current.

eunicid: a family belonging the to the Polychaetes, characterized by having up to five antennae and pincher-like jaw maxilla.

euphausiid: small, pelagic, shrimp-like crustaceans, e.g., krill.

euphotic: constituting the upper layers of a body of water where sufficient light penetrates to permit green plant growth.

ex-vessel: activities that occur when a commercial fishing boat lands or unloads a catch.

exclusive economic zone (EEZ): a zone under national jurisdiction (up to 200-nautical miles wide) within which the coastal State has the right to explore, and the responsibility to conserve and manage, the living and non-living resources.

exogenous: due to external causes; not arising within the organism.

extrapolate: to infer (values of a variable in an unobserved interval) from values within an already observed interval.

extrude: to force out.

$\boldsymbol{F}_{\mathbf{MSY}}$: a continuous fishing mortality rate that results in the maximum sustainable yield.

$\mathbf{F}_{\mathbf{\%SPR}}$: the fishing mortality rate associated with a stable spawning per recruit level equal to X% of the spawning per recruit level at equilibrium when no fishing has occurred.

faunal: being animal life.

fecundity: the measure of the egg-producing ability of a fish..

filter feeder: an animal that obtains food by filtering organic matter or minute organisms from a current of water passing through some part of its system.

fishery: as defined by the Magnuson-Stevens Fishery and Conservation Act, a fishery is one or more stocks of fish that can be treated as a unit for purposes of conservation and management and that are identified on the basis of geographic, scientific, technical, recreational, or economic characteristics.

fishery management plan (FMP): a plan developed by a regional fishery management council, or by the U.S. Secretary of Commerce, to manage a fishery resource to achieve specified management goals.

GLOSSARY (Cont.)

fishing mortality rate (F): a measurement of the rate of removal of fish from a population by fishing. Expressed as either "annual" or "instantaneous rates;" annual mortality if the percentage of fish dying in one year while instantaneous mortality is the percentage of fish dying at any one time.

fjord: a narrow inlet between cliffs or steep slopes.

fledge: to rear until ready for flight or independent activity.

foraminiferan: marine protozoans usually having calcareous shells that are perforated with minute holes for protrusion of slender locomotors or food gatherers.

forage fish: any fish eaten by larger predatory fish, seabirds, or marine mammals, usually swimming in large schools.

fossil fuel: a fuel (as coal, oil, or natural gas) that is formed in the earth from plant or animal remains.

fry: recently hatched or juvenile fish.

gadoid fish: resembling or related to the cods.

gammarid: a family belonging to the amphipods

gastropods: a large group of mollusks including the snails.

genus (plural, genera): a class or group marked by common characteristics.

gladius: the internal shell, or pen, of cephalopods like squid.

glaucous: of a pale yellow-green or a light bluish-gray or bluish-white color.

gorgonian: an anthozoan with a horny and branching axial skeleton.

GLOSSARY (Cont.)

gradient: the rate of regular or graded ascent or descent; part sloping upward or downward; change in the value of a quantity (temperature, pressure, or concentration) with change in a given variable.

greenhouse gases: gases that contribute to the greenhouse effect by trapping heat within the earth's atmosphere. The chief greenhouse gases are carbon dioxide and water vapor. Other potentially important trace gases are chlorofluorocarbons, methane, ozone, and nitrous oxide.

gregarious: tending to associate with others of one's kind.

groundfish: a species or group of fish that lives most of its life on or near the sea bottom.

guild: a group of species that utilize the same kinds of resources, such as food, nesting sites, or places to live, in a similar manner.

guild diversity: the variation in the number of species that share a common food source.

gyre: a giant circular oceanic surface current.

halocline: a usually vertical gradient in salinity.

harpacticoid copepods: minute crustaceans, often long and cylindrical in shape.

harvest: the total number or poundage of fish caught and kept from an area over a period of time.

holoplanktonic: living in the water column.

harpacticoid: a family belonging to the copepods.

haulout: a resting place.

hydroacoustic: sound waves bounced off the ocean floor.

GLOSSARY (Cont.)

hydrocarbon: an organic compound containing only carbon and hydrogen and often occurring in petroleum, natural gas, coal, and bitumens.

hydroid: of or relating to a hydrozoan; especially resembling a typical hydra.

hyperiid: a family belonging to the amphipods.

ichthyoplankton: fish eggs or larvae.

incidental catch: see *bycatch*.

indigenous: having originated or naturally occurring in a particular region or environment.

individual fishing quota (IFQ): a federal permit under a limited access system to harvest a quantity of fish, expressed by a unit or units representing a percentage of the total allowable catch of a fishery that may be received or held for exclusive use by a person.

infauna: invertebrates living in the sediment of the seafloor.

inflow: the flowing in [of air].

in situ: in the natural or original position or place.

instantaneous mortality: see *natural mortality*.

intertidal: relating to or being the part of the littoral zone above low-tide mark.

intra-annual: occurring during or within a year time span.

invertebrate: any animal lacking a spinal column.

isobath: a line of a map passing through all points of equal depth below water.

isomer: one of two or more compounds or ions that contain the same number of atoms of the same elements but differ in structural arrangement and properties.

isopod: a small crustacean with attached eyes and a body composed of seven free thoracic segments each bearing a pair of similar legs.

isotope: two or more species of atoms in a chemical element with the same atomic number and nearly identical chemical behavior but with differing atomic masses and different physical properties.

juvenile: a young fish or animal that has not reached sexual maturity.

kamaboke: white fish filleted and pounded into a paste.

Kamchatka Current: a current which brings water southward from the Bering Sea, where it is associated with the quasi-permanent anticyclonic eddies found close to the western shore.

kinetic energy: energy associated with motion.

kirimi: a fish processing style in which the head and tail are taken off and the guts are left in the fish.

landings: the number or poundage of fish unloaded at a dock by commercial fishermen or brought to shore by recreational fishermen for personal use.

larvaceans: small transparent animals found in marine plankton, e.g., tunicates

License Limitation Program (LLP): a limited access program intended to limit participation in the groundfish fisheries in the Gulf of Alaska and the Bering Sea and Aleutian Islands federal management areas and Bering Sea and Aleutian Islands crab fisheries based on past documented harvests made by each fishermen.

limit reference points: limits (e.g., OFL, MFMT) established by management to be avoided, constrains harvests so that the stock remains within safe biological limits.

littoral: of, relating to, or situated or growing on or near a shore. Or, a coastal region, especially the shore zone between high and low watermarks.

M: see *natural mortality*.

macrofauna: small to moderate sized invertebrates living on and in bottom sediments.

macrozooplankton: large, thick, or exceptionally prominent animal life of the plankton.

Magnuson-Stevens Fishery Conservation and Management Act: a federal law that created the regional councils and is the federal government's bases of fisheries management in the EEZ (U.S. Public Law 94-265, as amended through October 11, 1996).

marine mammal: animals that live in marine waters and breathe air directly, i.e., sea lions, porpoises, whales, and seals.

maximum fishing mortality threshold (MFMT): standard determination criteria for determining if overfishing is occurring within a stock; equivalent to OFL in the BSAI and GOA FMPs.

maximum sustainable yield (MSY): the largest average catch or yield that can continuously be taken from a stock under average environmental conditions.

medusae: jellyfish.

meiofauna: benthic animals that can fit a mesh size of 1 millimeter and be retained on a mesh size of 42 micrometers.

Meridional thermal gradient: the vertical (north-south) flow of water of which the surface is made up of warm waters underlain by deep cold waters.

mesopelagic region: relating to oceanic depths from about 600 feet to 3000 feet (200 to 1000 meters).

metabolite: substances which are required as basic raw materials for vital processes, such as glucose in respiration and other metabolic pathways.

GLOSSARY (Cont.)

meteorological regime: circulation air mass.

metric ton: 2,204.62 pounds.

microflora: minute plants not seeable with the naked eye.

micronekton: microscopic free-swimming aquatic animals that move independent of wave and current action.

millimeter (mm): ½5 of an inch.

milt: the sperm-containing fluid of a male fish.

minimum stock size threshold (MSST):a standard determination criteria used for determining when a stock is in a overfished condition; usually measured in terms of spawning biomass.

mollusk: an invertebrate animal with a soft unsegmented body usually with one or two hard shells made of calcium carbonate.

molt: to periodically shed hair, feathers, shell, horns, or other outer layer.

morphological: an organisms form and structure.

MSY control rule: a harvest strategy that results in a long-term average catch approximating MSY, enables the use of proxies.

multispecies perspective: a management theory that recognizes the interactions between organisms, for example: predator-prey relationships.

munid crabs: crustaceans belonging to the Family Galathoidae.

myctophids: members of the Family Myctophidae.

GLOSSARY (Cont.)

Myctophidae: deep sea fishes comprising the lantern fishes.

mysids: small, shrimp-like marine crustaceans, the females of which carry their eggs in a pouch beneath the thorax.

naphthalene: a crystalline aromatic hydrocarbon ($C_{10}H_8$) usually obtained by distillation of coal tar and used especially in organic synthesis.

natal area: area associated with birth.

National Standard Guidelines: seven FMP guidelines and standards required by MSFCMA to identify the nation's interest in fish management.

natural mortality rate (*M*): a measurement of fish deaths from all causes other than fishing such as predation, disease, starvation, and pollution.

nauplius (plural, nauplii): a crustacean larva usually in the first stage after leaving the egg and with three pairs of appendages, a median eye, and little or no segmentation.

nautical mile: 6,076.115 feet or 1,852 meters.

near-shore eddy(ies): inshore waters that run contrary to the current.

Near Strait Inflow: the primary source of inflow in the Bering Sea.

necropsy: an examination of an organism after death to determine the cause of death or the character and extent of changes caused by disease.

necrotic: localized death of living tissue.

nematode: elongated cylindrical worms parasitic in animals or plants or free-living in soil or water.

neoplasia: formation of tumors

GLOSSARY (Cont.)

neritic: region of shallow water adjoining the seacoast.

nocturnal: active at night.

nodal: being or located at or near a node. In a tide area, the point about which the tide oscillates and where there is little or no rise and fall of the tide.

Nor'eastern: a trawl constructed with polyethylene mesh and outfitted with other types of footropes for the Gulf of Alaska, the Aleutian Islands, and the Pacific West Coast shelf surveys, has a 27.2 meter headrope, and a 37.4 meter footrope; the body is 127 millimeter stretched mesh and the codend is 89 millimeter stretched mesh with a 32 millimeter stretched mesh codend liner; floats along the headrope hold the net open vertically.

North Pacific Index: the area-weighted sea level pressure over the North Pacific in the region 30°N to 65°N, 160°E to 140°W.

nuclide: species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content.

σ_t: a measure of the density of water, at its current pressure, if it were raised to the surface.

Ocean Current simulations model: ocean simulations models may input climate data, ocean circulation, sea-ice, temperature gradient, nutrient gradient, anthropogenic events and large climatic events (e.g. ENSO) among other information to better understand how the ocean works and predict weather events and possible human impacts on ocean systems (among other uses).

oceanographic: pertaining to the ocean.

offal: the waste or by-product of a process; debris, garbage, etc.

oikopleura: a small pelagic tunicate at the basis of the chordate phylum; larvaceans.

ommatidia: the structural elements forming the compound eye of arthropods, insects, etc.

omnivorous: feeding on both animals and vegetables.

ontogeny: the development or course of development of an individual organism.

onuphid: beachworm; a member of the family Onuphidae

optimum yield (OY): the harvest level for a species that achieves the greatest overall benefits, including economic, social, and biological considerations.

ostracods: very small, active, mostly freshwater crustaceans that have the body enclosed in a bivalve shell, the body segmentation hidden, the abdomen rudimentary, and only seven pairs of appendages.

overfished: a stock or stock complex whose size is sufficiently small that a change in management practices is required in order to achieve an appropriate level and rate of rebuilding; a stock is determined to be overfished when it is below the minimum stock size threshold.

overfishing: a rate or level of fishing greater than that which will meet the management goal and that jeopardizes the capacity of a fishery to produce the largest average catch or yield that can continuously be taken under average environmental conditions on a continuing basis.

overfishing level (OFL): a fishing rate that reduces the level of spawning biomass per recruit to some percentage of its original, pristine level; a limit reference point that management seeks to avoid.

overwintering: surviving the winter.

ovoviviparous: producing eggs that develop within the maternal body and hatch within or hatch immediately after being pushed out from the parent.

Pacific decadal oscillations: an El Niño-like pattern (see previous) of Pacific climate variability and persisting for 20 to 30 years with climatic fingerprints most visible in the North Pacific/North American sector.

panmictic: mating randomly.

GLOSSARY (Cont.)

parturition: the action of giving birth to offspring.

pelagic: refers to fish and animals who live in the open sea, away from the sea bottom.

per capita: per unit of population.

perylene: an organic molecule consisting of 20 carbon atoms and 12 hydrogen atoms arranged as five benzene-like rings connected to each other in a plane.

phenanthrenes: a crystalline aromatic hydrocarbon ($C_{14}H_{10}$) of coal tar isomeric with anthracene.

phyla: primary division of the animal kingdom.

phytoplankton: planktonic plant life.

pinniped: an aquatic carnivorous animal with all four limbs modified into flippers.

piscivorous: feeding on fishes.

planktivorus: feeding on plankton.

plankton: the passively floating or weak swimming animal and plant life of a body of water.

planktonic: of or relating to plankton

pleuronectid: pertaining to the flounder family.

polychaete: chiefly marine annelid worms, i.e., clam worms, usually with paired segmental appendages, separate sexes, and a free-swimming trochophore larva.

polychlorinated: PCB - any of several compounds that are produced by replacing hydrogen atoms in biphenyl with chlorine, have various industrial applications, and are poisonous environmental pollutants which tend to accumulate in animal tissues.

polycyclic: having more than one cyclic component, i.e. having two or more rings in the molecule.

polynias: see polynyas.

polynya(s): open water in sea ice.

population: fish of the same species inhabiting a specified area grouped together for management purposes.

predation: the act of preying or plundering; a mode of life in which food is primarily obtained by the killing and consuming of animals.

pre-neoplastic: pre-malignant.

probability density function: a statistical distribution; used in deriving overfishing limits and acceptable biological catch.

procellarid: one of a family of oceanic birds (Procellarid[ae]) including the petrels, fulmars, and shearwaters.

procellariiformes: tube-nosed swimmers, fulmars and albatrosses.

prohibited species catch (PSC): in applicable Bycatch Limitation Zones of the Bering Sea subarea - limits specified for red king crab, Chionoecetes bairdi Tanner crab, and C. opilio crab; throughout the BSAI - limits specified for Pacific halibut and Pacific herring. Regulations authorize the apportionment of each limit into allowances for specified fishery categories. Seven-and-a-half percent of each limit specified for halibut, crab, and salmon is reserved as a quota for use by the CDQ program.

protease: any of numerous enzymes that hydrolyze proteins.

GLOSSARY (Cont.)

protobranch: a gill structure occurring in bivalves in which gills are small and leaf like with the unmodified appearance occurring in primitive groups.

protozoan: minute cell-less or one-celled animals that often have complex life cycles and frequently are serious parasites to humans and other animals.

protracted spawning: a longer spawning period.

proxy: a substitution; something that is authorized to act in place of another.

pterpods: small mollusks that expand the front lobes of the foot into thin wing-like organs with which they swim.

pyrogenic: caused by or generating heat.

pteropod: holoplanktonic molluscs belonging to the orders of Thecosomata and Gymnosomata. The species have in common that the original foot has developed into a pair of 'wings' (parapodia), increasing the animals' buoyancy and locomotion capacity.

pycnocline: a layer in the water column separating two areas of different density.

quota: the maximum number of fish that can be legally landed in a time period.

radiolarian: spherical marine protozoans having radiating threadlike protrusions for locomotion or food gathering and often a siliceous skeleton of spicules.

radionuclide: a radioactive nuclide.

rebuilding plan: a plan that is designed to recover stocks when they are overfished.

recruit: an individual fish that has moved into a certain class, such as the spawning class or fishing-size class.

GLOSSARY (Cont.)

recruitment: a measure of the weight or number of fish that can enter a defined portion of stock, such as the fishable stock or the spawning stock, during some time period.

reef: a chain of rocks or coral or a ridge of sand at or near the surface of water or within a depth of 20 meters from the surface..

reference points: limits or values that are used to guide management decisions.

regime shift: a transition from one climactic state to another within a period substantially shorter than the lengths of the individual epochs of each of the two climatic states.

regulatory impact review (RIR): the part of a federal fishery management plan that describes the impacts resulting from the plan.

rip (also tide rip): agitation of water caused by the meeting of currents or by a rapid current setting over an irregular bottom. Termed tide rip when a tidal current is involved.

risk averse: avoiding risk.

roe: the eggs of a fish especially when still enclosed in the ovarian membrane.

rookery: the nest, haunt, or breeding ground of a colony, especially of gregarious birds or mammals.

salpa: a transparent barrel-shaped or fusiform free-swimming tunicate that is abundant in warm seas.

satiation: full or excessive satisfaction.

seamount: elevation rising 1000 meters or more from the sea floor and of limited extent across the summit.

sediment: matter that settles to the bottom; material deposited by water, wind, or glaciers.

GLOSSARY (Cont.)

serpulid: a small marine annelid worm which build limey tubes on stones and seaweed and extends a crown of tentacles to feed.

semidemersal: semi-bottom-dwelling.

sessile: permanently attached at the base or foot.

sideboard measures: constraints imposed on a directed fishery that restrict its participation in other directed fisheries.

sill fjord: natural rock barriers occurring at the mouth of a fjord and delineating the extent of the progress of the glacier that carved the fjord.

siphonophores: compound free-swimming or floating pelagic hydrozoans that are mostly delicate, transparent, and colored and have specialized zooids.

spatial dispersion: a movement over space or area.

spawning per recruit (SPR): amount of spawning biomass at a instantaneous fishing mortality rate, influenced by other values including growth, maturity, natural mortality and partial recruitment.

spermatheca: a sac for sperm storage in the female reproductive tract of many lower animals.

spermatophore: a capsule, packet, or mass enclosing spermatozoa extruded by the male and conveyed to the female in insemination.

standard determination criteria: criteria (e.g., MSST, MFMT) used to determine if a stock is in a overfished state, according to the National Standard Guidelines.

stalked ascidians: sea tulips.

steranes: organic molecules with 26 to 30 carbon atoms arranged in four rings.

stock or stock complex: a grouping of fish usually based on genetic relationship, geographic distribution, and movement patterns.

stock assessment: a means of estimating fish numbers and predicting how fish populations will respond to harvesting.

Stock Assessment and Fishery Evaluation Report (SAFE): a report that provides a summary of the most recent biological condition of a stock of fish as well as the economic and social condition of the recreational fishermen, commercial fishermen, and seafood processors who use the fish. It is used to determine harvest levels.

stratum: a sheet like mass of sedimentary rock or earth of one kind lying between beds of other kinds; a region of the sea or atmosphere that is analogous to a stratum of the earth.

subarctic: characteristic of, or being regions immediately outside of the arctic circle or regions similar to these in climate or conditions of life.

Subarctic Current: the current which flows eastward from the western Rim of the Pacific Ocean.

sublittoral: benthic region extending from mean low water to a depth of about 200 meters or to the edge of the continental shelf. Situated, occurring, or formed on the aquatic side of a shoreline or littoral zone.

subtidal: the zone that is permanently flooded by tidal water.

surimi: fish product made from inexpensive whitefish and often processed to resemble more expensive seafood (i.e., crabmeat).

Sustainable Fisheries Act (SFA): an amendment to the Magnuson-Stevens Fishery Conservation and Management Act which includes numerous provisions requiring science, management, and conservation action by NMFS.

target reference points: limits and benchmarks (e.g., ABC) to be achieved, but not exceeded, by management.

taxa: a category or group of related organisms.

taxonomic: classification of plants and animals according to their presumed natural relationships.

telemetry: the science of automatic data measurement and transmission of data.

teleost: a group consisting of fishes with bony skeletons and rayed fins.

temperate: marked by moderation; not extreme or excessive.

terrestrial: of or related to earth and its inhabitants.

terrigenous: relating to oceanic sediment derived directly from destruction of surface rock.

thermal stratification: horizontal layers of differing densities produced in a lake by temperature changes at different depths.

thermocline: the region in a thermally stratified body of water which separates warmer oxygen-rich surface water from colder oxygen-poor deep water and in which temperature decreases rapidly with depth.

thermoregulation: the maintenance or regulation of temperature, i.e., body temperature.

tide rip: see *rip*.

Tier: each stock or stock complex is categorized into a certain "tier" or level based on the amount of information available for the given stock or stock complex. From these tiers, certain limits are derived using mathematical equations.

tintinnid: marine plankton

topography: the configuration of an earth surface including its relief and the position of its natural and man-made features.

total allowable catch (TAC): the annual recommended catch for a species or species group. Set from the range of acceptable allowable catch.

Total Allowable Level of Foreign Fishing (TALFF): that portion of the optimum yield which will not be harvested by domestic vessels. The foreign allowable catch is determined by deducting the expected domestic annual harvest and reserve from the optimum yield (TALFF = OY- [DAH + reserve]).

triennial: occurring every three years.

triterpanes: pentacyclic biological marker hydrocarbons containing between 27 and 35 carbon atoms.

trophic: ecology of or involving the feeding habits or food relationship of different organisms in a food chain.

trophic level: a group of organisms that occupy the same position in a food chain.

trophic guild: a group of species which use similar resources (e.g. insectivorous birds are a trophic guild of birds that eat insects).

tunicate: marine chordate animals with a thick secreted covering layer, a greatly reduced nervous system, a heart able to reverse the direction of blood flow, and only in the larval stage a notochord.

turrid: a family of snails, now reclassified into several subfamilies.

ubiquitous: existing everywhere at the same time; constantly encountered.

µM: micrograms per liter.

uncertainty: a lack of perfect knowledge. Rosenberg and Restrepo (1994) identify five types of uncertainty: 1) measurement error, 2) process error, 3) model error, 4) estimation error, and 5) implementation error.

GLOSSARY (Cont.)

upwelling: the process by which water rises from a deeper to a shallower depth, usually as a result of offshore surface water flow; it is most prominent where persistent wind blows parallels to a coastline so that the resultant Ekman transport moves surface water away from the coast..

uterine cannibalism: while still in the mother's reproductive tract, the first hatchling eats either younger `hatchlings or unfertilized eggs to get nourishment.

vertebrate: having a spinal column.

vestigial: sign or evidence of some past thing.

viviparous: producing living young rather than eggs.

voracious: having a ravenous appetite.

vorticity: a swirling motion.

West Wind Drift: (also known as Antarctic Circumpolar Current) the ocean current from west to east through all the oceans around the Antarctic continent.

wind-stress curl: the plot of the energy transferred from the wind to the sea surface.

year-class: the fished spawned and hatched in a given year; a "generation" of fish.

young-of-the-year: fish or animals born in the past year, which have not yet reached one year of age.

zooplankton: plankton composed of animals.

Chapter 1

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Chapter 1 Purpose and Need

This Programmatic Supplemental Environmental Impact Statement (Programmatic SEIS) constitutes the central environmental document supporting the Fishery Management Plan (FMP) for the groundfish Fishery of the Bering Sea and Aleutian Islands (BSAI) and the FMP for groundfish of the Gulf of Alaska (GOA). The historical and scientific information and analytical discussions contained herein are intended to provide a broad, comprehensive analysis of the general environmental consequences of fisheries management in the Exclusive Economic Zone (EEZ) off Alaska, and thus provide agency decision-makers and the public with information necessary for making informed decisions in managing the groundfish fisheries and for setting the stage for future policy decisions and management actions.

This introductory chapter establishes the purpose and need for the federal action supported by this Programmatic SEIS. It provides an overview of the National Environmental Policy Act (NEPA) of 1969 and its procedural requirements; a history of this document and how the National Marine Fisheries Service (National Oceanic and Atmospheric Administration [NOAA] Fisheries or NMFS) has conducted the NEPA scoping process and addressed public comments; and a review of the future steps that will be taken to finalize the Draft Programmatic SEIS. Finally, this introduction describes the overall organization of this document.

1.1 Purpose and Need for Federal Action

This section describes the purpose of and need for federal action. In this case, the federal action is a continuing activity: the ongoing management of the groundfish fisheries in the EEZ off Alaska, as authorized by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and pursuant to NEPA and other applicable statutes and executive orders.

At a fundamental level, management of the groundfish fisheries has two interrelated purposes: to maximize the social and economic benefits of the groundfish resource to the people of the United States (U.S.) and to conserve the resource to ensure its sustained availability to current and future generations. The use and conservation of the fisheries need to be managed so that one objective—whether related to biological conservation or to socioeconomic well-being—does not take priority over the other, except when the resource itself is at risk of being depleted. To prevent such depletion of the resource, fisheries management strives to balance these two fundamental objectives.

The North Pacific Fishery Management Council (NPFMC) and NOAA Fisheries have managed the groundfish fisheries off Alaska for more than 20 years under the FMPs for the groundfish fisheries of the BSAI and GOA. These FMPs, subsequent FMP amendments, and related regulatory actions addressing changes in management measures have all been attended by NEPA documents, whether environmental impact statements (EISs), environmental assessments (EAs), or categorical exclusions that consider the environmental impact of those actions. At this juncture, however, the continuing effort to manage the groundfish fisheries requires a renewed evaluation of the overall environmental impacts of existing management policy and an analysis of alternative policies that will allow NPFMC and NOAA Fisheries to strike the most effective and efficient balance between the dual objectives of conservation and use.

1.2 Action Area

The subject groundfish fisheries take place in the Bering Sea and North Pacific Ocean within the U.S. EEZ from 50° North (N) to 65°N (Figure 1.2-1). The EEZ off Alaska extends seaward from 3 to 200 nautical miles (nm). The action area for the federally managed BSAI groundfish fisheries effectively covers all of the Bering Sea under U.S. jurisdiction, extending southward to include the waters south of the Aleutian Islands west of 170° West (W) longitude, to the border of the EEZ. The action area for the federally managed GOA groundfish fisheries includes the EEZ of the North Pacific Ocean, exclusive of the Bering Sea, between the eastern Aleutian Islands at 170°W longitude and Dixon Entrance at 132°40'W longitude. State waters and international waters adjacent to the action area are also affected by the federal groundfish fisheries. A review of areas fished by the groundfish fisheries (Fritz *et. al.* 1998) suggests that virtually the entire Bering Sea and GOA from the continental slope shoreward is utilized by one fishery or another.

The BSAI and GOA groundfish fisheries are divided into sub-areas for management purposes. The BSAI is divided into two sub-areas (eastern Bering Sea [EBS] and Aleutian Islands) and 19 reporting areas (Figure 1.2-2), and the GOA is divided into three sub-areas (western, central, and eastern) and eight reporting areas (Figure 1.2-3).

These regions constitute the areas that are potentially affected either directly or indirectly (or both) by the groundfish fisheries. A more detailed description of the action area is provided in Chapter 3, Affected Environment.

1.3 The Purpose and Need for the Programmatic Supplemental Environmental Impact Statement

The purpose of this Programmatic SEIS is to analyze comprehensive policy alternatives in support of the continuing management of the groundfish fisheries of the BSAI and GOA. A Programmatic SEIS such as this provides a broad, "big picture" environmental evaluation that examines a program on a large scale and may be used to evaluate an ongoing program and alternative directions that the program might take in the future (40 Code of Federal Regulations [CFR] 1502.4[b]). By providing up-to-date scientific information on the cumulative impacts of the groundfish fisheries on the physical, biological, and human environment of the action area, this Programmatic SEIS will serve as the environmental baseline for evaluating current and alternative management regimes and subsequent management actions.

As a comprehensive foundation for management of the BSAI and GOA groundfish fisheries, this Programmatic SEIS is intended to function as a "first tier" analysis for incorporation by reference into subsequent EAs and EISs that focus on specific federal actions. Rather, the federal action supported by this document is the continuing management of the groundfish fisheries in the EEZ off Alaska. This Programmatic SEIS sets forth four distinct management policies, including the current policy, from which NPFMC will choose a preferred management policy direction. Any specific FMP amendments or regulatory actions proposed in the future will be evaluated by subsequent EAs or EISs that are tiered from the Programmatic SEIS but stand as case-specific NEPA documents and offer more detailed analyses of the specific proposed actions. Any such amendments and actions will logically derive from the chosen policy direction set for the preferred alternative. To maintain this document's viability as the "first tier" reference for future analyses, NOAA Fisheries will periodically update this Programmatic SEIS as warranted by the availability of new information or the development of significant changes in the fisheries or their environment.

The need for a "Supplemental" EIS became apparent to NOAA Fisheries during the 1990s, when the agency was apprised of the legal and scientific insufficiency of the initial EISs prepared for the GOA and BSAI groundfish FMPs in 1979 and 1981, respectively. (For a more detailed discussion of the history of this document, see Section 1.5.) Regulations implementing NEPA require preparation of an EIS (or SEIS) when "there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts" (40 CFR 1502.9[c]). Significant changes have occurred in the resource and its environment over the past 20 years, and the initial EISs supporting the FMPs no longer adequately reflect the current state of the environment. While fishery management regulatory actions and FMP amendments have all been attended by environmental analyses, mainly EAs or EISs, none of those analyses attempted to examine the impact the FMPs in their entirety have had on the environment. Consequently, NOAA Fisheries announced its decision to prepare an SEIS that would, moreover, be a "programmatic" analysis based on the current state of the resource and its environment. In January 2001, NOAA Fisheries published the first draft Alaska Groundfish Fisheries Programmatic SEIS (hereinafter referred to as the 2001 Draft Programmatic SEIS).

The 2003 Draft Programmatic SEIS was released in August 2003 and substantially revised the 2001 Draft Programmatic SEIS. The 2003 Draft Programmatic SEIS public comment period began August 29, 2003 and ended November 6, 2003. This Final Programmatic SEIS responds to and integrates into the analysis, the substantive concerns raised by public comments on the 2003 Draft Programmatic SEIS.

1.4 National Environmental Policy Act of 1969

The Programmatic SEIS has been prepared to meet the requirements of NEPA (42 United States Code [USC] 4321-4347), the basic charter of the U.S. for protection of the environment. NEPA establishes the nationwide policy, goals, and legal authority for federal agencies regarding the environment (40 CFR 1500.1[a]). It requires federal agencies to study the environmental consequences of their actions and to use an interdisciplinary framework for environmental decision-making.

NEPA also requires federal agencies to make environmental information available to the public and to public officials, and to consider their comments, before making decisions that could affect the environment. Documents prepared by federal agencies in compliance with NEPA must focus on the issues that are truly significant to the action in question, rather than amassing needless detail, and present alternatives in a way that allows their potential environmental consequences to be clearly distinguished, along with "advice and information useful in restoring, maintaining, and enhancing the quality of the environment" (43 Federal Register [FR] 55990, November 28, 1978, and 40 CFR 1502.1, 1502.2, and 1502.14).

1.4.1 Provisions of National Environmental Policy Act

Title I of NEPA, "Congressional Declaration of National Environmental Policy," requires that a federal agency's study of environmental consequences be presented to the public in "a detailed statement" that must describe:

1. The environmental impact of the proposed action.
2. Any adverse environmental effects which cannot be avoided should the proposal be implemented.
3. Alternatives to the proposed action.
4. The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity.
5. Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented (42 USC 4332).

This requirement is based on the idea that if the potential effects of federal actions are publicly disclosed and considered before the actions are taken, the resulting decisions are more likely to be in the public interest (Bass, Herson, and Bogdan 2001).

Title II of NEPA, "Council on Environmental Quality," establishes and funds the President's Council on Environmental Quality (CEQ) to oversee the implementation of NEPA and, among other things, "to formulate and recommend national policies to promote the improvement of the quality of the environment" (42 USC 4342). In 1977, President Carter strengthened the CEQ's role in Executive Order (EO) 11991 (May 24, 1977), authorizing the CEQ to issue binding regulations to cover all of the procedural provisions of NEPA, which until that point had no formal guidance for implementation (Bass, Herson, and Bogdan 2001). A year later, the CEQ issued such regulations implementing NEPA (40 CFR 1500-1508). Among other provisions, the CEQ regulations set forth an orderly procedure that all federal agencies must follow to comply with NEPA, including the preparation of EISs. In accordance with these provisions, NOAA issued Administrative Order 216-6, the provides further guidance for implementing NEPA consistent with the agency's mission.

1.4.2 The National Environmental Policy Act Process for Environmental Impact Statements

The CEQ regulations provide a step-by-step procedure that federal agencies must follow when preparing EISs. (Figure 1.4-1 presents a diagram of how NOAA Fisheries has followed this procedure in preparing this Programmatic SEIS.) While the NEPA process is broad enough that agencies can tailor EISs to their individual missions and program needs, the preparation of an EIS must include the following five basic steps:

1. Scoping. Scoping, the first step in the NEPA process, provides an opportunity for the public, government agencies, and other interested groups to provide information and advice on issues that might be associated with the proposed project, so that the lead federal agency can decide whether and how to address them in the EIS. Scoping can also identify new alternatives to be considered in the EIS. This step is usually accomplished by publishing a Notice of Intent and through a combination of written communications, statements made at public meetings, and consultation with agency officials, interested individuals, organizations, and groups.

2. Draft Environmental Impact Statement. After scoping is completed, a draft EIS is prepared. The draft EIS describes and evaluates all reasonable alternative actions, including no action. If the lead agency has decided upon a preferred alternative by the time a draft EIS is prepared, it is identified. The draft EIS evaluates physical, biological, and socioeconomic environmental impacts that might result from the alternatives, and it identifies those impacts that are likely to be significant. It focuses on cause-and-effect relationships and provides sufficient evidence and analysis for determining the probable magnitude of predicted impacts. Finally, it identifies ways to mitigate the impacts–to avoid, minimize, rectify, reduce or eliminate those impacts over time, or to compensate for any potential harm to the environment that might be caused by any of the alternatives (40 CFR 1508.20).

3. Public Comment. Following publication of a draft EIS, a public notice of its availability for review is published in the FR, and a public comment period of no less than 45 days ensues. A public hearing may be conducted to provide an opportunity for interested parties to provide oral comments on the draft EIS. Following the public comment period, the lead agency considers all of the comments received and prepares a final EIS (FEIS) to incorporate responses to the comments. The responses to public comments can range from major document revisions to simple acknowledgments, depending on the nature of the comment, but the FEIS must address all of the comments received on the draft EIS–except when the public comments are particularly voluminous, in which case the federal agency may respond to comment summaries.

4. Final Environmental Impact Statement. The lead agency is required to address all substantive comments received on the draft EIS and include copies of the comments in the FEIS (40 CFR 1503). The FEIS must also identify the lead agency's preferred alternative and may identify the environmentally preferable alternative. These may be different: the preferred alternative is usually the one that the lead agency believes would best accomplish its mission and goals, whereas the environmentally preferable alternative is the one that would best promote NEPA's goals–that is, cause the least overall harm, on balance, to physical, biological, and socioeconomic resources. There

may be more than one environmentally preferable alternative; if so, they must each be identified and discussed. Once the FEIS is completed and published, agencies and the public may comment on the FEIS before a final decision is made by the lead agency (40 CFR 1503.1[6]). Public comments received on the FEIS are collected and considered by the lead agency prior to making a final decision regarding which of the alternatives to implement. No decision on the action may be made by the lead agency within the 30-day period following publication of the FEIS (40 CFR 1506.10[6]).

5. Record of Decision (ROD). Following completion of the FEIS process as described above, the lead agency prepares a ROD. The ROD must 1) state what the decision was, 2) identify all alternatives considered in reaching the decision and which were considered to be environmentally preferable, and 3) state whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why not (40 CFR 1505.2). If a monitoring and enforcement program is applicable for any mitigation, it must be adopted and summarized in the ROD (40 CFR 1505.2).

1.4.3 Supplemental and Programmatic Environmental Impact Statements

An SEIS is a document that is prepared after the issuance of an earlier EIS that pertains to the same federal action. The CEQ regulations require that an SEIS be prepared if a federal agency proposes substantial changes to an action that was the subject of a previous EIS, if those changes are relevant to environmental concerns, or if there are significant new circumstances or information bearing on the action or its impacts that are relevant to environmental concerns (40 CFR 1502.9[c]).

A Programmatic EIS is typically a broad-scale environmental evaluation that examines a program on a large scale. In keeping with CEQ regulations, agencies often prepare this type of EIS when considering new federal programs or regulations (40 CFR 1502.4[b]). However, a Programmatic EIS may also be used to evaluate an ongoing program and alternative directions that the program may take in the future. To streamline the NEPA process and avoid repetition, the CEQ regulations encourage federal agencies to develop a tiered approach to their analyses (40 CFR 1502.20). This allows broad, program-oriented issue analyses to be incorporated by reference into subsequent EAs or EISs that focus on specific proposed federal actions (40 CFR 1500.4[I]). NOAA, in its own NEPA guidelines (NOAA Administrative Order 216-6, Section 5.09a), states that “a programmatic environmental review should analyze the broad scope of actions within a policy or programmatic context by defining the various programs and analyzing the policy alternatives under consideration and the general environmental consequences of each.”

1.5 Historical Development of the Programmatic Supplemental Environmental Impact Statement

This section gives readers a brief overview of the history of this Programmatic SEIS and the key factors influencing its development.

Background

The present system of federal fisheries management in the EEZ was established by the MSA in 1976. In creating regional fishery management councils to manage fisheries, the MSA established NPFMC to develop FMPs and set fishery regulations for the marine waters off Alaska in conjunction with NOAA Fisheries, a federal regulatory agency.

The original EISs for the BSAI and GOA FMPs were finalized in 1981 and 1978, respectively. Although many EAs and several EISs have been prepared for FMP amendments and regulatory actions over the ensuing years, none examined the BSAI and GOA FMPs in their entirety or, in other words, at a programmatic level. Since the original EIS documents were developed, major changes have taken place in the technology of the fishing industry, in the allocation of the resources, in the environmental conditions, and in the FMPs themselves. The accumulation of these changes indicated a need for a revision of those initial EISs that would supplement the original analyses and would hence result in a Programmatic SEIS.

Among many other factors, the dramatic decline in the population of Steller sea lions since the 1970s has played a major role in shaping the supplemental analyses. NOAA Fisheries listed Steller sea lions as "threatened" under the Endangered Species Act (ESA) in 1990. Three years later, NOAA Fisheries designated "critical habitat areas" for sea lions around their major rookeries and haulouts. In 1997, NOAA Fisheries recognized two distinct populations of Steller sea lions and classified the western stock, including those animals living in the BSAI and GOA areas, as "endangered" under the ESA. Section 7 of the ESA required NOAA Fisheries to develop a Biological Opinion (BiOp) that analyzed the likelihood that the groundfish fishery would jeopardize the survival, recovery, or critical habitat of the endangered population. If a BiOp determines that a proposed action places the endangered species in jeopardy, ESA requires the agency to develop Reasonable and Prudent Alternatives (RPAs) for mitigating the impact of federal action and alleviating the condition of jeopardy.

In December 1998, NOAA Fisheries issued two documents to bring the federally managed fisheries into compliance with NEPA and ESA: the 1998 Final SEIS for the BSAI and GOA groundfish fisheries (NMFS 1998i) and a Steller sea lion BiOp (NMFS 1998j). Contrary to previous BiOps, the 1998 BiOp determined that the pollock fishery "jeopardized" the survival and recovery of the western stock of Steller sea lions and their critical habitat. In conjunction with this BiOp, NOAA Fisheries drafted a set of RPAs to mitigate the deleterious impacts of the pollock fisheries on sea lions (NMFS 1998k). These draft RPAs were used to implement emergency fishing rules by NPFMC. Since these RPAs constituted a separate federal action, they were also subject to the requirements of NEPA. NOAA Fisheries began work on a separate SEIS that would examine the impacts of the RPAs. At this point, NOAA Fisheries was responsible for developing a series of interrelated documents.

In 1999, the 1998 Final SEIS for the BSAI and GOA groundfish fisheries was challenged in court. In July of 1999, U.S. District Court Judge Thomas S. Zilly issued a ruling in *Greenpeace v. NOAA Fisheries* (Civ.No. C98-0492Z and 55F.Supp. 2d 1248 [W.D.Wash. 1999]) that the 1998 SEIS was legally inadequate and remanded the document back to NOAA Fisheries for additional analyses, directing the agency to produce a "programmatic" SEIS. Judge Zilly also upheld the conclusion of "jeopardy" in the pollock fisheries but remanded the 1998 BiOp back to NOAA Fisheries, directing them to revise the RPAs and explain how they will avoid the likelihood of jeopardy or adverse modification of critical habitat.

In October 1999, NOAA Fisheries published in the FR a Notice of Intent to prepare a Programmatic SEIS that would serve as a comprehensive foundation or "first tier" reference for future specific environmental analyses. NOAA Fisheries also issued a set of "Revised Final RPAs" (NMFS 1999d) in response to Judge Zilly's orders and which NPFMC implemented through emergency rules while litigation continued to challenge their sufficiency and legality.

In July of 2000, Judge Zilly ruled that NOAA Fisheries had not established sufficiently protective measures for Steller sea lions and ordered an injunction against all trawl fishing within designated critical habitat areas (*Greenpeace v. NOAA Fisheries*, 106 F.Supp.2d 1066 [W.D.Wash. 2000]). In November of 2000, NOAA Fisheries issued a new BiOp and an RPA (NMFS 2000a) that included further restrictions on the fishing industry. Judge Zilly lifted the injunction on trawl fishing at this point and attempted to get the litigants to settle their disputes through mediation. This effort was only partially successful. BiOp 2000 drew criticism from both sides. Environmental groups thought it sacrificed sea lion protection for industry profits and the fishing industry challenged the scientific basis for its conclusions of "jeopardy."

During this period of revising RPAs and legal challenges to the BiOps, NOAA Fisheries proceeded to develop a Programmatic SEIS for the groundfish fisheries and to incorporate government, industry, and public input at various stages through public hearings and comment periods. Then, in January 2001, NOAA Fisheries released the 2001 Draft Programmatic SEIS (NMFS 2001a). In November of the same year, NOAA Fisheries issued a Final SEIS for Steller sea lion protection measures (NMFS 2001b) that contained a great deal of similar information and analyses as the 2001 Draft Programmatic SEIS, but was more limited in scope and oriented toward compliance with the ESA. The 2001 BiOp and RPA (NMFS 2001c) concluded that the groundfish FMPs, as amended by the final RPA, did not jeopardize the survival or critical habitat of the western stock of Steller sea lions.

The 2001 Draft Programmatic SEIS

The 2001 Draft Programmatic SEIS was released for public review on January 26, 2001. This eight-volume report provided, for the first time, a comprehensive environmental review of the BSAI and GOA groundfish fisheries and their management over more than 20 years by NPFMC and NOAA Fisheries. In accordance with the requirements of NEPA, the 2001 Draft Programmatic SEIS was made available for public review. Given its significance as a precedent-setting analysis, and in light of on-going litigation and a number of environmental issues, extensive public comment was received on the 2001 Draft Programmatic SEIS.

Public Comment

The public comment period on the 2001 Draft Programmatic SEIS began on January 26, 2001 and was originally scheduled to end on April 26, 2001. Extended twice at the request of a number of public stakeholders, the public comment period closed on July 25, 2001. During the public comment period a number of public hearings were held on the 2001 Draft Programmatic SEIS in Anchorage, Kodiak, and Juneau, Alaska; Seattle, Washington; Washington, D.C.; and Portland, Oregon. In addition, two statewide teleconferences were held for the purpose of soliciting public comment from individuals living across Alaska, including Alaska Natives and tribal organizations, who were unable to attend any of the public hearings.

Approximately 21,000 comments were received during the comment period on the 2001 Draft Programmatic SEIS.One of the most substantive themes that emerged from the public comments was the concern that the alternatives analyzed in the 2001 Draft Programmatic SEIS focused too narrowly on specific issues, violated one pertinent law or another, and stood no realistic chance of being implemented. Many comments suggested that the document failed to present true alternative FMPs and, thus, simply reinforced the status quo and did nothing to promote ecosystem-based management policies. As a direct result of this input, NPFMC and NOAA Fisheries decided in December 2001 to revise the 2001 Draft Programmatic SEIS by restructuring the alternatives to better represent viable alternative FMPs.

The Restructured Alternatives

As described earlier, the programmatic alternatives put forward in the 2001 Draft Programmatic SEIS were based on different "primary objectives" that gave each alternative a distinct policy emphasis. For instance, Alternative 2 proposed the adoption of a fisheries management policy framework that emphasizes increased protection to marine mammals and seabirds, while Alternative 3 proposed adoption of a framework that emphasizes increased protection to target groundfish species; likewise, the remaining three alternatives proposed primary emphases, respectively, on protecting non-target and forage species, on protecting habitat, and on increasing the socioeconomic benefits of the fisheries.

The alternatives put forward in this revision replace the "primary-objective" approach with a more holistic approach that recognizes both the dynamic nature of the resource and its ecosystem and our imperfect understanding of their interactions. The restructured alternatives (now four in number) range from a relatively less environmentally precautionary approach to an approach that is relatively more precautionary. Toward this end, each policy alternative offers, to varying degrees, an integrated suite of comprehensive policy goals designed to meet the alternative's specific management or policy objective. To capture the breadth of each policy approach, each alternative (with the exception of the first, *status quo* alternative) contains two hypothetical FMPs that serve as "bookends" to illustrate a range of management actions and potential environmental effects consistent with that alternative policy framework (Section 2.6 provides a detailed description of the restructured alternatives and their development).

The 2003 Draft Programmatic SEIS

The 2003 Draft Programmatic SEIS was released for public review on August 29, 2003. This nine-volume report incorporated substantive public comments on the 2001 Draft document and was restructured substantially as described above.

Public Comment

The public comment period on the 2003 Draft Programmatic SEIS began on August 29, 2001 and was originally scheduled to end on October 15, 2001. However, at the request of a number of public stakeholders, the comment period was extended and finally closed on November 6, 2003 for a total comment period of 70 days. During the public comment period a number of public hearings were held on the 2003 Draft PSEIS in Anchorage, Kodiak, and Juneau, Alaska; in Seattle, Washington; and in Silver Spring, Maryland. All combined, only nine people provided oral testimony on the 2003 Draft PSEIS, however approximately 13,400 submissions were posted on the E-Comments website or mailed to NOAA Fisheries by the deadline.

The Comment Analysis Report (CAR) appended to this document (Appendix G) summarizes the public comments. As the primary response-to-comment document for this Programmatic SEIS, the CAR describes the methodology used by NOAA Fisheries in reviewing and sorting the comments and presents a synthesis of all comments that address a common theme. It also documents changes made in the revised Programmatic SEIS as a result of those comments. NOAA Fisheries undertook a careful and deliberate approach to ensure that all substantive public comments were treated equally and reviewed, considered, and responded to on the basis of the quality and substantive content of the comment, and not on the basis of who wrote the comment or how many other comments agree with it. Commenters can reference how and where their comments were responded to by using the cross-reference tables in the CAR.

1.6 The Final Programmatic Supplemental Environmental Impact Statement

The publication of this document begins the final stage of this NEPA process. CEQ regulations require that no decision be made until 30 days after publication of the Final Programmatic SEIS. Once that 30-day period has elapsed, NOAA Fisheries will issue its ROD in accordance with NEPA procedure.

The ROD will announce the selected policy alternative that will, in turn, be recommended by NPFMC for Secretarial review and approval in accordance with the MSA FMP amendment process. Subsequent to issuance of the ROD and upon Secretarial approval of an alternative, the NPFMC and NOAA Fisheries will likely need to prioritize the requisite amendments and regulatory actions required to effect the selected policy and identify those measures that may require additional data and analysis. The NPFMC and NOAA Fisheries will identify those priorities and set a realistic schedule for implementing the decision.

1.7 Document Organization

The management of the Alaska groundfish fisheries is a large, complex program that continues to evolve as more information is obtained on the fishery resources, the marine ecosystem, and those that derive benefits from both. The Programmatic SEIS provides a means for informing the public about Alaska groundfish management, the current regime, alternative regimes, known and unknown elements of the ecosystem, and the complex set of laws and regulations that apply to federal fisheries management. To meet its objectives, the document has been organized into a series of chapters and sections.

Chapter 1 establishes the purpose of and need for the federal action supported by this Programmatic SEIS. It provides an overview of NEPA and its procedural requirements, a history of this document including NOAA Fisheries' methods for conducting the NEPA scoping process and addressing public comments.

Chapter 2 presents the programmatic alternatives that are the focus of this document, beginning with a detailed explanation of the body of fisheries management policies, practices, tools, and methods that will give readers the foundation for a better understanding of the alternatives. This chapter also identifies the NPFMC's preferred alternative.

Chapter 3 describes the physical, biological, and socioeconomic resource components of the BSAI and GOA environments, and the eastern Bering Sea (EBS) and eastern North Pacific ecosystems. The objective of this chapter is to present a description of the relevant history and current status of the resources and environment that will serve as the baseline for the analyses of the alternatives. This chapter also includes a discussion of the past cumulative effects on the human environment, as they contribute to the existing baseline condition.

Chapter 4 discusses the effects of groundfish fishing on the environment under the different alternatives and their associated FMP bookends. The analyses examine the direct, indirect, and cumulative effects of each of the hypothetical FMPs that serve as bookends for the range of management actions appropriate to the particular policy alternative. This chapter then builds on these analyses and presents conclusions regarding the overall effects of the policy alternatives.

Section 4.1 provides a description of the methods used to determine the significance of potential consequences, the methods used to analyze the alternatives, and the application of the model output. The analysis of these model regimes and their contrast to the baseline condition established in Chapter 3 is intended to illustrate the general environmental effects of each programmatic policy alternative. In so doing, this Programmatic SEIS will provide the NPFMC and NOAA Fisheries, as well as the public, with information that can be used to guide future policy decisions.

Section 4.2 presents the analytical framework used to evaluate the alternatives. FMP bookends for each alternative were used as proxies for analyzing the policy alternatives. This section describes the FMP bookends and also presents maps that were developed to interpret the policy alternatives and depict some of the differences, such as closure areas, between the alternatives.

Section 4.3 presents abstracts of eleven Qualitative Analysis papers prepared to analyze the FMP components as they relate to the alternatives. These papers describe, in a qualitative manner, the effects of the alternative FMPs on key issues, such as fishing bycatch or overcapacity (the full text of these papers is included as Appendix F).

Section 4.4 provides a review of the comparative baseline statements carried forward for cumulative effects analysis for each key issue category.

Sections 4.5 through 4.9 present, by alternative, a detailed examination of the example FMP bookends and the likely environmental consequences of each alternative. Several key issues were identified through NOAA Fisheries' review of the scoping comments. A subset of ten key issues emerged as being mentioned more frequently and, we infer, most important to the public. The following list presents the ten key issues NOAA Fisheries used to develop the programmatic policy alternatives:

1. The effects of the alternatives on target groundfish species.

2. The effects of the alternatives on prohibited species.

3. The effects of the alternatives on other species.

4. The effects of the alternatives on forage species.

5. The effects of the alternatives on non-specified species.

6. The effects of the alternatives on essential fish habitat.

7. The effects of the alternatives on seabirds.

8. The effects of the alternatives on marine mammals.

9. The effects of the alternatives on the socioeconomics of the fishery.

10. The effects of the alternatives on the marine ecosystem.

Section 4.10 analyzes each alternative from a policy-level perspective, drawing on the results from the previous analyses, and Section 4.11 compares the alternatives at the policy-level, presenting the major conclusions of the findings on environmental and social issues.

Chapter 5 focuses on research and management, and provides a brief description of existing research priorities in fisheries management, as well as a list of data gaps and research needs for each policy alternative. This section also presents a discussion of management and enforcement considerations for each policy alternative.

Chapter 6 contains a list of preparers of the document while Chapter 7 presents the distribution list for the document. Chapter 8 contains the literature cited, and Chapter 9 provides an index.

The figures and tables of the document are included in Appendix A. Appendices B through E provide historical information on groundfish management. Appendix F contains the Qualitative Assurance papers, and Appendix G includes the comment analysis report (CAR) for the 2003 Draft Programmatic SEIS. Appendix H contains model output used to analyze the alternatives. Several appendices (I through L) provide copies of the Federal Register notices relating to the preparation of the Programmatic SEIS. Appendices M and N are informational NPFMC documents, and Appendix O is the Biological Assessment that presents the results from the informal Endangered Species Act consultation.

Chapter 2

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Chapter 2 The Programmatic Alternatives

This chapter has two purposes. The first is to give readers a broad understanding of fisheries management policies and practices in the United States (U.S.) and, specifically, in the federally managed waters off Alaska. Beginning with a review of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the other applicable federal statutes and executive orders (EO), we discuss the development of fisheries policy, its assumptions and intentions, and how policy is conveyed and applied to the subject groundfish fisheries. This chapter explains how decisions are made and who makes them; how a Fishery Management Plan (FMP) operates; and how National Marine Fisheries Service (National Oceanic and Atmospheric Administration [NOAA] Fisheries or NMFS) uses the practical tools of fishery management to manage the groundfish fisheries on a daily basis. Knowing how the fisheries management system works will make the programmatic alternatives easier to understand.

This chapter's second purpose is to present the programmatic alternatives. Beginning with Section 2.6, we recount the history of the development of the alternatives and briefly discuss those alternatives that were considered but not carried forward in this document. We then present the programmatic alternatives and the methods used to evaluate them. The chapter concludes by identifying the North Pacific Fishery Management Council's (NPFMC) preferred alternative (PA).

2.1 Background Specific to Understanding this Federal Action

Chapter 1 discussed the general purpose and need for this federal action, the ongoing management of the federal groundfish fisheries off Alaska. Chapter 1 defined the purpose of a Programmatic Supplemental Environmental Impact Statement (SEIS) in terms of the procedural requirements of the National Environmental Policy Act (NEPA) and as defined by both the Council on Environmental Quality (CEQ) and NOAA in their respective guidelines. Chapter 1 also explained the specific purpose of this Programmatic SEIS in support of the continuing management of the subject groundfish fisheries. As a Programmatic SEIS, this document proposes to analyze the general environmental consequences of a broad scope of actions presented in the context of various policy alternatives.

The policy alternatives have been developed as alternative frameworks. A framework is a statement of particular goals and objectives that allows the NPFMC and NOAA Fisheries some latitude in proposing specific future actions necessary to manage the fishery and conserve the groundfish resource consistent with the goals and objectives that form the framework. Such frameworks, found in the existing FMPs for both the Bering Sea and Aleutian Islands (BSAI) and the Gulf of Alaska (GOA), provide the flexibility needed to manage dynamic fisheries that rely on a no less dynamic, complex, and changing ocean environment for their continued survival. A framework also allows the accommodation of changing public values regarding the nation's natural resources and how best to utilize and conserve those resources. Moreover, the frameworks allow decision-makers the latitude needed to balance sometimes competing objectives and priorities.

The current management policy for the groundfish fisheries, as identified in the current FMPs and presented herein as Alternative 1 (the no-action alternative), is also structured as a framework composed of a number of management goals and objectives. The policy frameworks of the FMPs, as shown later in this chapter, have allowed considerable latitude for action by the NPFMC and NOAA Fisheries; both FMPs have been amended more than 65 times over the last 25 years to respond to new information and new environmental issues and to improve the efficiency and effectiveness of fisheries management.

The alternatives to the status quo are also structured as policy frameworks. Other than this Programmatic SEIS process, no formal proposal is currently before the NPFMC or NOAA Fisheries that outlines a new or alternative management policy. However, NEPA requires that resource managers identify and evaluate alternatives to the status quo before promulgating new actions or, as in this case, to support continuing actions. Therefore, NOAA Fisheries developed the present policy alternatives that, in response to the values and objectives expressed through scoping and public comments on the 2001 Draft Programmatic SEIS and the 2003 Draft Programmatic SEIS, attempt to capture those values and objectives while remaining consistent with the MSA and other applicable federal law (see Section 2.3). A common theme that emerged from the public comments was the need to pursue a more precautionary approach to fisheries management when faced with the uncertainties associated with the effects of commercial fishing on the environment. With the assistance of the NPFMC and public stakeholders, NOAA Fisheries has designed alternative policy frameworks that, to varying degrees, capture the precautionary principle and elevate key ecosystem issues to the forefront of the fisheries decision-making process.

The main purpose of this chapter is to present the programmatic policy alternatives. To help readers understand and evaluate the programmatic alternatives, this chapter first provides a detailed discussion of the federal fishery management system in the Exclusive Economic Zone (EEZ) off Alaska.

2.2 Management Policies and Objectives

The survey of fishery management laws, policies, and practices begins with a review of federal policies regarding marine fishery conservation and management as those policies have evolved historically and as they are currently mandated by federal statute and EO. Throughout this general discussion, references are provided to more detailed discussions contained in the appendices.

2.2.1 Origins of United States Fisheries Policy

Fisheries management in the U.S. has historically been based on the principle of the public trust doctrine, a principle of common law that reflects certain political and cultural concepts pertaining to natural resources. Based first on Roman law and then on English common law, the principle asserts that certain resources, such as the air and the water in rivers and oceans, are incapable of private ownership and control. Fish swimming freely in rivers and oceans, by extension, are included in the principle. In medieval England, running water, the air, the sea, the shores of the sea, and the right to fish in the rivers and sea were considered common to all by "natural law." The Crown held these resources in trust for the benefit of the nation as its sovereign right and responsibility. When the U.S. colonies successfully defended their independence from England in the late eighteenth century, they assumed the trust authority of the Crown over navigable waterways within their borders, including the fish within these waters.

The public trust is held to be inalienable, and stewardship of natural resources cannot be transferred from the government that has responsibility for protecting those resources from overuse or habitat degradation for the benefit of its people (National Research Council [NRC] 1999). In the U.S., the public trust principle was further advanced under the presidency of Theodore Roosevelt, whose Chief Forester, Gifford Pinchot, asserted the government's right and duty to control the use of natural resources for the greater prosperity of the public (Mitchell 1997).

Regarding fisheries, a corollary to the public trust principle is that the principle applies to the resource in its natural state only; a fisherman acquires title to fish when he removes them from their natural state and takes them into his possession, i.e., when he catches them.

2.2.2 Current Federal Statutes and Mandates

The public trust doctrine stands as the basis for the Federal Government's responsibility to conserve and manage marine fisheries resources in the EEZ for the overall benefit of the people of the U.S. The principles of the doctrine are mandated by the body of federal statutes and EOs that guide the formulation and implementation of federal fishery management policies. Currently, these include 12 statutes and 7 EOs. Some of these laws speak directly to the conservation or management of fishery resources; others are directed at ensuring that fishery management measures and federal actions, in general, are fair and equitable and that potential environmental, economic, and social effects of federal actions are considered before they are adopted. For purposes of managing federal fisheries, the executive branch's responsibility for compliance with these mandates resides primarily with the Secretary of Commerce and has been delegated largely to NOAA Fisheries, one of the five NOAA agencies in the Department of Commerce.

In the following paragraphs, each of these federal statutes and EOs are discussed in turn as they apply to management and conservation of the groundfish fisheries.

Magnuson-Stevens Fishery Conservation and Management Act

The MSA (16 United States Code [USC] 1801, *et seq*.) is the principal federal statute providing for the management of U.S. marine fisheries. Originally enacted as the Fishery Conservation and Management Act in 1976 (Public Law 94-265), this law was arguably the most significant fisheries legislation in U.S. history. It has been amended periodically since 1976; most recently in 1996, by the Sustainable Fisheries Act (SFA) (Public Law 104-297). The basic concepts of that original Act, however, have not changed. They include the following:

1. Fisheries should be managed in a sustainable manner such that conservation and management measures achieve the optimum yield (OY) from each fishery on a continuing basis while preventing overfishing.

2. Conservation and management decision-making must be based on the best available scientific information, which should include social, economic, and ecological factors along with biological factors.

3. The needs of fishery resource users vary across the nation, and public participation in the policy-making process should be maximized.

The MSA (as amended in 1996 by the SFA) adds the following policy statement regarding the nation's fisheries (16 USC 1801(c)):

> *POLICY–It is further declared to be the policy of the Congress in this Act:*
>
> *To maintain without change the existing territorial or other ocean jurisdiction of the U.S. for all purposes other than the conservation and management of fishery resources, as provided for in this Act;*
>
> *To authorize no impediment to, or interference with, recognized legitimate uses of the high seas, except as necessary for the conservation and management of fishery resources, as provided for in this Act;*
>
> *To assure that the national fishery conservation and management program utilizes, and is based upon, the best scientific information available; involves, and is responsive to the needs of, interested and affected states and citizens; considers efficiency; draws upon federal, state, and academic capabilities in carrying out research, administration, management, and enforcement; considers the effects of fishing on immature fish and encourages development of practical measures that minimize bycatch and avoid unnecessary waste of fish; and is workable and effective;*
>
> *To permit foreign fishing consistent with the provisions of this Act;*

To support and encourage active U.S. efforts to obtain internationally acceptable agreements which provide for effective conservation and management of fishery resources, and to secure agreements to regulate fishing by vessels or persons beyond the exclusive economic zones of any nation;

To foster and maintain the diversity of fisheries in the U.S.; and

To ensure that the fishery resources adjacent to a Pacific Insular Area, including resident or migratory stocks within the exclusive economic zone adjacent to such areas, be explored, developed, conserved, and managed for the benefit of the people of such area and of the U.S.

The MSA also established 10 National Standards that serve as the overarching objectives for fishery conservation and management and the development of FMPs (16 USC 1851):

(a) IN GENERAL–Any Fishery Management Plan prepared, and any regulation promulgated to implement any such plan, pursuant to this title shall be consistent with the following National Standards for fishery conservation and management:

(1) Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the OY from each fishery for the U.S. fishing industry.

(2) Conservation and management measures shall be based upon the best scientific information available.

(3) To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

(4) Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various U.S. fishermen, such allocation shall be (a) fair and equitable to all such fishermen; (b) reasonably calculated to promote conservation; and (c) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

(5) Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

(6) Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

(7) Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

(8) *Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (a) provide for the sustained participation of such communities, and (b) to the extent practicable, minimize adverse economic impacts on such communities.*

(9) *Conservation and management measures shall, to the extent practicable, (a) minimize bycatch, and (b) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.*

(10) *Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.*

The MSA also mandates the Secretary of Commerce to develop advisory guidelines to assist in FMP development. These guidelines serve primarily to interpret and aid compliance with the National Standards (codified at 50 Code of Federal Regulations [CFR] Part 600).

In recent years, amendments to the MSA have played a critical role in framing the regulatory regime within which the North Pacific groundfish fisheries operate. In particular, MSA amendments have addressed issues regarding overfishing, resource allocation among competing users, bycatch management, and conservation of essential fish habitat (EFH).

American Fisheries Act

Next to the MSA, the American Fisheries Act (AFA) (Public Law 105-277, division C, title II) is the only other fisheries-specific legislation affecting how groundfish fisheries in the BSAI and, to a lesser extent, the GOA are managed. Enacted in October 1998, the AFA represents the culmination of a decade-long struggle over the allocation of Alaska's most abundant fishery resource, pollock, in the BSAI. The AFA institutionalized a resource allocation scheme among competing onshore and offshore components of the fish processing industry.

Provisions mandated by the AFA, effective as of 1999, were implemented through the total allowable catch (TAC) specification process and emergency interim rule-making until the final regulations were published on December 30, 2002 (67 Federal Register [FR] 79692).

Major provisions of the AFA include the following:

- Requirement of a minimum of 75 percent U.S. ownership of fishing vessels (up from the majority ownership previously required) and maximum size and horsepower limits for replacement vessels.

- Specific allocation of the BSAI directed pollock fishery TAC among the inshore component (50 percent) catcher processor vessels in the offshore component (40 percent), and motherships in the offshore component (10 percent) after first deducting 10 percent of the TAC for the Community Development Quota (CDQ) Program and an incidental catch allowance.

- Buyout of nine catcher processor vessels' future fishing privileges, financed through a combination of a grant and direct loan obligations, to be paid back by a tax of $0.006 per pound of pollock harvested by the inshore sector.

- Specific naming of 20 catcher processor vessels that may participate in the (offshore) pollock fishery, seven catcher vessels that may deliver pollock to those catcher processors, and 19 catcher vessels that may deliver pollock to motherships.

- Criteria for catcher vessels to participate in harvesting BSAI pollock in the inshore sector, and criteria for limiting the participation of onshore processing plants in the BSAI pollock fishery.

- The ability to form fishery cooperatives (with limitations on their structure and the participation of catcher vessels and the inshore sector processing plants).

- Directions for the NPFMC to develop or improve on limitations (sideboards) on the activities of AFA vessels and processors in non-pollock fisheries to prevent negative spillover effects of fishery cooperatives.

Beginning January 1, 2000, all vessels and processors wishing to participate in the non-CDQ BSAI pollock fishery are required to have valid AFA permits on board the vessel or at the processing plant. AFA permits are required even for vessels and processors specifically named in the AFA and are required in addition to any other federal or state permits. AFA permits also may limit the take of non-pollock groundfish, crab, and prohibited species as governed by AFA "sideboard" provisions.

With the exceptions of applications for inshore vessel cooperatives and for replacement vessels, the AFA permit program had a one-time application deadline of December 1, 2000, for AFA vessel and processor permits. Applications for AFA vessel or processor permits were not accepted after this date, and any vessels or processors for which an application had not been received by this date became permanently ineligible to receive AFA permits.

National Environmental Policy Act

The first chapter explained the provisions of NEPA (42 USC 4331, *et seq*.), the U.S.'s basic national charter for environmental responsibility. To briefly recount those provisions: NEPA establishes the national environmental policy, provides an interdisciplinary framework for environmental planning by federal agencies, and contains action-forcing procedures to ensure that federal decision-makers take environmental factors into account. NEPA does not require that the most environmentally desirable alternative be chosen, but does require that the environmental effects of all the alternatives be analyzed equally for the benefit of decision-makers and the public.

NEPA has two principal purposes:

1. To require federal agencies to evaluate the potential environmental effects of any major planned federal action to ensure that public officials make well-informed decisions about the potential impacts.

2. To promote public awareness of potential impacts at the earliest planning stages of major federal actions by requiring federal agencies to prepare a detailed environmental evaluation for any major federal action significantly affecting the quality of the human environment.

As with the MSA, NEPA requires an assessment of both the biological and the social and economic consequences of fisheries management alternatives and provides that members of the public have an opportunity to be involved in and to influence decision-making on federal actions. In short, NEPA ensures that environmental information is available to government officials and the public before decisions are made and actions taken.

Title II, Section 202 of NEPA (42 USC 4332) created the CEQ. The duties of CEQ include, among other things, advising and assisting the President in preparing an annual environmental quality report, which is submitted to Congress. This report gathers information concerning trends in the quality of the environment, and developing policies to promote the goals of NEPA (42 USC 4344). The CEQ is also responsible for the development and oversight of regulations and procedures implementing NEPA. The CEQ regulations provide guidance for federal agencies regarding NEPA's requirements (40 CFR Part 1500) and require agencies to identify processes for issue scoping, for the consideration of alternatives, for developing evaluation procedures, for involving the public and reviewing public input, and for coordinating with other agencies—all of which are applicable to the NPFMC's development of the groundfish FMPs.

NOAA has also prepared environmental review procedures for implementing NEPA (NOAA Administrative Order 216-6). This Administrative Order describes NOAA's policies, requirements, and procedures for complying with NEPA and the implementing regulations issued by the CEQ. A 1999 revision and update to the Administrative Order includes specific guidance regarding categorical exclusions, especially as they relate to endangered species, marine mammals, fisheries, and habitat restoration. The Administrative Order also expands on guidance for consideration of cumulative impacts and "tiering" in the environmental review of NOAA actions. This Administrative Order provides comprehensive and specific procedural guidance to NOAA Fisheries and the NPFMC for preparing and adopting groundfish FMPs.

Federal fishery management actions subject to NEPA requirements include the approval of FMPs, FMP amendments, and regulations implementing FMPs. Such approval requires preparation of an environmental assessment (EA). The purpose of an EA is to determine if the proposed action is a major federal action significantly affecting the environment and thereby requiring an environmental impact statement (EIS) or whether the action does not significantly affect the environment, in which case a finding of no significant impact may be issued.

NEPA and the MSA requirements for schedule, format, and public participation are compatible and allow one process to fulfill both obligations. If an EIS or SEIS is prepared, however, the notice of availability (NOA) of a final EIS (or SEIS) must be published at least 30 days before the Secretary of Commerce approves, disapproves, or partially approves an FMP or FMP amendment.

Endangered Species Act

The Endangered Species Act (ESA) (16 USC 1531 *et seq.*), passed in 1973 and reauthorized in 1988, provides broad protection for fish and wildlife species that are listed as threatened or endangered. The ESA establishes procedures for the formal listing of a species, for the development of recovery plans, and for designation of critical habitats. It also outlines procedures for federal agencies to follow when taking actions that may jeopardize the continued existence of a species or that may adversely modify its critical habitat. Responsibilities for implementing the ESA are shared by the U.S. Fish and Wildlife Service (USFWS) and NOAA Fisheries. With some exceptions, the USFWS oversees freshwater fish, birds, terrestrial mammals, and plants, and NOAA Fisheries oversees anadromous and marine fish, marine mammals, and sea grasses. NOAA Fisheries is therefore tasked both with managing the groundfish harvest through FMPs and with ensuring that identified threatened and endangered species (e.g., the Steller sea lion) receive appropriate consideration and protection during the planning and implementation of groundfish management measures. It should be noted that compliance with ESA provisions is not subject to modification based on economic hardship. Recovery plans required under the ESA give priority to those listed species that may be affected by different economic activities.

Sections 2(c)(1) and 7(a)(1) of the ESA require federal agencies to conserve endangered and threatened species; however, conservation is broadly defined. Section 7(a)(2) of the ESA requires federal agencies to ensure that any action authorized, funded, or carried out by such agencies is not likely to jeopardize or result in the destruction or adverse modification of the critical habitat of endangered or threatened species.

Under an FMP, all fishing activities must be considered; not just the specific fisheries for which management measures are under consideration. NOAA Fisheries must conduct a formal Section 7 consultation that results in a biological opinion if a proposed action "may affect" or "is likely to adversely affect" endangered or threatened species or their critical habitat. If the biological opinion concludes that the proposed action "is likely to jeopardize the continued existence of" threatened or endangered species, then reasonable and prudent alternatives must be developed to minimize or mitigate the effect of the action. The fishery management action in question must then be revised to implement the reasonable and prudent measures.

The Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 USC 1361, *et seq.*), as amended, establishes a federal responsibility to conserve marine mammals. Congress declared that marine mammals are resources of great international significance and that they should be protected and their development promoted to the greatest extent feasible, commensurate with sound resource management policies. Finding that certain species and populations of marine mammals are or may be in danger of extinction or depletion due to human activities, Congress vested NOAA Fisheries with management responsibility for cetaceans (whales) and pinnipeds other than walrus (seals). (All other marine mammals found in Alaska, such as the sea otter, walrus, and polar bear, fall under the auspices of the USFWS.)

The MMPA's primary management objective is to maintain the health and stability of the marine ecosystem, with a goal of obtaining an optimum sustainable population of marine mammals within the carrying capacity of the habitat. The MMPA is intended to work in concert with the provisions of the ESA. The Secretary of Commerce is required to give full consideration to all factors regarding regulations applicable to the "take" of marine mammals. (The MMPA defines "take" broadly to mean "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.") Such factors include the conservation, development, and utilization of fishery resources, and the economic and technological feasibility of implementing the regulations. If a fishery affects a marine mammal population, then the potential impacts of the fishery must be analyzed in the appropriate EA or EIS, and the pertinent regional council or NOAA Fisheries may be requested to consider regulations to mitigate adverse impacts.

The Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) authorizes collection of fisheries data and coordination with other agencies for environmental decisions affecting living marine resources. Both formal and informal consultations, cooperative research, and data-gathering programs are routinely pursued.

The Federal Power Act

The Federal Power Act (FPA) provides for concurrent responsibilities with the USFWS in protecting aquatic habitat. The original statute was enacted in 1920; however, only the 1935 and 1986 amendments added new requirements to incorporate fish and wildlife concerns in licensing, relicensing, and exemption procedures for power projects.

Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) (16 USC 1451, *et seq.*) is designed to encourage and assist states in developing coastal management programs, to coordinate federal and state activities, and to safeguard regional and national interests in the coastal zone. Section 307(c) (16 USC 1456(c)) of the CZMA requires that any federal activity affecting the land or water uses or natural resources of a state's coastal zone be consistent with the state's approved coastal management program to the maximum extent practicable.

A proposed fishery management action that requires an FMP amendment or implementing regulations must be assessed to determine whether it directly affects the coastal zone of a state with an approved coastal zone management program. If so, NOAA Fisheries must provide the state agency having CZMA responsibility with a consistency determination for review at least 90 days before final NOAA Fisheries action.

Administrative Procedure Act

The Administrative Procedure Act (APA) (5 USC 551, *et seq.*) requires federal agencies to give the public prior notice of rule-making and an opportunity to comment on proposed rules. General notice of proposed rule-making must be published in the FR, unless persons subject to the rule have actual notice of the rule. Proposed rules published in the FR must include reference to the legal authority under which the rule is proposed and explain the nature of the proposed action, its intended effect, and any relevant regulatory history that provides the public with a well-informed basis for understanding and commenting on the proposed action. The APA also specifies conditions that allow an agency to implement regulations on an emergency or interim basis without requiring public comment periods. These emergency conditions can be of an ecological, economic, social, or public health nature.

Except for the emergency or interim rule provisions, a proposed rule is designed to give interested or affected persons opportunity to submit written data, views, or arguments for or against the proposed action. After the end of a public comment period, the APA requires comments received to be summarized and responded to in the final rule notice. Further, the APA requires the effective date of a final rule to be no less than 30 days after publication of the final notice in the FR. This delayed effectiveness or "cooling off" period is intended to allow the affected public to become aware of and be prepared to comply with the requirements of the rule. For fishery management regulations, the primary effect of the APA, in combination with the MSA, NEPA, and other statutes, is to provide for public participation and input into the development of FMPs, FMP amendments, and regulations implementing FMPs.

Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) (5 USC 601, *et seq*.) requires federal agencies to assess the impacts of their proposed regulations on small entities and to seek ways to minimize economic effects on small entities that would be disproportionately or unnecessarily adverse. The RFA defines small entities as (1) small businesses which, for commercial fishing or fish processing, are firms with receipts of up to $3 million annually or up to 500 employees, respectively, (2) small non-profit organizations, and (3) small governmental jurisdictions with a population of up to 50,000 persons. For Alaska fisheries, these criteria include most fishing firms except for the large catcher processor vessels and most coastal communities except for Anchorage. NOAA Fisheries has published revised guidelines dated August 16, 2000, for RFA analysis; they include criteria for determining if the action would have a significant impact on a substantial number of small entities. Those guidelines may be viewed online at www.nmfs.noaa.gov/sfa/prorules.

Although the RFA allows agencies to certify that a proposed rule will not have significant impacts on a substantial number of small entities, an initial regulatory flexibility analysis (IRFA) is routinely prepared for most proposed Alaska groundfish fishery management measures. The IRFA is usually combined with the EA or EIS document required by NEPA. If, following public comments on the proposed rule, the action is still considered to meet the criteria for requiring RFA analysis, then a final regulatory flexibility analysis (FRFA) must be prepared. The FRFA contains most of the same information presented in the IRFA, but also must include (1) a summary of significant issues raised in public comment on the IRFA and the agency's response to those comments, and (2) a description of the steps the agency has taken to minimize the significant economic impacts on small entities, including a statement of factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why all other alternatives considered were rejected. Finally, the FRFA or a summary of it must be published in the FR with the final rule.

Paperwork Reduction Act

The Paperwork Reduction Act (PRA) of 1995 (44 USC 3501 *et seq*., and 5 CFR part 1320) is designed "to minimize the paperwork burden for individuals, small businesses, educational and nonprofit institutions, federal contractors, state, local and tribal governments, and other persons resulting from the collection of information by or for the Federal Government." In brief, this law is intended to ensure that the government is not overly burdening the public with requests for information. Procedurally, the PRA requirements constrain what, how, and how frequently information will be collected from the public affected by a rule that requires reporting (e.g., the amount of fish caught during a fishing trip).

Data Quality Act

Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Public Law 106-554) directed the Office of Management and Budget (OMB) to issue government-wide guidelines that provide policy and procedural guidance for ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by federal agencies. This bill is known as the Data Quality Act. The OMB's guidelines require all federal agencies to develop their own guidelines for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by the agency. NOAA published its guidelines in February 2002 (available online at http://www.commerce.gov).

Executive Order 12630: Takings

This EO on Government Actions and Interference with Constitutionally Protected Property Rights was signed by the President on March 15, 1988, and published on March 18, 1988 (53 FR 8859). This EO requires that each federal agency prepare a "takings implications assessment" for any of its administrative, regulatory, and legislative policies and actions that affect, or may affect, the use of any real or personal property. Fishery management measures that limit fishing seasons, areas, catch quotas, the size of harvested fish, and bag limits have received a categorical exclusion from a takings analysis. However, takings issues are raised frequently in the context of limited access systems, which confer a harvesting privilege on a fisherman in the form of a permit to catch a specific amount of fish or a license to enter and participate in a fishery. Although such permits and licenses may be transferrable, and therefore increase (or decrease) in market value, they do not convey any property rights in the fishery resource (i.e., the fish).

Executive Order 12898: Environmental Justice

EO 12898, signed by the President on February 11, 1994, and published February 16, 1994 (59 FR 7629), requires that federal agencies make achieving "environmental justice" part of their mission by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low income populations in the U.S. A growing number of Alaska Natives participate in the groundfish fisheries as a result of the federal CDQ Program. As a result, coastal Native communities participating in the CDQ Program derive substantial economic benefits from the federal groundfish fisheries. The effects of the federal action on minority populations are described in Chapter 4.

Executive Order 13175: Consultation and Coordination with Indian Tribal Governments

This EO, signed by the President on November 6, 2000, and published November 9, 2000 (65 FR 67249), is intended to establish regular and meaningful consultation and collaboration between federal agencies and Native tribal governments in the development of federal regulatory practices that significantly or uniquely affect their communities. This EO prohibits regulations that impose substantial direct compliance costs on

Native tribal communities. In preparing this Programmatic SEIS, NOAA Fisheries has initiated a government-to-government consultation process with affected Native communities.

Executive Order 13158: Marine Protected Areas

This EO, signed by the President on May 26, 2000, and published on May 31, 2000 (65 FR 34909), directs the Departments of Commerce and the Interior to jointly develop a national system of marine protected areas (MPAs). The purpose of the system is to strengthen the management, protection, and conservation of existing protected areas and establish new or expanded MPAs. The MPA system is to be scientifically based, representing diverse U.S. marine ecosystems and the nation's natural and cultural resources. Establishing such a system is intended to reduce the likelihood that MPAs are harmed by federally approved or funded activities. Alternatives 1(b), 3, and 4 of this Programmatic SEIS specifically address this EO in their respective policy frameworks.

Executive Order 12114: Environmental Effects Abroad

This EO, signed by the President on January 4, 1979, and published on January 9, 1979 (44 FR 1957), directs agencies to consider the effects of major federal actions upon the environment of foreign nations or of "global commons" such as the oceans. These actions include those major federal actions that result in significant environmental effects that extend outside of the geographic borders of the U.S. In some cases, an EIS may be required. This EO encourages international agreements and an exchange of information between the affected nations and the U.S. This EO may pertain to the groundfish fisheries in the EEZ off Alaska to the extent that those fisheries impact the ocean environment beyond the EEZ.

Executive Order 12866: Regulatory Planning and Review

EO 12866, signed by the President on September 30, 1993, and published October 4, 1993 (58 FR 51735), replaced EOs 12291 and 12498. Its purpose, among other things, is to enhance planning and coordination with respect to new and existing regulations, and to make the regulatory process more accessible and open to the public. In addition, EO 12866 requires agencies to take a deliberative, analytical approach to rule-making, including assessment of costs and benefits of the intended regulations. For fisheries management purposes, it requires NOAA Fisheries (1) to prepare a regulatory impact review (RIR) for all regulatory actions, (2) to prepare a unified regulatory agenda twice a year to inform the public of the agency's expected regulatory actions, and (3) to conduct a periodic review of existing regulations.

The purpose of an RIR is to assess the potential economic impacts of a proposed regulatory action. As such, it can be used to satisfy NEPA requirements and to serve as a basis for determining whether a proposed rule will have a significant impact on a substantial number of small entities which would trigger the completion of an IRFA under the RFA. For this reason, the RIR is frequently combined with an EA and an IRFA in a single EA/RIR/IRFA document that satisfies the analytical requirements of NEPA, RFA, and EO 12866. Criteria for determining "significance" for EO 12866 purposes, however, are different than those for determining significance for RFA purposes. A significant rule under EO 12866 is one that is likely to (1) have an annual effect on the economy (of the nation) of $100 million or more; (2) create serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or (4) raise novel legal or policy issues.

Although fisheries management actions rarely have an annual effect on the national economy of $100 million or more or trigger any of the other criteria, OMB makes the ultimate determination of significance under this EO, based in large measure on the analysis in the RIR. A recent example of a fishery management action determined to be "significant" under this EO is the regulatory action to implement provisions of the AFA. The significance determination is in part because, at least initially, the AFA rule-making raises novel legal or policy issues arising out of legal mandates. An action determined to be significant is subject to OMB review and clearance before its publication and implementation.

Executive Order 13132: Federalism

The "Federalism" EO, signed by the President on August 4, 1999, and published on August 10, 1999 (64 FR 43255), supercedes earlier federalism EOs (12612 and 13083), and supplements EOs 12372 ("Intergovernmental Review of Federal Programs"), 12866, and 12988 ("Civil Justice Reform"). This EO is intended to guide federal agencies in the formulation and implementation of "policies that have federalism implications," such as regulations, legislative comments or proposed legislation, and other policy statements or actions that have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government. This EO requires federal agencies to have a process to ensure meaningful and timely input from state and local officials in the development of regulatory policies that have federalism implications. A federalism summary impact statement is also required for rules that have federalism implications.

To preclude conflict between state and federal law on fishery management issues, the MSA (16 USC 1856) explicitly establishes conditions for federal preemption of state regulations (and of any extension of state fishery management authority into the EEZ). Furthermore, close consultation between the state and federal governments on Alaska groundfish fishery measures is provided by the NPFMC process (see Section 2.4).

Summary

These federal statutes and EOs constitute the legal foundation for all fishery management actions in the EEZ. As we have shown, some, such as the MSA and AFA, provide direct statutory direction for fisheries management, while others, such as the Administrative Procedure and PRAs, pertain to more general issues that impact all federal actions, including fisheries management. Together they require the NPFMC and NOAA Fisheries to create management policies and practices that are environmentally, socially, and economically responsible to the people of the U.S.

In the following section, we continue our discussion of how federal fisheries are managed by examining the components and functions of those FMPs and how they are developed by the NPFMC under the regional council process.

2.3 Components of a Fishery Management Plan

The MSA mandates the creation of FMPs as the primary fisheries management tools to be developed by the regional councils. Sections 303(a) and (b) of the MSA (16 USC 1853(a) and (b)) mandate that each FMP will contain 14 mandatory provisions and may contain 12 additional, discretionary provisions. The provisions are statements of policy and, in some cases, reflect competing objectives which must be balanced in the course of decision-making. These provisions are summarized below.

Required Provisions

FMPs must:

1. Contain conservation and management measures to prevent overfishing, rebuild overfished stocks, and promote the long-term health and stability of the fishery.

2. Contain a description of the fishery, including, but not limited to, the number of vessels involved, the type and quantity of fishing gear used, the species of fish involved and their location, the cost likely to be incurred in management, actual and potential revenues from the fishery, any recreational interest in the fishery, and the nature and extent of foreign fishing and Indian treaty fishing rights, if any.

3. Assess and specify the maximum sustainable yield and OY from the fishery and include a summary of calculations used to specify the maximum sustainable yield.

4. Assess and specify the proportion of OY that can be harvested and processed by U.S. interests.

5. Specify the fishing industry data that will be submitted to the Secretary of Commerce.

6. Consider and provide for temporary adjustments of fishing efforts that were curtailed for safety reasons.

7. Describe and identify EFH and protect such habitats from adverse fishing impacts.

8. Assess and specify the nature and extent of the scientific data needed for effective implementation of the plan.

9. Include a fishery impact statement that describes the likely effects of conservation and management measures, if any, on participants in the fisheries and fishing communities.

10. Specify objective and measurable criteria for identifying when the fishery is overfished with an analysis of how the criteria were determined.

11. Establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include measures to minimize bycatch and minimize the mortality of bycatch that cannot be avoided.

12. Assess the efficacy of catch-and-release fishery management programs.

13. Describe the participation of the recreational and charter fishing sectors.

14. Allocate any harvest restrictions or recovery benefits fairly and equitably among the commercial, recreational, and charter fishing sectors in the fishery.

Discretionary Provisions

FMPs may:

1. Require permits and fees from any fishing vessel or fish processor who receives fish that are subject to the plan.

2. Establish time, area, and gear restrictions to limit fishing effort as necessary.

3. Establish catch, sale, or transportation limits based on area, species, size, number, weight, sex, bycatch, total biomass, or other factors consistent with any applicable federal and state safety and quality requirements.

4. Prohibit, limit, condition, or require the use of specified types and quantities of fishing gear, fishing vessels, or equipment for such vessels, including devices which may be required to facilitate enforcement provisions.

5. Incorporate (consistent with other applicable laws) the relevant fishery conservation and management measures of the coastal states nearest to the fishery.

6. Establish a limited access system for the fishery in order to achieve OY.

7. Require fish processors to submit data necessary for the conservation and management of the fishery.

8. Require observers to be carried aboard a vessel for the purpose of collecting data necessary for the conservation and management of the fishery.

9. Assess and specify the impact of the plan on the naturally spawning anadromous fish stocks of the region.

10. Include incentives to minimize bycatch and decrease bycatch mortality.

11. Reserve portions of the allowable catch for use in scientific research.

12. Prescribe other measures, requirements, conditions, and restrictions necessary for the conservation and management of the fishery.

The First BSAI and GOA FMPs

An FMP thus comprises a set of coherent, specific policy statements that define a particular fishery. The role of the NPFMC and its regulatory partners is to apply a long list of general fishery policy objectives—the FMP requirements and standards listed above—to the particulars of the Alaska groundfish fishery. Competing interests within the fishing industry and competing policy objectives make this deliberative process a continual balancing act.

Both the BSAI and GOA groundfish FMPs state the NPFMC's goals and objectives for managing the fisheries (see Section 2.6.1). These goals and objectives and their accompanying policy statements are intended to clarify the basis for the NPFMC's decisions and recommendations to the Secretary of Commerce. They are also intended to provide the public and the stakeholders of the resource a clear sense of the management direction for the fisheries. It is important to recognize that at the time the original FMPs were prepared, the Alaska groundfish fisheries were going through a remarkable transition, changing from a foreign-dominated fishery to a purely domestic fishery. The goals and objectives developed during this period reflect the issues and needs of the time, and do not necessarily represent today's perspective and our current understanding of the fisheries and the marine ecosystem. (In Appendices C and D, readers may review a summary of the original FMPs and the numerous amendments that have been adopted since that time to see how changes in policy emphasis have reflected changing conditions in the fishery and environment.)

The GOA groundfish FMP, published in 1979, was the first FMP adopted by the NPFMC. Following implementation of the MSA in 1976, preliminary management plans were prepared for the GOA and BSAI to establish a management regime to control the foreign fisheries. The management of domestic harvests of groundfish requires an FMP. The NPFMC chose to prepare an FMP for the GOA first because at the time it was the only area with an existing domestic groundfish fishery. As a result, the GOA FMP was a simple document and limited in scope, compared to the regime in place today. In 1985, a general omnibus amendment (Appendix D; Amendment 14) overhauled the GOA FMP by addressing a number of administrative weaknesses. It also updated the plan's policy statement to better reflect the thinking at that time.

The BSAI groundfish FMP, implemented in 1981, set new standards for fisheries management. The FMP introduced a "framework" approach to decision-making. This plan authorized certain management tools, the subsequent application of which would not require a lengthy plan amendment process. Rather, such tools—already authorized by the FMP—could be implemented by regulatory amendment, a more efficient and expeditious means of implementing actual management measures than by FMP amendment. The BSAI FMP was also based on ecosystem principles, reflected in a statement of policy goals and objectives that has not been changed since 1981.

Subtle differences exist between the BSAI and GOA FMPs in terms of policy. Prepared by different authors, the FMPs exhibit differences in wording that can be attributed to the respective authors' different writing styles. Partially conflicting policy goals and objectives listed in both FMPs require that the NPFMC balance conflicting goals (e.g., stimulating the development of domestic fisheries versus rebuilding depressed stocks). Both policy statements reference the National Standards of the MSA as the overarching principles for managing the groundfish fisheries. The GOA FMP policy places primary emphasis on maximizing positive economic benefits to the U.S., consistent with resource stewardship responsibilities for the continuing welfare of the GOA's living marine resources. The BSAI FMPs policy is more neutral. The BSAI policy recognizes the dynamics of the Bering Sea ecosystem and the need for a flexible management regime to accommodate new information as more is learned about the ecosystem. Among other secondary objectives, the BSAI FMP also highlights the importance both of designing fishing strategies that have minimal impact on the environment and of taking a precautionary approach when data on the stock or the ecosystem is lacking. The differences in wording of the BSAI policy goals and objectives reflect a broader ecosystem view of the fisheries. Even though the policy statements in the two FMPs are worded differently, both areas are managed using the same principles. The NPFMC has always managed the BSAI and GOA groundfish fisheries as a whole, recognizing the close inter-relationships that exist between the fisheries and the two geographical areas.

The specificity of FMPs has changed over time. Early FMPs contained very specific management measures and harvest levels that could only be changed through a lengthy plan amendment process, which could require 18 to 24 months from problem identification to a change in management. Because of this process delay, changes in harvest limits often lagged behind changes in stock abundance. In addition, federal regulations often lagged behind changes in regulations for adjacent state waters, causing conflicts and confusion where stocks had to be managed as a unit throughout their range. This process has been streamlined by incorporating "framework" management tools into the FMP that allow for management changes within prescribed boundaries. For instance, harvest levels are now adjusted through a relatively brief specifications process, implemented by notice in the FR, rather than by the FMP amendment process (see Section 2.4).

2.4 Decision-Making Process for Fishery Management Plans

In addition to establishing the requirements for FMPs, the MSA also created a system of regional councils to manage the nation's marine fisheries. Unlike management of the nation's timber, mineral, grazing, and water resources, for which policy is determined by a federal agency, management responsibility for the nation's marine fisheries is assigned by the MSA to eight regional councils, which are charged with overseeing fisheries in their respective regions. For the federal waters off Alaska, the MSA thus created the NPFMC to be charged with responsibility for making fisheries management policy in the Alaska region of the EEZ.

The North Pacific Fishery Management Council

The NPFMC is composed of 15 members: 11 voting and four non-voting. Seven of the voting members are appointed by the Secretary of Commerce upon the recommendation of the governors of Alaska and Washington. The Governor of Alaska nominates candidates for five seats, the Governor of Washington two seats. Each member is appointed to a three-year term and may be reappointed, but may not exceed three consecutive terms. Four mandatory voting members are the leading fisheries officials from the states of Alaska, Washington, and Oregon, as well as the Alaska Regional Administrator for NOAA Fisheries. The four non-voting members are the Executive Director of the Pacific States Marine Fisheries Commission, the Area Director for the USFWS, the Commander of the 17th Coast Guard District, and a representative from the U.S. State Department. From the voting membership, the NPFMC elects a Chairman and Vice-Chairman to serve one-year terms. The NPFMC's current members are identified on the NPFMC website (http://www.fakr.noaa.gov/npfmc/).

The NPFMC has five regularly scheduled meetings each year, four in communities in Alaska, and one in Washington or Oregon. The NPFMC may also schedule additional meetings if the need arises. At each of these meetings, the NPFMC receives advice from its 22-member Advisory Panel, representing fishing industry groups, environmentalists, and consumer groups, and from its 12-member Scientific and Statistical Committee, made up of highly respected scientists who review all information brought to the NPFMC. In addition, the NPFMC works collaboratively with NOAA Fisheries, the federal regulatory agency charged with implementing and enforcing the management decisions of the NPFMC and running the day-to-day operations of fishery management. NOAA Fisheries scientists also conduct research and provide analysis for the NPFMC.

North Pacific Fisheries Management Council Action

The NPFMC uses a formal public process to solicit proposals on how the fisheries should be managed. Through this deliberative public process, and in consultation with several federal and state agencies, the NPFMC develops and amends the FMPs (with the approval of the Secretary of Commerce). FMP amendments may be inspired by a variety of events, including new laws, statutory requirements, and operational problems. Most FMP amendments, however, are generated by public recommendation through an open process (Figure 2.4-1).

The NPFMC annually solicits proposals for FMP amendments or regulatory changes from the public. These proposals are reviewed and qualitatively ranked in terms of analytical difficulty by the NPFMC's Plan Development Team for each FMP. Unfortunately, the number of proposals that merit serious policy consideration far exceed the number of policy analyses that the NPFMC can reasonably accomplish in any one year, so amendments that are needed to address critical issues, such as overfishing, take precedence. All of the amendment proposals are reviewed by the NPFMC's Advisory Panel, which makes recommendations on which proposals should be considered. After hearing the recommendations and public testimony on them (usually at the NPFMC's October meeting), the NPFMC selects the proposals—those it considers most urgent—that it will consider during the coming year.

Selected proposals are then analyzed in compliance with the laws and statutory requirements outlined in Section 2.2.2. Amendment analyses are usually drafted by NPFMC staff biologists and economists, with whatever assistance and collaboration may be needed from scientists and managers of NOAA Fisheries and the Alaska Department of Fish and Game (ADF&G). Sometimes the NPFMC contracts with private consultants to prepare all or part of an analysis. Any proposals made by NOAA Fisheries or ADF&G to improve the implementation of existing management policies frequently are analyzed by staff of the proposing agency.

No specific time limit is imposed by law for completing the draft analysis. Generally, for any particular amendment proposal, the NPFMC staff attempts to complete its analysis before the NPFMC's April meeting following the year in which the NPFMC decided to address the proposal. This is not always possible, however. Controversial proposals, or those that have a large number of alternatives and options for analysis, may require more time than the four months typically allocated for the analytical task. In addition, a proposal that, if implemented, could have a significant impact on the human environment is required by NEPA to have an EIS or SEIS instead of an EA. In this event, NEPA requires "scoping": "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action" (40 CFR 1501.7). Formal scoping officially begins with publication in the FR of a notice of intent to prepare an EIS or SEIS. Depending on the nature of the proposed action, it may be a lengthy period, involving numerous public hearings, or it may be fairly brief and involve no hearings and only a brief public comment period. At a minimum, however, the public comment period on the scope of issues to be addressed in the analysis should be at least 30 days (NAO 216-6). This additional public process, which occurs at the beginning of the analysis period, plus the greater depth of analysis in a draft EIS or SEIS, adds substantially to the overall time to plan and draft the analysis.

The next step is for the NPFMC to review a draft analysis and decide whether to release it officially for public review and comment. In making this decision, the NPFMC relies heavily on the advice it receives from its Advisory Panel and Scientific and Statistical Committee. The NPFMC also receives public testimony before making this decision, as the public too is given access to the initial draft analysis in advance of the formal public comment period. This "public release" decision also considers whether the analysis adequately addresses a reasonable range of alternatives and options, and adequately responds to the requirements of the MSA and other applicable laws. The NPFMC may decide at this point to release the initial draft analysis "as is" for formal public review; to instruct staff to make certain minor revisions before release; to request major revisions and another NPFMC review before release; or to suspend further action on the analysis, which would, at least temporarily, stop further development of the proposal. If the NPFMC decides to release the initial draft analysis for public review, the comment period is normally scheduled to begin at least four weeks before the NPFMC's next meeting. Complicated proposals are often granted longer public comment periods.

The NPFMC's next action on a management proposal is to decide on its PA. The NPFMC's PA at this point may be entirely different from the preference of the person or constituency group that originally proposed the action, or the NPFMC may decide to abandon the proposal. Normally, however, the NPFMC selects a PA from those in the analysis or one that is reasonably within the range of alternatives analyzed. The NPFMC takes this action after hearing again from its Advisory Panel, Scientific and Statistical Committee, and the public. If the NPFMC chooses a policy alternative that is not explicitly assessed in the analysis as its PA, the analysis is revised to include the PA.

The NPFMC's choice of a PA is frequently referred to as the "final action of the NPFMC to adopt an FMP/amendment for recommendation to the Secretary of Commerce," or simply as the NPFMC's "final action." Although the analysis frequently needs to be revised to specify the PA and rule-making documents that need to be drafted, the NPFMC rarely reviews the decision-making documents and analyses following a final vote. Instead, the NPFMC relies on the work of its staff and the NOAA Fisheries staff in the Alaska Regional Office and NOAA General Counsel, Alaska region, to prepare the necessary documents in final form. This cooperation among professional staffs is necessary to ensure that the proposed regulatory language accurately reflects the intent of the PA, results in an administratively efficient and enforceable program, and meets all the applicable laws. When all the necessary documents are complete, the NPFMC then transmits the necessary legal documents to the Secretary of Commerce for official review.

Secretarial Review

Section 304(a)(1) of the MSA (16 USC 1854(a)(1)) requires the Secretary of Commerce, "upon transmittal by the NPFMC to the Secretary of a Fishery Management Plan or plan amendment," to "immediately commence a review" of the FMP/amendment and to "immediately publish" a NOA in the FR soliciting public comment on the proposed plan/amendment for a 60-day period beginning on the date of publication. NOAA Fisheries, by delegation of the Secretary's authority, is required to review the documents and determine if they comply with the MSA and other applicable laws and if the policy proposal is structurally complete.

The decision to approve or disapprove a proposal is prescribed by the MSA (16 USC 1854(a) and (b)). For an FMP/amendment, NOAA Fisheries must approve, disapprove, or partially approve the FMP/amendment within 30 days of the end of the comment period published in the NOA. If Secretarial action is not taken within this 30-day period, then the FMP/amendment takes effect as if it were fully approved. The MSA clearly gives NOAA Fisheries only the power to approve, disapprove, or partially approve a NPFMC-recommended FMP/amendment and does not allow NOAA Fisheries to substitute its judgment for that of the NPFMC's or to attach conditions for approval. If an FMP/amendment is disapproved or partially approved, NOAA Fisheries must give written notice to the NPFMC specifying the applicable law with which the FMP/amendment is inconsistent, the nature of the inconsistency, and recommendations on how the NPFMC could correct the inconsistency. A similar process is required for proposed regulatory amendments. If NOAA Fisheries determines that the proposed regulatory amendment is consistent with the FMP/amendment and applicable laws, then it is published in the FR for a 15- to 60-day public comment period. If the determination is negative, NOAA Fisheries must notify the NPFMC in writing, specifying the inconsistencies and providing recommendations for revision that would make the proposed regulation consistent. A schematic representation of the procedural steps involved from NPFMC transmittal to an approval/disapproval decision is presented in Figure 2.4-2.

An approved FMP/amendment is implemented by publication of the final rule in the FR. The preamble to a final rule must summarize and respond to comments received on the proposed FMP/amendment or proposed rule. The MSA requires that a final rule be published within 30 days of the end of the comment period on the proposed rule. The rule normally is not effective for an additional 30 days after it is published as required under the APA. Regulations governing federal marine fisheries off the coast of Alaska are codified in the CFR at 50 CFR Part 679.

2.5 Fishery Management Practices

To govern a fishery, policy statements must be translated into the regulatory language of management rules. In the Alaska region, this is the responsibility of NOAA Fisheries. These fishery regulations must not only accurately reflect the intent of the NPFMC's policy; they must be consistent with national policy as expressed by the laws and EOs described in Section 2.2.

Although an FMP is technically a set of policy statements and does not implement any specific regulatory language, the proposed plan amendment must be analyzed in a manner that satisfies both MSA and NEPA requirements. In order to accomplish this analysis at a meaningful level of detail and specificity, managers and researchers must analyze sets of particular management tools as alternatives to the existing management tools used in the FMP (e.g., the status quo FMP). These alternatives must address the proposed action. Since the NPFMC could elect to use a different set of tools, or more likely, different configurations of the same tools, it is important for the reader to have a basic understanding of the nature of these management tools and how they might be used to achieve particular results. It is also useful to have an understanding of what types of information, or data, are available to guide and monitor the effectiveness of different management measures. The following sections will provide a brief summary of the management practices and tools currently used in the Alaska groundfish fisheries. Technical descriptions and stock assessment models are included in Appendix F-1.

2.5.1 Management Tools

Management measures and management tools are the means by which managers control the fishery. The two terms, "management measures" and "management tools" (often used interchangeably by fishery managers), refer to all the rules, regulations, conditions, and methods that are required to rebuild, restore, or maintain any fishery resource and the marine environment. For each management issue or problem, managers review the available tools to determine the best way to address the issue or solve the problem. Some management tools are designed to be manipulated within the broadly authorized regulatory framework of the FMPs. Others require a lengthy process of amending the FMP to be implemented.

Most fisheries management regulations limit the power of individuals and corporations to catch fish. These regulations govern who can fish, what species they can catch, when they can fish, where they can fish, and what gear they can use. Some fishery regulations are more administrative in nature and require those fishing to keep records of and report certain data to fishery managers. This data is used by fishery managers and biologists to monitor the biological and economic health of the fishery, develop conservative harvest strategies and assess their potential impacts, and to enforce regulations. In addition, the regulations sometimes define measures that ensure fairness for all participants in a fishery. For example, some regulations require fishermen to apply for a license, file a particular report, or pay certain fees. Such fairness rules may also apply to the regulatory agency itself by requiring the agency to issue certain reports, specify catch limits, or make certain determinations by a certain date.

The following paragraphs discuss each of the management measures or tools that fishery managers use to manage and conserve the resource: who can participate in a fishery; what species may be harvested; when and where harvesting may occur; and what restrictions may be placed on fishing gear.

Who May Participate

Until the MSA was implemented in 1976, the only restrictions on who could participate in offshore fisheries were imposed by bilateral or multilateral agreements with foreign countries (see Appendix B). Fishery resources beyond the territorial jurisdiction (which at that time extended to only 3 nautical miles [nm] from shore) of any nation were considered common property and open to access by fishermen from all nations. Freedom to fish on the high seas was considered a basic principle of international law of the sea. (Koers 1973). The MSA established, for the first time at the national level, an access priority for U.S. domestic fishermen over foreign fishermen in the U.S. EEZ (3 nm to 200 nm from shore off the coast of Alaska). Although this change was made primarily to support a growing U.S. industry, it was also justified on the grounds of addressing environmental conservation concerns. While the MSA began to limit participation in the fisheries in the EEZ to domestic fishermen, it nonetheless continued to allow an "open access" fishery with few limitations on fishing activities.

The problem with such an open access fishery has been summarized as follows:

If no control exists over access in fisheries and if demand for a stock (or stocks) of fish increases, then:

- Overcapitalization is inevitable and will become worse as prices for the product increase.
- Measures to prevent depletion will either impose or lead to increased costs of fishing to the fishermen, and these costs will become greater as prices for the product increase.
- The costs of management, research, and enforcement will be borne entirely by the taxpayer (Christy 1978).

Theoretically, the problem of an open-access resource may easily be solved by limiting access or establishing a system of property rights in the resource. Once a policy decision is made to limit access to a fishery, the first question is raised: to whom should exclusive harvesting privileges be granted? Typically, fishermen who have traditionally and regularly participated in a fishery in the past are included (i.e., licensed or permitted) in a limited-access fishery, and those who have never participated or have had insignificant involvement are not included. Early limited-access programs had problems in defining these categories of participants (Ginter and Rettig 1978). Fair and defensible implementation of a limited-access system requires precise and politically acceptable definitions of traditional, regular, and insignificant participation. Not surprisingly, most of the political controversies and legal challenges attending limited-access systems have focused on the questions, "Who is in?" "Who is out?" and "Why?"

Although limiting the number of vessels that can fish in a given area is a powerful tool for protecting limited stocks, modern fishing technologies (such as computerized fish detectors and global positioning systems, as well as gear improvements) often allow fishermen to harvest a large amount of fish in a short period of time. If the TAC for a given area can be caught in a matter of days, fishermen wishing to participate in that particular fishery are forced into a "race-for-fish," where the fishermen who catch the most fish in the shortest amount of time "win" the race. This is one indication that, even with limited entry, a given fishery may have an over-harvesting capacity. While the race-for-fish system is "fair" in the sense that everyone has the same opportunity to enter the race, such a system leads to needlessly dangerous fishing conditions by compelling fishermen to work with very little sleep and heedless of weather or sea conditions. Another argument against the race-for-fish is that it tends to swamp the capacity of fish processors when all the fish come in at the same time and leads to wasteful and inefficient use of the resource and increased bycatch and discards.

One way that fishery managers have responded to this situation is by developing so-called “rationalized” or “rights-based” fisheries. These controversial programs give specific individuals or communities the right to harvest a given percentage of the TAC, thus eliminating the race-for-fish because each individual’s (or community’s) share is protected from harvest by another individual or community. These programs can be designed to allow individuals to catch their quota of fish over a relatively long time period. The intent is that quota holders would fish when it is safe or convenient to do so, given all other fishing restrictions. If designed properly, this individual flexibility could reduce the race-for-fish, increase the temporal and spatial distribution of fishing effort, allow fishermen the time to minimize bycatch, and distribute the fishery’s demands on the processing/marketing sectors more evenly. The controversy arises over the contention that these programs grant private access to public resources, with all the economic benefits that accrue, to the exclusion of other citizens. Some people feel that rationalization plans have little to do with conservation or safety concerns and are really designed to preserve profitability for the select few who receive the fishing rights.

Under the MSA, limited-access systems are discretionary, but the law provides some guidance and standards in developing them. The NPFMC has exercised this discretionary limited-access authority on several occasions.

In December 1991, in response to overcapacity conditions, the NPFMC adopted a limited-access system in the form of an Individual Fishing Quota (IFQs) Program for the halibut and sablefish fixed-gear fisheries. An IFQ is essentially a federal permit that gives the person holding the IFQ an exclusive harvesting privilege to catch a specified percentage of the TAC of a fishery (i.e., a certain amount of fish). A novel feature of the IFQ Program is that it includes a separate allocation of halibut and sablefish for a CDQ Program. A CDQ is an allocation of a specific amount of fish that may be harvested by a particular type of coastal community or group of communities.

(It should be noted here that while sablefish are a target species defined under the BSAI and GOA groundfish FMPs and governed under the MSA, Pacific halibut are governed under the Northern Pacific Halibut Act of 1982, which authorizes the NPFMC to recommend allocation measures for the halibut fishery to the Secretary of Commerce.)

In the early 1990s, the NPFMC became increasingly aware of excess harvesting capacity also in the groundfish and crab fisheries under its jurisdiction. In June 1992, the NPFMC again exercised its discretion to recommend a limited-access policy by adopting a moratorium on the entry of new vessels into the groundfish and Bering Sea crab fisheries. The Vessel Monitoring Program (VMP) was designed to be an interim measure until a comprehensive “rationalization” plan could be developed and implemented. The VMP limited the ability of new participants to enter these fisheries until it was replaced by the License Limitation Program (LLP) in October 1998. The LLP was adopted together with a multi-species CDQ Program that included all other groundfish and crab species for which there were no CDQ allocations at that time. Under the LLP, qualified fishing vessels receive a license that authorizes fishing operations. The LLP, in and of itself, does not eliminate the race-for-fish situation; although the use of qualifying criteria has reduced the number of vessels, the race-for-fish can still occur even though the fleet size is smaller than it once was. This realization has led managers to consider other types of programs for rationalizing fisheries.

Currently, participation in all fisheries for which the NPFMC has an FMP is managed under a limited-access program. The federal regulations that implement such programs for the IFQ, CDQ, LLP, and AFA programs for the groundfish fisheries are published primarily at 50 CFR 679.4, 679.30–32, 679.40–45, and 679.60–64, which list the qualification criteria for receiving and transferring harvesting privileges (permits or licenses) under these limited-access systems and other management considerations. The Restricted Access Management division of NOAA Fisheries, Alaska Region administers these programs (http://www.fakr.noaa.gov/ram/).

What May Be Harvested

To manage the species of groundfish likely to be taken in the groundfish fisheries, the FMPs divide those species into four categories.

1. Target Species–Those species that are commercially important and for which a sufficient database exists that allows each to be managed on its own biological merits. Accordingly, a specific determination of the total amount of fish that can be taken (the TAC) is established annually for each target species. Catch of each species must be recorded and reported.

2.. Other Species–Species that are currently of slight economic value and not generally targeted. This category contains species with economic potential or those that are important ecosystem components, but for which there is insufficient stock assessment data to manage each separately. Accordingly, a single TAC applies to this category as a whole. Catch of this category as a whole must be recorded and reported.

3. Nonspecified Species–Those species and species groups of no current economic value but that are taken by the groundfish fishery only as incidental catch in the target fisheries. Virtually no data exist that would allow population assessments. No record of catch is required. The TAC for this category is the amount that is taken incidentally while fishing for target species, whether retained or discarded.

4. Prohibited Species–Those species and species groups that must be returned to the sea with a minimum of injury, except when their retention is authorized by other applicable law. Groundfish species and species groups for which the annual TAC has already been taken are treated in the same manner as prohibited species.

Restrictions on what species of fish and, more specifically, how much of a particular species of fish may be harvested represent the most basic form of fisheries management in the EEZ off Alaska. Such restrictions focus on either numbers of animals, volume, or weight of the regulated species and are commonly referred to as *quotas*, *catch limits*, or *bag limits*. A catch limit is designed to balance the natural reproductive growth of the stock and the desire to harvest fish. Theoretically, at the "right" catch limit, the stock can continue to reproduce itself and sustain being harvested over time. A corollary control that is frequently integrated in a catch limit rule is a size limit. Minimum size limits are designed to allow fish to grow to sexual maturity and spawn at least once before becoming vulnerable to fishing gear or "recruited to the fishery." Maximum size limits may also be used to protect the largest animals from harvest because, in some species, the largest animals are the best reproducers.

A TAC is specified for each target groundfish species. The FMP implementing regulations require NOAA Fisheries, through formal consultation with the NPFMC, to establish TACs annually for each groundfish species, based on the biological condition of the stocks and on socioeconomic considerations (50 CFR 679.20(a)). The analytical basis for the NPFMC's TAC recommendations is the annual Stock Assessment and Fishery Evaluation (SAFE) report, produced by NOAA Fisheries biologists and economists and reviewed by the NPFMC's Plan Teams, Scientific and Statistical Committee, and Advisory Panel.

The sum of the TACs for all groundfish species is restricted to an established range of OY for the groundfish complex as a whole. OY represents a calculation of the amount of harvest that provides the greatest overall benefit to the nation with particular reference to food production and the protection of marine ecosystems. The OY range represents the lower and upper limits within which the yield is "optimum" for both the fishery and the resource. In the BSAI, the lower limit of that range is 1.4 million metric tons (mt), and the upper limit is 2 million mt (50 CFR 679.20(a)(1)(I)). In the GOA, the OY range is between 116,000 mt and 800,000 mt (50 CFR 679.20(a)(1)(ii)).

The annual TAC-setting process is similar to the public rule-making process for FMP amendments. The process begins in September with the NPFMC Plan Teams' review of preliminary stock assessment data. The NPFMC deliberates on TAC limits and some prohibited species catch (PSC) limits, and decides how the TACs should be apportioned and allocated among various fishing industry components. In October, the NPFMC selects proposed TACs and allocations that are published by NOAA Fisheries in the FR for public comment. With public input and further committee reviews of updated stock assessments, the NPFMC selects final TACs for the following year at its December meeting. Ultimately, when approved by NOAA Fisheries, the final TAC amounts and their apportionments and allocations among areas, gear types, or sectors are published in the FR. Fishery closures are made by the agency during that fishing year to avoid exceeding the amounts of fish authorized for harvest, as specified by the TACs. See Section 2.3 and Appendix F-1 for more details on how TACs are calculated.

Another major fishery management issue is the regulation of incidentally caught species, or "bycatch." Bycatch is inevitable in almost all fisheries that use nets, hooks, or traps of any kind. Bycatch may not always be a species different from that being targeted. For example, individual fish of the target species that are too small, too large, or of the wrong gender may be worthless in the fisherman's market; any fish that is discarded because it has little or no value to the fisherman is often referred to as "economic bycatch." Another form of bycatch occurs when fishermen catch fish that are commercially valuable but, if retained, would violate various fishing regulations designed to conserve or allocate the resource. Fishing vessels are usually required to discard these fish at sea, and this is called "regulatory bycatch."

Fishery managers can implement regulatory incentives and gear restrictions to minimize economic bycatch. Bycatch limits may be imposed that, when reached, cause closure of the targeted fishery or closure of certain high bycatch areas. Alternatively, fishery managers may require fishermen to retain bycatch onboard rather than discard it at sea. This imposes an economic cost in the time it takes fishermen to handle the bycatch and in the hold space it takes up. These management measures in Alaska are called Improved Retention/Improved Utilization programs (IR/IU). Gear restrictions include minimum mesh sizes for trawls, biodegradable panels and halibut excluder devices on pot gear, and careful release mechanisms for longline gear. Certain gear types, like seine and gillnets, have been prohibited in the groundfish fishery because of their indiscriminate bycatch. Efforts to measure and improve the effectiveness of bycatch measures receive a great deal of attention from the fishing industry, conservation organizations, and fishery managers alike.

The groundfish fisheries are prohibited from harvesting some species because other fisheries depend on them. Prohibited species (crab, Pacific halibut, Pacific salmon, and Pacific herring) are identified in the FMPs and must be discarded if caught (with certain exceptions). Management efforts to minimize this regulatory bycatch include PSC limits that, when reached, cause closure of the targeted fishery or closure of certain high bycatch areas. As mentioned above, gear restrictions also help minimize catch of prohibited species.

When, Where, and How Harvesting May Occur

In the U.S., fishing has historically been allowed unless regulations specifically close or limit the harvesting of fish. In other words, if there are no regulations prohibiting or constraining a fishery, gear type, or catch level, then a fishing activity can legally proceed without any constraints. Typically, such constraints are specified in terms of the area and time period during which they apply. Hence, regulations governing when and where fish may be harvested are nearly always linked. For example, a rule usually specifies an area in which certain restrictions apply for a specified time period or season. An area may be closed all the time, only for certain periods, or it may be open at the beginning of a fishing year and remain open unless certain criteria are triggered during the year that cause it to close. The reasons for restricting fishing in a certain area are as varied as the types of restrictions that apply. An area may be closed to fishing to protect spawning stocks, to protect sensitive habitat, to control the bycatch of a non-target species, or to prevent competition between the fishery and marine mammals protected under the ESA. Fishing in certain areas may also be restricted for allocation purposes or to eliminate conflicts between different gear types. Fishing effort may be dispersed over a larger area by selectively closing smaller areas.

For the groundfish fisheries in the EEZ off Alaska, rules restricting where and when fishing can occur generally appear at 50 CFR 679.22–23. In addition, regulations at 50 CFR 679.20–21 provide for certain area closures when specified TAC and PSC limits are reached.

Management Areas and Area Closures

Sectioning areas of ocean along the Alaska coastline into discrete management areas has been a fundamental fishery management tool beginning with the declaration of the EEZ by the MSA in 1976. With further division of the EEZ into the GOA and BSAI in 1978 and 1981, respectively, the NPFMC and NOAA Fisheries have used area designations to more effectively gather data, prevent overharvest of the TACs, reduce bycatch, allocate harvesting and processing privileges, promote rebuilding of depressed crab stocks, and protect areas containing sensitive marine habitat. For more than 25 years, a complex grid of management areas and area closures has been used to provide strict control over the GOA and BSAI groundfish fisheries and to achieve the policy objectives of the FMPs. Groundfish management areas and area closures are implemented by regulations at 50 CFR 679.21-24. See Figure 4.2-1 for a map of these areas as defined in the 2002 regulations. See also Appendix F-3 for a qualitative discussion paper on the current closed areas and an environmental impact assessment of potential amendments to this regulatory scheme.

Fishing Gear Restrictions

Many species of fish can be caught with a variety of fishing techniques. Although some types of fishing gear are more selective than others for the species targeted, there are many logistical and traditional reasons that certain gear types are preferred in different areas. For fishery managers, restrictions on the types of fishing gear that may be used represent another basic management tool. Such restrictions usually prescribe what types of fishing gear may or may not be used to harvest certain species and are often linked to specific areas and time frames.

Gear restrictions may be imposed for various reasons, including biological conservation of target or non-target species, habitat protection, or socioeconomic management. Also, gear restrictions may be necessary to resolve gear conflicts or to protect the interests of fishermen who have traditionally used a particular gear type. For example, GOA FMP Amendment 14, adopted by the NPFMC in 1985, prohibited the use of pot gear in the eastern GOA in the sablefish fishery because pots conflicted with the retrieval of hook-and-line gear, which was traditionally used in that fishery. In addition, gear restrictions are commonly used in an open-access fishery to impose constraints on the harvesting efficiency of the fleet. Efficiency restrictions effectively allow for more participation in the fishery rather than less, which may be desirable to slow the pace of harvesting or to distribute the social and economic benefits of the harvest among more participants.

Until recently, any fishing gear could be used to harvest fish in the EEZ unless it was specifically prohibited or regulated. The 1996 amendments to Section 305(a) of the MSA (Section 305(a)) changed this approach by requiring the Secretary of Commerce to publish a list of authorized fisheries and fishing gear. Under this change, a fish, regardless of whether it was targeted for capture, may be retained only if it is taken within a listed fishery, is taken with gear authorized for that fishery, and is taken in conformance with all other applicable regulations. A final rule that lists authorized fisheries and gear types was published December 2, 1999 (64 FR 67511). Authorized gear types for the BSAI and GOA groundfish fisheries include bottom and pelagic trawls, pots, and hook-and-line. Groundfish gear limitations are implemented by regulations at 50 CFR 679.24. See Appendix F-7 for the distribution of gear types used to catch different groundfish species. (The reader can learn more about the current Federal Observer Program and potential changes being considered by NOAA Fisheries in Appendix F-10). See Appendix F-7 for a qualitative discussion paper on the rationale behind the current gear restrictions and gear allocations in the Alaska groundfish fisheries and on the environmental tradeoffs of potential amendments to these regulations.

Summary

These management tools—restrictions on who may fish what, when, where, and how—allow NOAA Fisheries and the NPFMC to maintain the control necessary to maximize the benefit of the fisheries while conserving the resource to ensure its sustained availability. The success of these tools requires that managers have access to up-to-date information, sometimes on a daily basis, about the fisheries and their harvests and about the state of the resource and its environment. To gather that information, NOAA Fisheries has developed an elaborate system for monitoring the fisheries, the resource, and the environment. The sources and methods for gathering data on the fisheries are the subject of the following section.

2.5.2 Sources of Fisheries Management Data

Fisheries managers use several different sources of information to design, implement, and monitor the specific goals and effects of FMPs. These include catcher vessel and processor logbook records, data collected by trained observers, detailed location data collected with automated Vessel Monitoring System (VMS) units, and independent research carried out by government agencies and academia. This section summarizes the collection and importance of those data for fisheries management.

Record-Keeping and Reporting Requirements

Reporting requirements include maintaining logbooks at sea and on shore, as well as submitting certain forms to NOAA Fisheries. Catcher vessels and buying stations (tender vessels and land-based buying stations) are required to record fishery information in logbooks daily. Processors (motherships, catcher processors, shoreside processors, and stationary floating processors) are required to record fishery information in logbooks daily and summarize the information on production reports that are submitted weekly to NOAA Fisheries.

To assist NOAA Fisheries in determining fishing effort by species, processors also report the start and end of their participation in fishing operations (called check-in/check-out reports). To allow NOAA Fisheries to develop a catch history for catcher vessels delivering to motherships, each mothership must issue ADF&G fish tickets for each groundfish delivery. Information common to all the logbooks includes participant identification; amount and species of harvest, discard, and product; gear type used to harvest the groundfish; area where fish were harvested; and observer information. The reader can learn more about the current data and reporting requirements and the cost and benefits of potential changes in Appendix F-11.

Participation in the BSAI and GOA groundfish fisheries in any manner (i.e., as catcher, processor, or transporter of fish) requires one or more federal permits. All permit holders are required to comply with record-keeping and reporting requirements to report groundfish harvest, discard, receipt, and production (50 CFR 679.5).

Since 1992, NOAA Fisheries has based all estimates of catch in the groundfish fisheries on a combination of observer data and Weekly Production Report (WPR) data. The WPR summarizes the Daily Cumulative Production Logbook (DCPL) on a weekly basis. The operator of a catcher processor or mothership or the manager of a shoreside processor must submit a WPR for any week the mothership, catcher processor, or shoreside processor is checked in. A Shoreside Processor Electronic Logbook Report (SPELR) is required instead of a DCPL and WPR for shoreside processors or stationary floating processors receiving groundfish from AFA catcher vessels or receiving pollock harvested in a directed pollock fishery.

The blend data processing system developed by NOAA Fisheries combines data from industry and observer reports to estimate groundfish harvest in North Pacific groundfish fisheries. The systems blends the best available data from different sectors of the fishery to generate what, NOAA Fisheries believes, is the most accurate estimate of total groundfish harvest possible with the existing data.

WPRs for shoreside processors report landed weight of catch. These WPRs are the best source of data for retained groundfish landings. All fish delivered to shoreside processors are weighed on scales, and these weights are used to account for retained catch. Observers on catcher vessels report groundfish species composition, total catch, and estimates of retention and discard on a weekly basis. Observer information on groundfish discards is used in conjunction with total retained groundfish catch from shoreside weekly production reports to estimate total at-sea discards from all catcher vessels, including observed and unobserved vessels. All observer data for a month, gear, and target fishery are combined to compute discard rates for each groundfish species observed to be discarded. The discard rates are expressed as a ratio of the weight of the discarded species to the total retained groundfish weight. The discard rates are multiplied by the retained landings for each shoreside processor to estimate total at-sea discards of groundfish associated with the groundfish landed to the processor.

Total catch for shoreside processors is obtained by adding the landed catch weights reported on shoreside processor WPRs to the estimates of at-sea discards. WPRs for catcher processors and motherships report weights of processed product and round weights of discards. Product weights are converted to equivalent round weights using product recovery rates (PRRs). Total catch may be estimated using cod-end or bin volumetrics, scales, or conversion from production data. Species composition of the catch is obtained by sampling the catch, and the total catch is apportioned by species based on that sampling.

Total groundfish catch for all species combined is computed each week for each processor vessel from the WPR and the observer report. If either report is missing, the available report is selected. If both reports are available, the blend compares the two numbers: if the WPR and observer total catch numbers are within 5 percent, the WPR is selected as the data source; if the WPR is more than 30 percent higher than the observer total catch (for pollock target fisheries) or more than 20 percent higher (for all other target fisheries), the WPR is selected as the data source. In all other cases, the observer report is selected as the data source. The blend program then returns to the source data (WPR or observer) and copies the detailed records, showing gear type, area and species, to the blend. Records from WPRs are identified in the blend by a source field value of "W," observer records are identified by a source field value of "O."

As noted above, the blend process combines data from industry production reports and observer reports to make the best possible, comprehensive accounting of groundfish catch. These data are used to manage quotas for groundfish in the GOA and BSAI . The blend data are also used as the basis for computing estimates of prohibited species bycatch and for numerous regional and national reports, fishery stock assessments, and analysis of FMPs.

In 2003, NOAA Fisheries, Alaska Region implemented a new groundfish accounting system. This new groundfish catch accounting system utilizes the same data sources as the blend—observer data, shoreside processor landings data, and processor weekly production report data, but where the blend aggregated all data to the level of processor and week, the new system accounts for data at the haul (observer) and delivery (shoreside landings) level and can track all the current quotas. The new system is also more adaptable for anticipated future changes. More information on the new accounting system is online at http://www.fakr.noaa.gov/sustainablefisheries/catchaccounting.htm.

The reader can learn more about the current data and reporting requirements and the cost and benefits of potential changes in Appendix F-11.

Observer Program

The North Pacific Groundfish Observer Program offers an important check on the validity of data reported by catcher vessels and processors and provides some data that would not otherwise be available. Observers are trained by NOAA Fisheries (through contract with the University of Alaska's North Pacific Observer Training Center in Anchorage) and hired by private contractors who provide observer services to catcher vessels and processors. NOAA Fisheries requires that observers have a minimum of a bachelor's degree in biology, zoology, wildlife management, fisheries, or a related area of study; and one course each in math and statistics. Some contractors also require employees to have additional coursework or experience, especially with computers.

As a condition of their fishing permits (see 50 CFR 679.50), fishing vessels and processors are required to provide various levels of observer coverage for their operations. Vessels 125 feet (ft) or greater in length overall (LOA) are required to carry observers for 100 percent of their fishing days. Vessels that are 60 ft LOA or greater but less than 125 ft LOA are required to carry observers for 30 percent of their fishing days. (Vessels under 60 ft LOA are not required to carry observers.) Observers are also required at shoreside and floating processing plants according to processing rate, with 100 percent observer coverage of plants processing 1,000 mt or more per month, and 30 percent observer coverage of plants processing 500 to 1,000 mt per month.

Groundfish observers collect catch and other biological data throughout the groundfish fishing season. Information is recorded on catch composition of targeted, bycatch, and prohibited species; total groundfish catch, location of fishing, and fishing effort; length and weight frequency measurements, collection of age structures (scales/otoliths), and retrieval of tags from tagged fish. Observers also record the species, number, and condition of marine mammals and seabirds observed in the area or interacting with the fishing gear.

The catch-estimation methods used by observers vary among the vessel types, due to differences in available equipment and fishery operations. For individual hauls at sea, observers aboard catcher vessels using trawl gear make volumetric estimates of catch weight (by making either measurements of the trawl net as it is hauled aboard or measurements of fish in the holding bins multiplied by a density factor). When the vessel delivers to a shoreside processor, the catch is weighed on scales. The observer then uses the at-sea volumetric estimates and discard information to calculate the proportional weight of individual hauls. If an observer is unable to make volumetric estimates at sea (for a variety of logistical reasons), the vessel operators estimate individual haul weights using a variety of methods. The accuracy or precision of vessel estimates is unknown.

The trawl catcher processors that fish under the AFA or the CDQ regulations are required to weigh their catches using NOAA Fisheries-inspected, in-line motion-compensated scale systems that provide very accurate individual haul weights. All fish coming aboard these vessels are weighed, and these weights are reported to NOAA Fisheries by the observer. The observer also has a role in monitoring the daily testing of the scale to ensure its accuracy.

Aboard hook-and-line vessels, observers count or estimate the total number of hooks in each set, tally the number and species caught in sampled sections of the set, estimate the average weight of individuals of each species sampled, and multiply these average species weights and numbers by the number of hooks in the entire set. Observers are instructed not to use vessel estimates of total catch aboard hook-and-line vessels because they usually do not include bycatch and fish that drop off hooks before being hauled aboard. Consequently, observer catch estimates for unsampled sets are extrapolated from similar sampled sets. Observers aboard boats using pot gear count and weigh the catch in sampled pots and estimate the total catch in a set by multiplying the sampled species' numbers and average weights by the number of pots in the set. Weekly summary reports of observer data are sent to the NOAA Fisheries, Alaska Region for use in groundfish and prohibited species accounting. Daily reports are sent as needed to monitor specific fisheries. The reader can learn more about the current federal observer program and potential changes being considered by NOAA Fisheries in Appendix F-10.

Vessel Monitoring System

Beginning in 2002, all fishing vessels participating in the directed fisheries for pollock, Pacific cod, or Atka mackerel using pot, hook-and-line, or trawl gear are required to have aboard an operable VMS, which provides regular vessel location data to NOAA Fisheries via satellite (40 CFR 679.7(a)(18)). This requirement is necessary to monitor fishing restrictions in Steller sea lion protection and forage areas. A VMS consists of a Global Positioning System unit that is integrated with a satellite communication device in a tamper-proof system. The VMS determines vessel location in latitude and longitude and transmits this data, along with a vessel identifier number and the time of transmission, to NOAA Fisheries. VMS data are used to monitor compliance with closed areas and to verify the location of catch when separate quotas are established inside small or irregularly shaped areas that do not correspond with the standard reporting or statistical areas.

Independent Resource Surveys

Measuring fish stock abundance or biomass in the ocean is not easy. Unlike trees, and even unlike fish that have been harvested, fish below the water surface cannot simply be individually counted. Assessing stock abundance and biomass is further complicated because fish move around and may migrate extensively over relatively short time periods. This means that the abundance of oceanic fish stocks can only be estimated, and the only feasible way to estimate fish abundance independent of commercial harvests is by survey sampling methods. The Alaska Fisheries Science Center (AFSC), the research arm of NOAA Fisheries in Alaska, and specifically, the AFSC's Resource Conservation Assessment Engineering (RACE) Division have primary responsibility for conducting sampling surveys and have made some of the most significant contributions to the science of fishery resource surveys as it has developed over the past 40 years (Gunderson 1993).

Several different surveys have been developed for the BSAI and GOA areas, including bottom trawl surveys, acoustic echo-integration/trawl surveys, and longline surveys. Each survey has unique strengths and weaknesses for estimating abundance depending on the species' social behavior, preferred habitat, location in the water column or proximity to the sea floor, swimming ability, and attraction to bait, among other variables. For example, the bottom trawl survey can do a good job of estimating the biomass of rock sole, which inhabit the seafloor, but will be less effective at estimating the biomass of midwater or pelagic fishes, such as herring and squid. Conversely, fish without air bladders or that live on the sea floor are very difficult to detect by acoustic survey systems. For estimating abundance and distribution of Alaska's groundfish resources, the AFSC's primary methods include area-swept bottom trawl surveys for shellfish and bottomfish stocks; echo-integration/trawl surveys (acoustic surveys) for the dominant semipelagic stocks, such as pollock; and longline surveys for measuring relative abundance of valuable bottom species that inhabit the deeper waters of the upper portion of the continental slope.

The AFSC's comprehensive survey strategy consists of a suite of annual and triennial bottom trawl and acoustic surveys alternating among the eastern Bering Sea (EBS), Aleutian Islands, GOA, and the West Coast regions. Annual surveys have been conducted for the crab and groundfish stocks in the Bering Sea, spawning pollock in Shelikof Strait of the GOA, and Bogoslof Island area of the Bering Sea, and sablefish in the GOA. In recent years, NOAA Fisheries bottom trawl surveys have annually sampled an area of approximately 600,000 square kilometers (km^2), an area that includes as many as 1,400 sampling stations. The winter and summer acoustic surveys cover about 15,000 km of tracklines annually. The annual Alaska sablefish longline survey covers about 95,000 km^2 and fishes 16 km (7,200 hooks) of longline per station over a depth range of about 660 to 3,960 ft at about 90 sampling stations.

Survey gear is generally designed to catch fish over a wide range of sizes. Hence, surveys provide a consistent sample of fish from year to year, and provide information on prerecruit-size fish (fish smaller than those "recruited" to the fishery, i.e., available for legal harvest) that would otherwise not be available for stock assessment. Survey stations are either laid out in a systematic pattern over the fishing grounds or in a stratified random pattern. Table 2.5-1 summarizes the survey strategy for the BSAI and GOA fisheries for the 1999-2000 period. See Appendix B for maps and tables summarizing the historic survey efforts. For further information on the AFSC, RACE, and the surveys, visit the AFSC website at www.afsc.noaa.gov.

In summary, the groundfish surveys conducted off Alaska represent probably the most extensive survey effort implemented by a single government agency anywhere in the world. The survey strategy is currently being expanded to an annual/biennial cycle, which will greatly increase the pollock stock monitoring in the groundfish stocks. The increased age composition data from expanded surveys will also improve stock assessments and forecasts, particularly for the younger incoming year-classes (all fish born in a particular year). Data collection management from the observer program and resource surveys has been enhanced by modern computer technology, which expedites the availability of fishery catch data to allow in-season management of harvest quotas. Both survey and catch data now become available in time to be incorporated into annual stock assessment updates used to set TACs for the upcoming fishing season. These surveys also provide the best database for identifying EFH, interspecific interactions (interactions between different species), and biodiversity of marine ecosystems.

Summary

This section has outlined the systems and methods that the NPFMC and NOAA Fisheries use to gather information about the fisheries, the resource, and the environment. Yet, however elaborate and sophisticated these systems and methods may be, the fact remains that fishery scientists and managers cannot simply count the individual fish below the surface, and for this reason, the fisheries must necessarily be managed in the face of some degree of uncertainty. The following sections discuss the strategies fisheries biologists and managers have developed for accounting for uncertainty and integrating it into fisheries management.

2.5.3 Establishing Limits in the Face of Uncertainty

Fishery managers face the daunting task of controlling the large-scale manipulation of a complex system, the marine environment, without causing unacceptable changes in that system. The traditional scientific approach to this task is to reduce the complex problem into simpler components, analyze these components separately, and then try to synthesize the different pieces and extrapolate the effects on the whole. Fishery managers have followed this tradition by reducing the complex ecosystem problem to a series of single-species management problems, analyzing the impacts of fishing on one species at a time, and then trying to synthesize the impacts at a broader management level.

While single-species management analyses try to incorporate a wide variety of environmental information into their stock assessment models and the NPFMC has established principles of ecosystem-based management, the reality is that the larger system is far too dynamic and complex for even the best minds with the fastest computers to fully understand. Of course, managers of other natural resource systems struggle with the same issue, namely, how do you do your job in the face of continual uncertainty about how the system really works and how it responds to various human activities?

The short answer is that fishery managers do the best they can with the available information, however imperfect and uncertain. At the same time, they try to eliminate as much uncertainty as possible by expanding and improving the types of information available to them and improving the integration of that information into the decision-making process. That is one of the major goals of this Alaska Groundfish Fisheries Programmatic SEIS.

This section will provide brief descriptions of the complicated processes required to establish the goals and limits of the groundfish fisheries and, at the same time, to account for uncertainty at every level in order to manage the system in a "precautionary" manner, as required by the NPFMC policy. Discussion of these processes is simplified for readers. Details of the calculations and methodology discussed here can be found in Appendix B.

Stock Assessments for Alaska Groundfish Stocks

Passage of the MSA in 1976 marked the beginning of the collection by NOAA Fisheries of fisheries data in an effort to generate stock assessments of major groundfish resources. The AFSC, responsible for BSAI and GOA groundfish assessments, updates the stock assessments annually in the SAFE reports. These SAFE reports are prepared and reviewed by the NPFMC's BSAI and GOA groundfish plan teams, which are comprised of scientists from NOAA Fisheries, ADF&G, USFWS, several universities, and NPFMC staff.

Spearheading each of these plan teams are NOAA Fisheries scientists from the AFSC Resource Evaluation and Fishery Ecology Division. These scientists incorporate the biomass estimates generated by the RACE division's stock assessment surveys into statistical models to provide insight into the effects of different harvesting strategies, to test analytical assumptions, and to learn more about how the marine ecosystem works and the effects of fishing on that ecosystem. For further information on the AFSC, Resource Evaluation and Fishery Ecology Division, and the methods and analyses used in making stock assessment projections, visit the AFSC website at www.afsc.noaa.gov.

Stock assessment analysis is a way to estimate how many fish are in a specific geographic ocean area or fishing grounds and to predict how these fish stocks or populations will respond to a particular harvest rate. Scientists use resource survey and fishery information in mathematical calculations to estimate how many fish are in a specific management area of the ocean (abundance or biomass). Life history information (growth, maturity, fecundity) is combined with estimates of natural mortality, including removals by predators, and used to estimate how many fish can be caught in a fishing season without impacting future stocks. While the NPFMC weighs economic and social considerations along with biological and ecological concerns to establish OY, stock assessments are primarily concerned with biological limits and stock production variability.

Three analytical assessment methods are typically used for Alaska groundfish: index methods, stock synthesis, and an Automatic Differentiation (AD) model builder. (For a review of current stock assessment methodology used in the TAC-setting process, see Section 4.3.1 and Appendix F-1.) A brief discussion of these three assessment methods, beginning with the simplest follows below.

Index Methods

The simplest way to assess a fish stock is to create an index of population size or biomass based primarily on resource surveys (see Section 2.3). A survey method is selected that targets one or more stocks in a specific area. By multiplying the average catch rate (the rate at which the survey caught fish) by the size of the area fished, scientists can estimate the abundance of fish or the biomass for that survey area. The results can be expressed either as an index of abundance or as an estimate of stock biomass in metric tons. There are several sources of sampling and statistical uncertainty inherent in these surveys that cannot be eliminated merely by increasing the frequency or intensity of the surveys. Ideally, the amount of uncertainty at each step in the process is incorporated into a "confidence interval" for each estimate. For example, the stock assessment could say there is a 95 percent chance that the actual biomass of the stock in the given area is between a range of high and low values. Given a particular data set, the narrower the range of points between those high and low values, the less confidence one may have that a point between that range is an accurate estimate of biomass.

Stock Synthesis and Automatic Differentiation Model Builder

Stock synthesis and AD model builder are computer programs that create statistical models of complex fish population dynamics. Without going into the details of statistical analysis and model-building here, we can say that, as the name suggests, model builder software allows us to create models: statistical replicas of a fish population that, while not as accurate as, say, a photograph, nevertheless provide scientists with a statistically reasonable facsimile of what a population looks like and what it will look like at a given time in the near future. Basically, this software allows us to input what we do know about the fish stocks to find out some of what we do not know (again, because we can not count the fish) and to predict short-term trends in biomass with some certainty.

The survival and growth of eggs, larvae, and juvenile fish are highly variable over time due to natural fluctuations in the marine environment. The appearance of small, younger fish in resource survey and observer data provides a means to forecast the strength of various year-classes. However, variability in recruitment (the number of fish that survive and grow large enough to be targeted by the fishery) from one year to the next impairs our ability to project stock trends with much certainty. The ability to determine changes over time in the age-structure of a fish population (how many fish of each year-class make up the total population) is critical to assessing a stock accurately—particularly if the population has undergone extreme changes in abundance. With a time series of age composition data, scientists can use stock synthesis and AD model builder software to generate complex population models.

For most Alaska groundfish, spawning is highly seasonal, so that all fish in a particular year-class will have been born within a month or two of each other. Stock synthesis and AD model builder keep track of each year- class as it ages, enters the fishery, and eventually dies out. Recruitment occurs when a year-class begins to be captured by fishing gear. For example, the relatively strong 1994 year-class of pollock in the GOA "recruited" to the fishery in 1996 at age two; in 1999, at age five, it constituted 36 percent of the total pollock catch. Being able to keep track of year-classes in this way improves abundance estimates and allows scientists to better predict short-term trends.

One of NOAA Fisheries's primary long-term objectives is to reduce uncertainty in stock assessments. Moving from an assessment based on a biomass index, or an aggregate biomass model, to an age-structured assessment is a positive step towards achieving this objective. In 1990, four Alaska groundfish assessments were based on age-structured models. By 2004, 19 assessments were based on age-structured models, and 19 were based on a survey index (Table 2.5-2).

Further refinements, such as the development of AD model builder applications specific for Alaska groundfish, may further reduce uncertainty, but only moderate gains can be expected. The real strength of these modern assessment methods lies in their ability to realistically integrate into the model the uncertainty inherent in the assessment processes. Using AD model builder, it is possible to obtain confidence limits for current stock size that reflect the uncertainty in the input parameters and in how well the model fits the data. These confidence limits may be rather large for many groundfish stocks.

Setting Fishery Targets and Limits

Fishery managers have developed a series of targets and limits for each fishery. They are all abbreviated in common usage among scientists and managers, and can be quite confusing at first. Readers new to the science should refer to the Acronyms and Abbreviations located in the beginning of this document. This section will introduce the terms, their relationships to each other, and how they are used in fishery management. Details on the mathematical derivations of each term are listed in Appendix B. The Appendix also includes a qualitative discussion paper on the TAC-setting process currently being used and provides an EA of potential amendments to that process (see Appendix F-1).

The National Standards established in the MSA (see Section 2.2.2) establish guidelines for the management of fishery resources based on the concept of Maximum Sustainable Yield (MSY). According to these FMP guidelines, a stock is defined to be overfished if the harvest exceeds MSY for a year or more. Overfishing is, by definition, a rate of fishing that is not sustainable over time. Thus, MSY and the overfishing level (OFL) are examples of a fishery *limit*, an amount of fishing that management is trying to avoid. The FMP guidelines distinguish such a limit from a fishery *target*, an amount of fishing that management is trying to achieve. Historically, NPFMC policy has been to use a precautionary approach in setting target levels so that they are well below the appropriate limits. Furthermore, NPFMC policy holds that the criteria used to set target catch levels should be explicitly risk-averse, so that the caution used in setting target levels is commensurate with the uncertainty about the status or productivity of a stock.

The National Standards require that each FMP specify, to the maximum extent possible, objective and measurable criteria for determining the status of each stock or stock complex covered by the FMP. The FMP must also provide an analysis of how those criteria were chosen, and describe how they relate to the reproductive potential of a stock. One such criterion is the maximum fishing mortality threshold: in other words, the maximum allowable number of fish killed through fishing. In the BSAI and GOA groundfish FMPs, the maximum fishing mortality threshold is equivalent to the OFL. The OFL is the most basic fishery limit and is defined as any amount of fishing in excess of a prescribed maximum allowable rate. Exceeding the maximum fishing mortality threshold for a period of one year or more constitutes *overfishing*. The maximum allowable rate of fishing varies depending on the amount of information available from the stock assessment. The BSAI and GOA groundfish stocks are managed within a system of six tiers corresponding to a descending order of the availability of reliable information. Stocks managed under Tier 1 have the most reliable stock assessment data, and those managed under Tier 6 have the least reliable data. The NPFMC's Scientific and Statistical Committee has the final authority for determining whether a given item of information is "reliable" for the purpose of assigning a stock to a certain tier, and may use either objective or subjective criteria in making such determinations.

The second status determination criterion of the National Standards is the minimum stock size threshold (MSST). Although MSSTs are not specified by the BSAI and GOA groundfish FMPs, the fact that their use is required by the National Standards resulted in their becoming a standard component of the SAFE Reports beginning in 1999. It is currently considered impossible to evaluate the status of stocks in Tiers 4-6 with respect to their MSSTs because stocks qualify for management under these tiers only if reference stock levels (such as MSST) cannot be reliably estimated. Derivation and values of MSST for Tier 1-3 species are included in Appendix B.

The stock-specific TAC has been the basic target or goal for a fishery and is set by the NPFMC for different categories of groundfish species and species groups every year after taking into account other uses and needs of the ecosystem. The decision to manage a species individually or as part of a species group depends on the commercial importance and the amount of biological information that is available for each species. *Target species* are commercially valuable and are managed individually with separate TACs. *Other species* have some economic potential but are not generally targeted and are managed as a group with a single TAC that applies to the whole category. *Nonspecified species* have no commercial value, and the single TAC for the group is whatever amount is caught incidentally. *Prohibited species* have, by definition, no allowable catch limit and must be released with a minimum of injury. The NPFMC has the discretion to create or change subgroups of species within a management category, but an FMP amendment is required to move a species into the target category.

The TAC specifications define upper harvest limits, or fishery removals, for the next fishing year. The sum of the TAC specifications is important because the FMPs specify the upper and lower ceilings for total TAC in each management area. As noted earlier, those upper and lower ceilings define the OY for each management area. In the BSAI, the lower limit is 1.4 million mt and the upper limit is 2 million mt (50 CFR 679.20(a)(1)(I)). In the GOA, the lower limit is 116,000 mt and the upper limit is 800,000 mt (50 CFR 679.20(a)(1)(ii)).

Sub-allocations of TAC are made for biological and socioeconomic reasons according to percentage formulas established through FMP amendments. For particular target fisheries, TAC specifications are further allocated within management areas (Eastern, Central, Western Aleutian Islands; Bering Sea; Western, Central, and Eastern GOA), among management programs (open access or CDQ Program), processing components (inshore or offshore), specific gear types (trawl, nontrawl, hook-and-line, pot, jig), and seasons according to regulations at 50 CFR 679.20, 50 CFR 679.23, and 50 CFR 679.31.

There are certain notice and comment rule-making requirements that NOAA Fisheries must meet, particularly those of the APA, concerning prior public review and comment regarding regulatory actions. To satisfy these requirements, NOAA Fisheries uses a three-part process for publishing the TAC specifications and allocations in the FR. Proposed, interim, and final TAC specifications and allocations are published in sequence by NOAA Fisheries.

NOAA Fisheries first publishes *proposed specifications* based on the NPFMC's recommendations from its October meeting. These recommendations are typically based on the previous year's fishing data, as contained in the SAFE reports. All Plan Team and NPFMC meetings leading up to the proposed specifications are open to the public with opportunities for public comment. It then takes NOAA Fisheries about two months to draft, review, get internal clearance, and publish the proposed regulations after receiving the NPFMC's recommendations in October. The proposed regulations are typically published in December. In 2002, for example, the NPFMC met and recommended proposed year 2003 specifications on October 6, 2002, and the proposed specifications were published December 13, 2002. After the publication date, NOAA Fisheries must then provide a 30-day public comment period before publishing *final specifications*.

However, because the fishing year in both the GOA and BSAI begins on January 1, and because the final specifications and allocations cannot be published by this date, NOAA Fisheries publishes *interim specifications* which are effective from January 1 until implementation of the final specifications. The interim TAC specifications are prescribed as 25 percent of the proposed TACs. Final TAC specifications are recommended by the NPFMC at its December meeting. These recommendations are based on the final SAFE reports that incorporate much of the data from the most recent fishing season and so represent an updated picture of the fishery. Again, it takes NOAA Fisheries about two months to prepare and approve the final regulations based on these new recommendations from the NPFMC. For the 2003 fishing year, the NPFMC met December 4–9, 2002, and recommended final TAC specifications that were published in the FR on February 18, 2003.

Since 1991, an EA has been prepared on each year's TAC specifications to comply with both MSA and NEPA requirements. These EAs are used in the decision-making process and accompany the specification rules through regulatory review and filing with the FR.

The TAC-setting process is known to have flaws. The proposed specifications are outdated by the time they are published and the public has a formal opportunity to comment on them. Compounding the problem is that the initial specifications are not based on the best scientific information. The scientific information obtained from the surveys, observer program, and other sources is usually not available until November. Stock assessment biologists need some time to review the data, correct errors, and run their population dynamics models. The NPFMC recommended a revision of the TAC-setting process in 1996 (BSAI/GOA FMP Amendments 48/48), but technical difficulties pertaining to the timing and completion of analyses have delayed a regulatory amendment. A new draft analysis to revise the process was presented to the NPFMC in September 2002. If approved, a revised TAC-setting process would be in effect in time for setting the TACs for the 2004 fishing year. See www.fakr.noaa.gov for updates on this analysis and schedule for decision-making.

Target Species Limits

Target species are those groundfish species or species groups that are actively pursued by the fishing industry. As described above, an annual process has been established for setting TAC for each of these target species. The annual TAC for each species of groundfish is allocated or apportioned to industry components based on gear type, vessel size category, processing sector, and quota recipient class (such as CDQ group or AFA cooperative or IFQ holders).

The CDQ Program receives an allocation of a percentage of each groundfish species or species group that are managed under the BSAI FMP and that have an annual TAC. The overall CDQ allocation for each species is further allocated to the six CDQ groups. NOAA Fisheries requires each CDQ group to submit catch reports for all vessels fishing for it. Observer data are used to monitor groundfish CDQ harvests by all catcher processors and motherships. Trawl catcher vessels are required to retain and deliver groundfish CDQ harvest to a shoreside processor, where they must be sorted by species, weighed (or, as in the case of salmon, counted), and reported by the processor on a CDQ delivery report. Observer data are used to verify the species reported on the CDQ delivery report and to check the species weights. For hook-and-line and pot catcher vessels, they may either deliver their fish to shoreside processors and use their delivery reports or use on-board observer data.

TACs are further subdivided for the GOA and BSAI sablefish fixed gear fisheries, which are managed under the IFQ Program (see 50 CFR 679.40 to 679.45). Once all of the CDQ and or trawl allocations have been subtracted, the remaining sablefish TAC is allocated to the fixed gear sablefish fishery. Permits are issued to qualified IFQ Program participants, allocating them a specific amount of sablefish quota by area and vessel size category. Individual accounts are established for each permit in the NOAA Fisheries database. Fishermen must report landed weights of sablefish using a real-time transaction processing system. A computer system subtracts the amount from the IFQ account and prints a receipt for the fisherman showing the transaction amount and remaining account balance. For more details on the sablefish IFQ program, see the NOAA Fisheries webpage at www.fakr.noaa.gov.

The pollock fishery in the BSAI is managed under the AFA. The annual pollock TAC, after subtracting the CDQ percentage and an incidental catch allowance, is allocated among the catcher processor, mothership, and inshore sectors that have formed cooperatives. Currently, one catcher processor cooperative, one mothership cooperative, and eight inshore cooperatives have formed, each of which receives an allocation of pollock based on the historic harvest percentages of each catcher vessel in the cooperative. The history of catcher vessels not in cooperatives forms the basis of an open-access quota, available to vessels not in cooperatives. Pollock caught in the directed pollock fishery count against the cooperative allocations. NOAA Fisheries considers all pollock caught by vessels using pelagic trawl gear to be directed fishing. Pollock caught with non-pelagic (bottom) trawl gear is counted against the incidental catch allowance. Regulations at 50 CFR 679.24(b)(4) prohibit directed fishing for pollock with nonpelagic trawl gear. The pollock cooperatives actively monitor their pollock harvest and cease fishing activity when their catch equals their allocation. NOAA Fisheries also monitors the pollock harvest and can close a cooperative fishery if needed.

For the general groundfish fishery—all groundfish fishing not managed under either the CDQ, IFQ, or AFA Cooperative Programs—NOAA Fisheries monitors the catch and issues regulatory notices to open and close specific fisheries. In some cases, catch is monitored from daily or weekly reports, and a closure date is projected by extrapolating catch rates. If fishing effort is high relative to the available quota, NOAA Fisheries will estimate the length of the fishery using historic effort and catch rates, and open the fishery for a specific length of time, ranging from as little as six hours to several days.

If NOAA Fisheries determines that a groundfish allocation or apportionment (quota) will be reached, the agency establishes a directed fishing allowance (DFA) under regulations at 50 CFR 679.20(d)(1)(I). The DFA is an amount less than the quota, leaving a portion to support incidental catch of the species in other fisheries. When the DFA is reached, NOAA Fisheries prohibits directed fishing for that species under 50 CFR 679(d)(1)(iii). When directed fishing is closed, fishermen may retain incidental catch of the species up to specified percentage limits (50 CFR 679.20(e)), which allows limited retention of the species but greatly reduces the catch rate compared to the directed fishery.

When a groundfish TAC is reached, NOAA Fisheries prohibits further retention of the species under 50 CFR 679.20(d)(2). If catch amounts reach the level defined as overfishing for the species, the agency can take actions to restrict other fisheries to prevent overfishing the species, under 50 CFR 679.20(d)(3).

Most groundfish quotas are for areas that correspond with federal statistical areas or FMP management areas. For these quotas, the location of catch is determined by the reported catch location or the observed haul location. However, when catch quotas are established for small areas (for example, the Atka mackerel TAC in the Aleutian Island Steller sea lion critical habitat area), the agency cannot accurately monitor the quotas based on the reporting areas or observer data alone. Fishing vessels typically haul their nets for at least several hours; so, in a small enough area, a vessel's initial setting of the net could occur inside the area, while the haul-back of the net occurs outside the area. NOAA Fisheries has adopted two strategies to address this type of problem.

One strategy is to treat the critical habitat quota as a limit within the overall area quota. NOAA Fisheries monitors the overall area catch, and when an amount equal to the critical habitat quota is reached, the agency closes critical habitat. This method is very effective in controlling the catch inside critical habitat. Because all catch from the larger area is initially counted against the critical habitat quota, it tends to encourage vessels to fish inside critical habitat first, which may cause concerns about temporal concentration of the catch in critical habitat, even though the catch amount is well-controlled.

The other strategy, which has become popular, is to utilize VMS data in conjunction with observer data to monitor vessel location during the time between gear set and retrieval. This method allows assignment of catch from a specific haul or set as inside or outside critical habitat. If any portion of the haul or set occurs inside critical habitat, the catch for that haul or set is counted as coming from inside critical habitat.

Prohibited Species Catch Limits

Bycatch—defined as fishery discards (e.g., fish not kept for sale or personal use) and unobserved mortalities resulting from direct encounter with fishing gear—has become a central concern of commercial and recreational fisheries, resource managers, scientists, and the public, both nationally and globally. Bycatch concerns arise from the apparent waste that discarded fish represent when so many of the world's marine resources are either fully utilized or overexploited. These issues apply to fishery resources as well as to marine mammals, seabirds, sea turtles, and other components of the marine ecosystem even though they may not technically be included in the bycatch definition. There are allocative issues related to bycatch as well.

The U.S. Congress, NOAA Fisheries, and the NPFMC have responded to these concerns by modifying the groundfish management program in ways that result in lower bycatch and waste. Bycatch limits, specified in regulations, provide a popular management tool that serves as an economic disincentive to those fisheries that experience high bycatch levels. When specified for a particular species, bycatch limits close all further groundfish fishing in an area once the limit is reached. The disincentive, then, is for fishermen to find ways through improved gear technology, improved communication among the fleet, and changed fishing behavior, to reduce their bycatch and not reach the bycatch limit. In doing so, the fishermen can continue to harvest groundfish up to the TAC. The lower their bycatch rate, the more fish they catch, and the more profitable the fleet.

In order to eliminate any incentive for the groundfish fleet to target commercially exploited species that already support their own commercial fishery off Alaska, the BSAI and GOA FMPs prohibit the groundfish fisheries from retaining all species of salmon, king and Tanner crabs, Pacific halibut, and Pacific herring taken as bycatch. Annual PSC are specified each year based on a review of the fishery and the policy goals for bycatch reduction. These prohibited species must be returned to the sea as soon as possible after they are caught. One exception to the mandatory discard rule is the Prohibited Species Donation Program. Under this program, groundfish fishermen who incidentally harvest salmon or halibut can donate them to a foodbank for the poor. Retaining them for donation is a legal alternative that does not "waste" the resource, yet maintains the disincentive to target salmon or halibut.

The North Pacific Groundfish Observer Program collects data on the numbers and weights of each prohibited species caught and sorts them by vessel, gear type, season, and fishing area. NOAA Fisheries combines this information with the catch rate of targeted species and calculates the rates at which prohibited species are caught per unit of groundfish caught for each fishing sector. Bycatch rates of prohibited species for unobserved vessels are extrapolated from similar observed vessel data. Observer data also provides estimates for the proportion of each prohibited species that is effectively killed before it is released under different fishing regimes.

PSC limits for each species are expressed in terms of mortality. Annual PSC limits for some species are specified under 50 CFR 679.21, or through the annual specification process. The PSC limits may be further allocated to fishery categories, gear groups, or seasons to create PSC quotas. The rules for whether particular prohibited species count against a PSC quota are specific to different fisheries, areas, gear types, and seasons (see Appendix B, Table B.4-3). When NOAA Fisheries projects that a PSC quota will be reached in a given fishery, the agency publishes a notice in the FR closing the area or season for the fishery, even if groundfish quota remains unharvested.

Other management tools have been used to directly control and meet bycatch reduction objectives. These include gear restrictions, season delays, and mandatory retention and utilization regulations. For information pertaining to these FMP management tools, see Chapter 4. The reader is also directed to the Appendix which also includes a qualitative discussion paper on bycatch and incidental catch restrictions currently being used and provides an environmental impact assessment of potential amendments (see Appendix F-5).

In-Season Monitoring and Control of Catch Limits

The annual TAC for each species of groundfish is allocated or apportioned to industry components based on gear type, vessel size category, processing sector, and quota recipient class such as CDQ group or AFA Cooperative. These allocations and apportionments result in a set of quotas that NOAA Fisheries must monitor. The procedures for monitoring and management of each quota depend on the regulatory program that established the quota. All of these systems rely heavily on catch reports from observers on catcher vessels and in processing facilities. Reports of catch from unobserved vessels and processors are combined with observer reports from similar operations. NOAA Fisheries accounting systems are quite complicated and require consistent and standardized input from the fishing industry. Changes in management rules, especially those triggered by certain catch limits, can happen very quickly. Communication channels between NOAA Fisheries and the industry, including where catch data and stock assessments are published, are spelled out in the regulations governing each program. The reader can read more about in-season management by reviewing Appendix F-11, which provides a qualitative discussion paper on the data and reporting program and the federal fishery observer program.

Summary of Sections 2.1 through 2.5

The preceding sections of this chapter have outlined the laws and policies governing fisheries management in the EEZ off Alaska; described the tools and practices that the NPFMC and NOAA Fisheries use to manage the groundfish fisheries in conformance with those laws and policies; and presented some of the complexities of groundfish management—all in an effort to provide readers with a basic context for understanding and evaluating the programmatic alternatives.

2.6 The Programmatic Alternatives

National Environmental Policy Act Guidance for Alternatives

In keeping with CEQ requirements for implementing NEPA, the Programmatic SEIS offers a range of alternatives, in addition to the no-action, or status quo, alternative, and a discussion of the environmental impacts of activities that flow from each. The alternatives, four in number, represent alternative policies for the continuing management of the federal groundfish fisheries off Alaska and range from an aggressive harvest strategy to a more environmentally precautionary harvest strategy. These alternatives are intended to serve as options for an overarching framework for managing the groundfish fisheries off the coast of Alaska. Each is based on a different philosophy and management approach and, to varying degrees, contains the principles of ecosystem-based management. Each alternative contains a policy statement, a set of goals and objectives for that policy, and, with the exception of the status quo alternative, a pair of example FMPs that would achieve the goals and objectives of the policy statement. The selection of one of these policy alternatives will set the stage for subsequent FMP amendments that will alter the FMP and its implementing regulations to achieve a particular policy goal or objective. In providing such policy options, these alternatives are action-forcing and binding.

The impacts of the four alternatives presented in this section are evaluated from information and analysis summarized in Chapter 3 (Affected Environment) and Chapter 4 (Environmental and Economic Consequences). Chapter 4 presents the issues (and their potential impacts) as defined by the public scoping and comment process. Our findings in these chapters provide the basis for the public's assessment of the relative merits of the alternatives and, ultimately, for the NPFMC's and NOAA Fisheries' choice of a PA.

Recent History of the Development of the Alternatives

The alternatives presented here are the product of two-and-a-half years of public process. As noted in the review of the history of the development of this Programmatic SEIS in Chapter 1, NOAA Fisheries announced its decision to revise the January 2001 draft Programmatic SEIS (2001 Draft Programmatic SEIS) after reviewing public comments and determining that, as those comments suggested, the alternatives could be improved by 1) being restructured from single-focus to multi-component alternatives; 2) expanding the cumulative effects analysis; and 3) making the document more concise and easier to read. In January 2002, the agency placed these new alternatives on its website and solicited public comment. In February of the same year, following review of the public comment, the NPFMC developed a range of eight policy alternatives and case studies ranging from the original FMPs to a "No Fishing" FMP. The NPFMC requested that NOAA Fisheries continue to work with these alternatives to make them more specific and differentiable, to address problems of combining specific management tools with the policy objectives in each alternative's set of goals and policies, and to consolidate the alternatives if possible.

Between the February and April, 2002 NPFMC meetings, NOAA Fisheries, including the AFSC, consulted with public stakeholders and legal counsel to determine the best way to restructure the alternatives to provide the specificity needed to differentiate between the policy alternatives, as well as to provide the detail necessary to conduct a meaningful scientific analysis. At the April 15, 2002 NPFMC meeting, NOAA Fisheries recommended that the eight more specific objective alternatives be consolidated into four broad-band policy alternatives (Figure 2.6-1). Each alternative to the status quo would include two FMP-like examples that would serve as bookends to an FMP framework, within which future project-level management decisions could be made. Under this scenario, the bookends do not reflect the actual specific measures that will be chosen in the future. Rather, they represent the outer bounds of the range of management decisions and measures specific to any policy alternative and serve, also, to provide the basis for a solid scientific analysis of the effects of each specific policy alternative.

This approach to developing the programmatic alternatives sets a distinct course for decision-making. At the same time, it maintains flexibility in decision-making by providing a range of policy goals and objectives that form a framework within which the NPFMC and NOAA Fisheries can work as they seek to satisfy their statutory obligations under the MSA, the MMPA, and other federal statutes. These alternatives also provide the NPFMC with flexibility in selecting those policy goals, objectives, and foreseeable actions that it intends to pursue as FMP amendments in the near future. This approach allows the alternatives to capture the full range of policy options and actions approved by the NPFMC at the February 2002 meeting. This approach also will provide the specificity needed to satisfy the legal and analytical requirements of this Programmatic SEIS.

This approach does, however, constitute a departure from the 2001 Draft Programmatic SEIS. In adopting the current approach, the NPFMC recognized that to satisfy the legal requirements of this Programmatic SEIS by examining alternative FMPs that are comparable in scope to the current FMPs, the NPFMC and NOAA Fisheries needed to commit to a review of different policy objectives as well as the "means" of achieving a change in policy direction. Developing an example FMP range for each alternative to status quo will allow the NPFMC to consider potential FMP management measures and a preliminary assessment of their environmental impacts. These measures will subsequently be further developed and implemented by the NPFMC as follow-on amendments through its normal FMP decision-making process. The time schedule for developing any follow-on amendments will be determined after the NPFMC has constructed its PA, reviewed data requirements and public comment, and prioritized its policy objectives.

During its June 4-12, 2002 meeting, the NPFMC received a report from NOAA Fisheries staff on the refinements made to the April 2002 suite of programmatic alternatives and the results of several meetings held with public stakeholder groups. The NPFMC also reviewed written comments from the public and received oral testimony from a number of representatives of fishing industry and environmental organizations. Following a review of all this information, the NPFMC modified, through a series of motions, the wording of alternative policy language as well as details of the alternatives' associated FMP examples. The NPFMC completed its June action by adopting the present suite of alternatives for analysis. [At its June 2003 meeting the Council adopted a PA based on a preliminary review of the findings contained in the 2003 Draft Programmatic SEIS. This PA is based on a variation of Alternative 3 where the Council incorporated a number of policy elements from the other alternatives. For more information on the PA, see Section 2.6.9.]

This Final Programmatic SEIS identifies the PA. The NPFMC revisited the preliminary PA (PPA) after reviewing all the public comments on the 2003 Draft Programmatic SEIS and has recommended a final PA (PA) that contains FMP policy goals and objectives that are different from the policy goals and objectives contained in the current FMPs. The NPFMC will formally move to amend the BSAI and GOA groundfish FMPs to incorporate any change in policy. NOAA Fisheries will announce the PA in the Record of Decision document, which will also contain a time schedule for implementing FMP amendments and regulatory changes necessary for implementing the selected policy. Following publication of the Record of Decision, the NPFMC will submit the proposed FMP policy amendment for approval by the Secretary of Commerce and, upon Secretarial approval, NOAA Fisheries will publish the new policy in the FR.

Overview of the Programmatic Alternatives

The four policy alternatives range from a harvest policy that is more aggressive than the status quo to two different harvest policies that are more environmentally precautionary. Each policy alternative is comprised of a set of FMP policy goal and objective statements. Additionally, except for Alternative 1 (the no-action or status quo alternative), each new policy alternative includes two illustrative FMPs that serve as bookends to a management framework consistent with that policy. Each FMP bookend will be analyzed separately and will serve as a proxy for a range of future management actions. As explained above, the bookend approach will illustrate the range of environmental effects of that policy. The bookends are not intended to be self-sufficient alternatives. Rather, the bookends establish the likely range of management actions the NPFMC will examine when implementing the selected policy alternative and predict the range of potential environmental effects from the use of those management tools. Once the NPFMC and NOAA Fisheries choose a policy-level alternative (and accompanying bookends), it will be committing, to the extent practicable, to devise and implement FMPs and management actions consistent with the goals and objectives of that chosen alternative.

This alternative structure recognizes that the resource being managed and the marine ecosystem are quite dynamic in nature and only partially understood. By providing a range of management tools and their potential effects for each policy alternative, attempts were made to take into account the dynamic nature of the fisheries as a whole and to provide enough flexibility in each alternative management regime to allow decision-makers to base decisions on the best available science.

Each of the alternatives is informed by ecosystem-based policies. The NOAA Fisheries Ecosystem Principles Advisory Panel (NMFS Ecosystem Principles Advisory Panel 1999) describes ecosystem-based management for marine fisheries as follows:

> *Ecosystem-based management can be an important complement to existing fisheries management approaches. When fishery managers understand the complex ecological and socioeconomic environments in which fish and fisheries exist, they may be able to anticipate the effects that fishery management will have on the ecosystem and the effects that ecosystem change will have on fisheries. However ecosystem-based management cannot resolve all of the underlying problems of the existing fisheries management regimes. Absent the political will to stop overfishing, protect habitat, and support expanded research and monitoring programs, an ecosystem-based approach cannot be effective.*
>
> *A comprehensive ecosystem-based fisheries management approach would require managers to consider all interactions that a target fish stock has with predators, competitors, and prey species; the effects of weather and climate on fisheries biology and ecology; the complex interactions between fishes and their habitat; and the effects of fishing on fish stocks and their habitat. However, the approach need not be endlessly complicated. An initial step may require only that managers consider how the harvesting of one species might impact other*

species in the ecosystem. Fishery management decisions made at this level of understanding can prevent significant and potentially irreversible changes in marine ecosystems caused by fishing.

While the alternatives are all ecosystem-based and conform to federal law, they differ in the number and specificity of the policy objectives contained within each policy statement. The alternatives provide vision. They set the stage for future decision-making. They capture a range of philosophical differences and varying degrees of precautionary management when faced with uncertainty about the effects of fishing on the environment and the lack of understanding of the ecological processes exhibited by a dynamic ever-changing marine ecosystem. They capture a range of values and needs from a diverse and educated group of public stakeholders. The goals and objectives are grouped around the key principles and issues identified by the public as being very important in the management of the Alaska groundfish fisheries. These principles and issues led to the list of key FMP components that would need to be addressed in an Alaska groundfish FMP.

The policy issues associated with management of the fisheries and reflected in this analysis arise from a number of questions faced by the NPFMC and NOAA Fisheries. In what direction should the NPFMC and NOAA Fisheries go with regard to managing the fishery resources off Alaska? How successful has past management policy been in meeting the goals and objectives of national fisheries policy, while conserving marine fish resources and providing protection to marine mammals and endangered species? Do we need to change our current policy, and if so, in what ways? How can we achieve the broadly supported goals of sustainable fisheries while still generating the social and economic benefits of a diverse population of citizens? The information and analyses needed to answer these questions are contained in this Programmatic SEIS. Whether past management policy has been in the best interest of the U.S., or whether a change in policy is needed, is ultimately a decision that will be made by the NPFMC and NOAA Fisheries. With public comment, the NPFMC and NOAA Fisheries will make what they believe to be the wisest policy decision for managing the Alaska groundfish fisheries in the future. Once a policy alternative is adopted and made a part of the BSAI and GOA groundfish FMPs, the preferred policy will establish a path for managers and stakeholders to follow. Future management actions taken by the NPFMC and implemented by NOAA Fisheries, through FMP amendments and regulatory changes, will each aim to achieve the goals and objectives of the policy in a balanced fashion.

2.6.1 Alternative 1(a) – Continue Under the Current Risk-Averse Management Policy (the no-action, status quo alternative)

The GOA and BSAI groundfish FMPs, first implemented in 1978 and 1981, respectively, contained management policy statements that incorporated the MSA's National Standards (there were seven then; now there are 10) and reflect the management issues and priorities of that period. Because the two FMPs were prepared by different writers, their respective policy statements differ in wording. They differ also because, in 1985, the GOA FMP policy was updated. Since 1985, there have been no formal amendments to either the GOA or the BSAI FMP policy statement. Adoption of this alternative would leave these sections of the FMPs unchanged.

Current Policy Statement for Managing the BSAI Groundfish Fisheries (FMP 3.2)

Goals for Management Plan

The NPFMC has determined that all its FMPs should, in order to meet the requirements of its constituency, the resources, and the MSA, achieve the following goals:

1. Promote conservation while providing for the OY from the region's groundfish resource in terms of providing the greatest overall benefit to the nation with particular reference to food production and recreational opportunities; avoiding irreversible or long-term adverse effects on the fishery resources and the marine environment; and ensuring availability of a multiplicity of options with respect to the future uses of these resources.

2. Promote, where possible, efficient use of the fishery resources but not solely for economic purposes.

3. Promote fair and equitable allocation of identified available resources in a manner such that no particular group acquires an excessive share of the privileges.

4. Base the plan on the best scientific information available.

In accomplishing these broad objectives a number of secondary objectives have been considered:

1. Conservation and management measures have taken into account the unpredictable characteristics of future resource availability and socioeconomic factors influencing the viability of the industry.

2. Where possible, individual stocks of fish are managed as a unit throughout their range, but such management is in due consideration of other impacted resources.

3. In such instances when stocks have declined to a level below that capable of producing MSY, management measures promote rebuilding the stocks. In considering the rate of rebuilding, factors other than biological considerations have been taken into account.

4. Management measures, while promoting efficiency where practicable, are designed to avoid disruption of existing social and economic structures where fisheries appear to be operating in reasonable conformance with the MSA and have evolved over a period of years as reflected in community characteristics, processing capability, fleet size and distribution. These systems and the resources upon which they are based are not static, but change in the existing regulatory regime should be the result of considered action based on data and public input.

5. Management measures should contain a margin of safety in recommending allowable biological catches when the quality of information concerning the resource and ecosystem is questionable. Management plans should provide for accessing biological and socioeconomic data in such instances where the information base is inadequate to effectively establish the biological parameters of the resource or to reasonably establish OY. This plan has identified information and research required for further plan development.

6. Fishing strategy has been designed in such a manner as to have minimal impact on other fisheries and the environment.

Current Policy Statement for Managing the GOA Groundfish Fisheries (FMP 2.1)

Goals and Objectives for Management of GOA Groundfish Fisheries

The NPFMC is committed to developing long-range plans for managing the GOA groundfish fisheries that will promote a stable planning environment for the seafood industry and will maintain the health of the resource and the environment. In developing allocations and harvesting systems, the NPFMC will give overriding considerations to maximizing economic benefits to the U.S. Such management will:

- Conform to the National Standards and to the NPFMCs' Comprehensive Fishery Management Goals.

- Be designed to assure that to the extent possible:
  – Commercial, recreational, and subsistence benefits may be obtained on a continuing basis
  – Chances of irreversible or long-term adverse effects on fishery resources and the marine environment are minimized
  – A multiplicity of options will be available with respect to future use of the resources
  – Regulations will be long-term and stable with changes kept to a minimum

Principal Management Goal. Groundfish resources of the GOA will be managed to maximize positive economic benefits to the U.S., consistent with resource stewardship responsibilities for the continuing welfare of the GOA living marine resources. Economic benefits include, but are not limited to, profits, benefits to consumers, income and employment.

To accomplish this goal, a number of objectives will be considered:

Objective 1: The NPFMC will establish annual harvest guidelines, within biological constraints, for each groundfish fishery and mix of species taken in that fishery.

Objective 2: In its management process, including the setting of annual harvest guidelines, the NPFMC will account for all fishery-related removals by all gear types for each groundfish species, sport fishery, and subsistence catches, as well as by directed fisheries.

Objective 3: The NPFMC will manage fisheries to minimize waste by:

– Developing approaches to treating bycatches other than as a prohibited species. Any system adopted must address the problems of covert targeting and enforcement.
– Developing management measures that encourage the use of gear and fishing techniques that minimize discards.

Objective 4: The NPFMC will manage groundfish resources of the GOA to stimulate development of fully domestic fishery operations.

Objective 5: The NPFMC will develop measures to control effort in a fishery, including systems to convert the common property resource to private property, but only when requested to do so by industry.

Objective 6: Rebuilding stocks to commercial or historic levels will be undertaken only if the benefits to the U.S. can be predicted after evaluating the associated costs and benefits and the impacts on related fisheries.

Objective 7: Population thresholds will be established for economically viable species complexes under NPFMC management on the basis of the best scientific information, and acceptable biological catches (ABCs) will be established as defined in this document. If population estimates drop below these thresholds, ABCs will be set to reflect necessary rebuilding as determined in Objective 6.

2.6.2 Alternative 1(b) – Update and Reformat the Current Policy Statement for both the Bering Sea and Aleutian Islands and Gulf of Alaska Groundfish Fishery Management Plans

This variation of Alternative 1 would update the old policy by modifying its format and incorporating the new National Standards and ecosystem-based management principles. Adoption of this variation of Alternative 1 would lead to a plan amendment that would replace the current BSAI and GOA policy statements with the new statement below.

Management Approach

Continue to work toward the goals of maintaining sustainable fisheries, protecting threatened and endangered species, and protecting, conserving, and restoring living marine resource habitat through existing institutions and processes. Continue to manage the groundfish fisheries through the current risk-averse conservation and management program that is based on a conservative harvest strategy. Under this management strategy, fishery impacts to the environment are mitigated as scientific evidence indicates that the fishery is adversely impacting the ecosystem. Management decisions will utilize the best scientific information available; the management process will be able to adapt to new information and respond to new environmental issues. Management will incorporate and apply ecosystem-based management principles; consider the impact of fishing on predator-prey, habitat, and other important ecological relationships; maintain the statute-mandated programs to reduce excess capacity and the race-for-fish; draw upon federal, state, and academic capabilities in carrying out research, administration, management, and enforcement; and consider the effects of fishing and encourage the development of practical measures that minimize bycatch and adverse effects to EFH. This strategy is based on the assumption that fishing produces some adverse impact on the environment and that as these impacts become known, mitigation measures will be developed and FMP amendments implemented. Issues will be addressed as they ripen and are identified through NPFMC staff tasking and research priorities. The NPFMC will continue to use the National Standards and other applicable law as its guide in practicing adaptive management and responsible decision-making and will amend the FMPs consistently and accordingly. To meet the goal of this overall program, the NPFMC and NOAA Fisheries will seek to achieve the following management objectives:

Prevent Overfishing

1. Adopt conservative harvest levels for single-species fisheries and specify OY.

2. Continue to use existing OY cap for BSAI and GOA groundfish fisheries.

3. Provide for adaptive management by continuing to specify OY as a range.

Preserve Food Web

4. Incorporate ecosystem considerations into fishery management decisions.

5. Continue to protect the integrity of the food web through limits on harvest of forage species.

6. Develop a conceptual model of the food web.

Reduce and Avoid Bycatch

7. Continue current incidental catch and bycatch management program.

8. Continue to manage incidental catch and bycatch through seasonal distribution of TAC and geographical gear restrictions.

9. Continue to account for bycatch mortality in monitoring annual TACs.

10. Control the bycatch of prohibited species through PSC limits.

11. Continue program to require full utilization of target species.

12. Continue to respond to evidence of population declines by closing areas and implementing gear and seasonal restrictions in affected areas.

Avoid Impacts to Seabirds and Marine Mammals

13. Continue to cooperate with USFWS to protect ESA-listed and other seabird species.

14. Maintain current protection measures in order to avoid jeopardy to ESA-listed Steller sea lions and adverse modification of their critical habitat.

Reduce and Avoid Impacts to Habitat

15. Respond to new scientific information regarding areas of critical habitat by closing those regions to all fishing (i.e., no-take marine reserves such as Sitka Pinnacles).

16. Evaluate the impacts of trawl gear on habitat through the stepwise implementation of a comprehensive research plan, to determine appropriate habitat protection measures.

17. Continue to evaluate candidate areas for MPAs.

Allocation Issues

18. Continue to reduce excess fishing capacity, overcapitalization and the adverse effects of the race for fish.

19. Provide economic and community stability by maintaining current allocation percentages to harvesting and processing sectors.

Increase Alaska Native Consultation

20. Continue to incorporate Traditional Knowledge in fishery management.

21. Continue current levels of Alaska Native participation and consultation in fishery management.

Data Quality, Monitoring, and Enforcement

22. Continue the existing reporting requirements and Observer Program to provide catch estimates and biological information.

23. Continue on-going effort to improve community and regional economic impact assessments.

24. Increase the quality of monitoring data through improved technological means.

2.6.3 Alternative 2 – Adopt a More Aggressive Management Policy

This policy alternative, while still meeting the minimum requirements of the MSA, MMPA, ESA, and other federal law, would result in a more aggressive management approach when faced with uncertainty as compared to Alternative 1. Adoption of Alternative 2 would lead to a plan amendment that would replace the current BSAI and GOA policy statements with the new statement below.

Management Approach

Amend the current FMPs to establish a more aggressive harvest strategy while still preventing overfishing of target groundfish stocks. The goal would be to maximize biological and economic yield from the resource. Such a management approach will be based on the best scientific information available, take into account individual stock and ecosystem variability; involve and be responsive to the needs and interests of affected states and citizens; continue to work with state and federal agencies to protect threatened and endangered species; maintain the statutorily mandated programs to reduce excess capacity and the race-for-fish; draw upon federal, state, and academic capabilities in carrying out research, administration, management, and enforcement; and consider the effects of fishing and encourage the development of practical measures that minimize bycatch and adverse effects of fishing on EFH. This strategy is based on the assumption that fishing does not have an adverse impact on the environment except in specific cases as noted. To meet the goal of this overall program, the NPFMC and NOAA Fisheries will seek to achieve the following management objectives:

Prevent Overfishing

1. Prevent overfishing by setting an OY cap at the sum of OFL or the sum of the ABCs for each species.

2. Provide for adaptive management by continuing to specify OY as a range.

Preserve Food Web

- (none)

Reduce and Avoid Bycatch

3. Monitor the bycatch of prohibited species and adjust or eliminate PSC limits.

4. Manage incidental catch and bycatch through closure areas for selected gear types.

Avoid Impacts to Seabirds and Marine Mammals

5. Maintain current protection measures to protect ESA-listed seabird species.

6. Maintain current protection measures to avoid jeopardy to ESA-listed Steller sea lions and adverse modification of their critical habitat.

Reduce and Avoid Impacts to Habitat

7. Evaluate the impacts of trawl gear on habitat through the implementation of the existing research plan, identify EFH, and determine appropriate habitat protection measures.

8. Continue to evaluate candidate areas for MPAs.

Allocation Issues

9. Maintain AFA and CDQ program as authorized by MSA.

Increase Alaska Native Consultation

10. Continue to incorporate Traditional Knowledge in fishery management.

11. Continue current levels of Alaska Native participation and consultation in fishery management.

Data Quality, Monitoring, and Enforcement

12. Continue the existing reporting requirements to provide catch estimates and biological information.

13. Continue on-going effort to improve community and regional economic impact assessments.

14. Consider repealing the Observer Program.

2.6.4 Alternative 3 – Adopt a More Precautionary Management Policy

This policy alternative, while still meeting the requirements of the MSA, MMPA, ESA, and other federal law, would result in a more precautionary management approach when faced with uncertainty as compared to Alternative 1. Adoption of Alternative 3 would lead to a plan amendment that would replace the current BSAI and GOA policy statements with the new statement below.

Management Approach

Accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles, and where appropriate and practicable, increased habitat protection and additional bycatch constraints. This policy objective seeks to provide sound conservation of the living marine resources; provide socially and economically viable fisheries and fishing communities, minimize human-caused threats to protected species; maintain a healthy marine resource habitat; and incorporate ecosystem-based considerations into management decisions. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management. This policy will utilize and improve upon existing processes to involve a broad range of the public in decision-making. Further, these objectives seek to maintain the balanced goals of the National Standards and other provisions of the MSA as well as the requirements of other applicable law, all as based on the best scientific information available. This policy takes into account the National Academy of Sciences Policies Recommendations for Sustainable Fisheries (NAS SF). Under this approach, additional conservation and management measures will be taken as necessary to respond to social, economic or conservation needs, or if scientific evidence indicates that the fishery is negatively impacting the environment. To meet the goal of this overall program the NPFMC and NOAA Fisheries will seek to achieve the following management objectives.

Prevent Overfishing

1. Adopt conservative harvest levels for multi-species and single-species fisheries.

2. Provide for adaptive management by continuing to specify OY as a range or a formula.

3. Initiate a scientific review of the adequacy of F_{40} and implement improvements accordingly.

4. Continue to collect scientific information and improve upon MSSTs including obtaining biological information necessary to move Tier 4 species into Tiers 1-3 in order to obtain MSSTs.

Preserve Food Web

5. Incorporate ecosystem-based considerations into fishery management decisions.

6. Develop indices of ecosystem health as targets for management.

7. Improve the procedure to adjust ABCs as necessary to account for uncertainty and ecosystem factors such as predator-prey relationships and regime shifts.

8. Initiate a research program to identify the habitat needs of different species that represent the significant food web.

Reduce and Avoid Bycatch

9. Continue and improve current incidental catch and bycatch management programs.

10. Developing incentive programs for incidental catch and bycatch reduction including the development of mechanisms to facilitate the formulation of bycatch pools, vessel bycatch accountings, or other bycatch rationalization programs.

11. Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits as information becomes available.

12. Continue program to reduce discards by developing management measures that encourage the use of gear and fishing techniques that reduce discards.

Avoid Impacts to Seabirds and Marine Mammals

13. Continue to cooperate with USFWS to protect ESA-listed and other seabird species.

14. Initiate joint research program with USFWS to evaluate current population estimates for all seabird species that interact with the groundfish fisheries.

15. Maintain or adjust current protection measures as appropriate in order to avoid jeopardy to ESA-listed Steller sea lions and adverse modification of their critical habitat.

16. Encourage programs to review status of other marine mammal stocks and fishing interactions (e.g., right whales, sea otters) and develop fishery management measures as appropriate.

Reduce and Avoid Impacts to Habitat

17. Develop goals, objectives, and criteria to evaluate the efficacy of MPAs and no-take marine reserves as tools to maintain abundance, diversity, and productivity of marine organisms. Consider implementation of MPAs if and where appropriate, giving due consideration to areas already closed to various types of fishing operations.

18. Develop a research program to identify regional baseline habitat information and mapping.

19. Evaluate the impacts of all gear on habitat through the implementation of a comprehensive research plan, to determine habitat protection measures as necessary and appropriate.

20. Identify and designate EFH and habitat areas of particular concern.

Allocation Issues

21. Provide economic and community stability to harvesting and processing sectors through fair allocation of fishery resources.

22. Maintain LLP program and further decrease excess fishing capacity and other adverse effects of the race-for-fish by eliminating latent licences and extending programs such as community- or rights-based management to some or all groundfish fisheries.

23. Provide for adaptive management by periodically evaluating the effectiveness of rationalization programs and the allocation of property rights based on performance.

24. To support fishery management, extend the cost recovery program to all groundfish fisheries.

Increase Alaska Native Consultation

25. Continue to incorporate Traditional Knowledge in fishery management.

26. Consider ways to enhance collection of Traditional Knowledge from communities, and incorporate such knowledge in fishery management where appropriate.

27. Increase Alaska Native participation and consultation in fishery management.

Data Quality, Monitoring, and Enforcement

28. Increase the utility of groundfish fishery observer data for the conservation and management of living marine resources.

29. Improve the Groundfish Observer Program, and consider ways to address the disproportionate costs associated with the current funding mechanism.

30. Improve community and regional economic impact assessments through increased data reporting requirements.

31. Increase the quality of monitoring data through improved technological means.

32. Establish a coordinated, long-term ecosystem monitoring program to collect baseline information and compile existing information from a variety of ongoing research initiatives.

33. Adopt the recommended research plan included in this document.

34. Cooperate with research institutions such as the North Pacific Research Board in identifying research priorities to address pressing fishery issues.

2.6.5 Alternative 4 – Adopt a Highly Precautionary Management Policy

This policy alternative, while still meeting the requirements of the MSA, MMPA, ESA, and other federal law, would result in a highly precautionary management approach when faced with uncertainty as compared to Alternative 1. Adoption of Alternative 4 would lead to a plan amendment that would replace the current BSAI and GOA policy statements with the new statement that follows.

Management Approach

Adopt a highly precautionary approach to managing fisheries under scientific uncertainty in which the burden of proof is shifted to the user of the resource to demonstrate that the intended use will not have a detrimental effect on the environment. Modify restrictive conservation and management measures as additional, reliable scientific information becomes available. Establish a fishery conservation and management program to maintain ecological relationships among exploited, dependent, and related species, as well as the ecosystem processes that sustain them. Management decisions assume that science cannot eliminate uncertainty and that action must be taken in the face of large uncertainties, guided by policy priorities and the strict interpretation of the precautionary principle. Management decisions will involve and be responsive to the public but decrease emphasis on industry and community concerns; incorporate and apply strict ecosystem principles; address the impact of fishing on predator-prey, habitat, and other important ecological relationships in the marine environment; implement measures that avoid or minimize bycatch; include the use of explicit allocative or cooperative programs to reduce excess capacity and allocate fish to particular gear types and fisheries; identify and incorporate non-consumptive use values; and draw upon federal, state, academic, and other capabilities in carrying out research, administration, management, and enforcement. This strategy is based on the assumption that fishing produces adverse impacts on the environment but due to lack of information and uncertainty, little is known about these impacts. This strategy would result in a number of significant changes to the FMPs that would significantly curtail the groundfish fisheries until more information is known about the frequency and intensity of fishery impacts upon the environment. Expanded research and monitoring programs will fill critical data gaps. Once more is known about fishery effects on the ecosystem, precautionary measures initially adopted will be modified or relaxed when scientific information warrants such a change. To meet the goals of this overall program, the NPFMC and NOAA Fisheries will seek to achieve the following management objectives:

<u>Prevent Overfishing</u>

1. Prevent overfishing by transitioning from single-species to ecosystem-oriented management of fishing activities.

2. Close an additional 20 to 50 percent of known spawning areas of target species across the range of the stock to protect the productivity and genetic diversity.

Preserve Food Web

3. Develop and implement a Fishery Ecosystem Plan through the modification or amendment of current FMPs.

4. Conserve native species and biological diversity at all relevant scales of genetic, species, and community interactions.

5. Reduce the ABC to account for uncertainty and ecological considerations for all exploited stocks, including genetic, life history, food web, and habitat considerations.

6. Set fishing levels in a highly precautionary manner to preserve ecological relationships between exploited, dependent, and related species.

Reduce and Avoid Bycatch

7. Include bycatch mortality in TAC accounting and improve the accuracy of mortality assessments for target, non-target, and PSC bycatch, including unobserved mortality.

8. Reduce incidental catch, bycatch, and PSC limits (e.g., by 10 percent/year for 5 years).

9. Phase out fisheries with >25 percent incidental catch and bycatch rates.

10. Establish PSC limits for salmon, crab, and herring in the GOA.

11. Set stringent bycatch limits for vulnerable non-target species based on best available information.

Avoid Impacts to Seabirds and Marine Mammals

12. Set protection measures immediately for all seabird species and cooperate with USFWS to develop fishing methods that reduce incidental takes to levels approaching zero for all threatened or endangered species and for USFWS's list of species of management concern.

13. Initiate joint research program with USFWS to evaluate current population estimates for all seabird species that interact with the groundfish fisheries and modify protection measures based on research findings.

14. Increase existing protection measures for ESA-listed Steller sea lions by further restricting gear in critical habitat and setting more conservative harvest levels for prey base species.

Reduce and Avoid Impacts to Habitat

15. Zone and delimit fishing gear use in the action area and establish no-take marine reserves (both pelagic and nearshore) encompassing 20 to 50 percent of management areas to conserve EFH, provide refuges from fishing, serve as experimental controls to test the effects of fisheries, protect genetic and biological diversity, and foster regeneration of depleted stocks in fished areas.

16. To protect habitat and reduce bycatch, prohibit trawling in fisheries that can be prosecuted with more selective gear types and establish trawl closure areas.

17. Manage fisheries in an explicitly adaptive manner to facilitate learning (including large no-take marine reserves that provide experimental controls).

18. Protect marine habitats, including EFH, habitat areas of particular concern, ESA-designated critical habitats and other identified habitat types.

19. Commit to funding a comprehensive research plan in order to provide a baseline habitat atlas.

Allocation Issues

20. Reduce excess fishing capacity and employ equitable allocative or cooperative programs to end the race-for-fish, reduce waste, increase safety, and promote long-term stability and benefits to fishing communities.

21. Consider non-consumptive use values.

Increase Alaska Native Consultation

22. Utilize Traditional Knowledge in fishery management, including monitoring and data-gathering capabilities, through co-management and cooperative research programs.

23. Increase participation of and consultation with Alaska Native subsistence users and explicitly address the direct, indirect and cumulative fishery impacts on traditional subsistence uses and cultural values of living marine resources.

Data Quality, Monitoring, and Enforcement

24. Increase the precision of observer data through increased observer coverage and enhanced sampling protocols, and address the shortcomings of the current funding mechanism by implementing either a federally funded or equitable fee-based system for a revamped Observer Program Research Plan.

25. Improve enforcement and in-season management through improved technological means.

26. Establish a coordinated, long-term monitoring program to collect baseline information and better utilize existing research information to improve implementation of the Fishery Ecosystem Plan.

27. Adopt the recommended research plan included in this Programmatic SEIS.

2.6.6 Management Tools for Achieving Policy Goals and Objectives

A description of the principle management tools used to make up an FMP is provided in Section 2.5.1. This section briefly describes the combination of management tools used to achieve each goal and objective set forth in the alternatives.

Prevent Overfishing

Fishery managers can achieve this policy goal in a number of ways. Most commonly, managers establish quotas, or TACs to limit commercial, recreational, and subsistence catch. Setting conservative TAC levels are intended to reduce the probability of overfishing a particular fish species, fish population, or fish stock. Resource managers in some parts of the U.S. and the world have chosen not to use quotas but instead attempt to control fishing effort through use of seasons, vessel days, gear restrictions, and restrictions on the number of fishing vessels. In Alaska, the NPFMC and NOAA Fisheries have chosen to use TACs in combination with other measures such as defined fishing seasons, IFQs, and PSC limits. The components of the BSAI and GOA groundfish FMPs must therefore contain such basic elements as a TAC-setting process, bycatch reduction measures, PSC limits, marine mammal and seabird protection measures, habitat protection measures, and data collection and information reporting programs.

Preserve Food Web

Efforts to explicitly preserve the ecological food web of marine ecosystems and maintain biodiversity in fishery management programs have only recently begun as public consciousness has become more aware of the importance of marine ecosystems in the overall environmental health of a region. Such increased awareness has led to new and expanded research programs that are designed to teach us how marine ecosystem processes function and how fishing affects those processes. There is much to learn about marine ecosystems. Currently, fishery managers in Alaska rely heavily on government and academic research programs and attempt to incorporate ecosystem considerations into their decision-making through synthesis of ongoing research into the annual TAC-setting process, as well as when taking actions intended to protect endangered Steller sea lions and short-tailed albatrosses. Information on marine ecosystems is increasingly being used by the NPFMC when considering management actions such as bycatch reduction measures, closures to protect EFH, and the effects of fishing on non-target groundfish species.

Reduce and Avoid Bycatch

The reduction of bycatch and the minimization of waste have become important management goals for the NPFMC and NOAA Fisheries. Management tools used to achieve these goals include direct measures, such as PSC limits to control the mortality of prohibited species, gear restrictions to minimize bycatch, and regulations requiring that certain target species be kept and utilized, regardless of their size or condition. Management tools that indirectly reduce bycatch include area closures, allocations of TAC spread out over time, and programs designed to address overcapacity by slowing the rate of harvest and reducing the number of fishing vessels. Overcapacity programs like the sablefish IFQ program or the pollock cooperative program are proving to be significantly beneficial indirect management approaches to reduce bycatch.

Avoid Impacts to Seabirds and Marine Mammals

Management tools used to achieve the goal of minimizing adverse impacts to seabirds and marine mammals include required gear modifications and fishing techniques in the hook and longline fisheries, reduced TAC of bird and mammal prey species, use of closure areas to minimize any disturbance to rookeries and haul-out sites from commercial fishing operations, and specific take limits.

Reduce and Avoid Impacts to Essential Fish Habitat

Marine habitat determined to be important to the life history of groundfish species and the ecology of the marine ecosystem can be afforded some protection by the use of closed areas, gear restrictions, and some combination of the two management tools. Such tools can also be used to restore damaged habitats that have been identified as important and warrant recovery.

Allocation Issues

The allocation of fish resources among users usually takes the form of a specific quota. The groundfish TAC can be allocated to different harvesting and processing sectors of the fishing industry, to specific communities, and to individual users or groups of users. Other allocation-based management tools include area registration requirements (where fishermen can register for no more than one area at a time, thereby spreading out the effort over a broad area), and allocations of fishing effort (e.g., vessel days or trip limits).

Increase Native Consultation and Participation

Management tools used to address Alaska Native issues and satisfy federal requirements for public outreach, NEPA, and government-to-government consultation, typically take the form of informal and formal discussions. These discussions are enhanced by special meetings, newsletters, webpage bulletins, and e-mail. Public hearings and NPFMC meetings provide a frequent venue for public stakeholders to provide comments and any information that may improve the management of fisheries off Alaska as well as opportunities to learn more about the effects of management on subsistence fishing and minority populations. Opportunities for cooperative research may also serve as a management tool to increase Native involvement in the management of fisheries, as well as to foster transfer of Traditional Ecological Knowledge.

Data Quality, Monitoring, and Enforcement

The success of any fishery management policy is dependent on the ability of the manager to collect biological, economic, and social information on the fishery. The management tools typically used to accomplish this collection of data include requirements to submit fishing logbooks, written harvest and processing summary reports, and observer information. Monitoring objectives are accomplished through electronic location devices placed on vessels, radio check-in and check-out reports, onboard fishery observers, and enforcement overflights. These management tools are designed to provide the information needed to measure the success of the various components of the FMPs. Fishery management plans are routinely amended to address subject areas where fishing effects are unacceptable.

2.6.7 The Alternatives Considered but Not Carried Forward

A No-Fishing Policy

People have fished from waters off North America for thousands of years. The traditional uses of fish for food and commerce were recognized as a common practice during formation of the republic. Citizens of the U.S. have since continued to harvest fishery resources from waters off the coasts and as a matter of policy and custom place high value on fish and fishing.

A permanent "no-fishing" policy would end all commercial groundfish fishing in the EEZ off Alaska. Adoption of such a policy would be inconsistent with one stated purpose of the MSA: "to promote domestic commercial and recreational fishing under sound conservation and management principles." Through its 10 National Standards and other mandates (see Section 2.2.2), the MSA directs the NPFMC and NOAA Fisheries to authorize fisheries—no matter how large or small—as long as those fisheries are managed in way that is consistent with the 10 National Standards.

When the NPFMC first prepared its GOA and BSAI groundfish FMPs, it considered a no-fishing policy. In its analysis of this alternative, the NPFMC found that adopting this policy would result in the economic ruin of the fishing industry and place great hardship on fishing communities economically and socially dependent upon the BSAI and GOA groundfish resources. This policy was believed by the NPFMC to violate the MSA by preventing the U.S. from exploiting the social and economic benefits of groundfish of the BSAI and GOA in the nation's interest (NPFMC 1981).

NOAA Fisheries subsequently reviewed and prepared a detailed analysis of the effects of a no-fishing policy in its 1998 final SEIS (NMFS 1998i). Such a policy would reduce EEZ fishing mortality to zero for all target groundfish and non-target species, resulting in no commercial catch except for harvests within the State of Alaska's jurisdiction and beyond 200 miles. The primary impact of this action would be to eliminate the impact of fishing on stock trends and conditions. For example, a pollock TAC of zero would eliminate the directed fishery for pollock and eliminate the risk of overfishing and localized stock depletion (provided that harvests within Alaska waters remain low). A zero TAC for pollock and other directed fisheries would eliminate any bycatch of pollock caught in this fishery. A zero TAC of pollock and other groundfish would impact the amounts of groundfish available to the ecosystem. More commercial-sized fish would be available as prey and predators in the ecosystem. Additionally, zero TACs on the predators of pollock would increase the predation on pollock and other forage fish.

A no-fishing policy could have positive benefits for the western stock of Steller sea lions if it eliminates fisheries harvest from a list of factors causing or contributing to Steller sea lion population decline. Direct takes from federally managed groundfish fisheries would be zero. Benthic habitat communities would eventually move toward a prefished condition.

However, closing the fisheries would likely result in alterations to existing predator–prey relationships, which over time could influence the population dynamics of a particular resource. Fish stocks could decline below current levels. A no-fishing policy would also eliminate thousands of jobs in the groundfish harvesting, processing, and support sectors. It would idle over $1 billion of harvesting and processing capital, decrease the income of groundfish fishermen and processing plant employees by several $100 million, and decrease the value of U.S. seafood exports by more than $500 million. Few opportunities appear to offset these losses to the fishing industry, to the communities in which they are based, and to the nation. In short, implementation of such a policy would have widespread effects to the human environment.

NOAA Fisheries concluded that such a policy was not a reasonable choice among the alternatives considered in its 1998 SEIS. NOAA Fisheries again considered "no fishing" as a policy alternative during the development of the 2001 Draft Programmatic SEIS and again in this Programmatic SEIS but rejected full consideration of such a policy alternative. NOAA Fisheries rejected the no-fishing policy alternative because such an alternative would be based on the premise that no fishing could occur in the Alaska groundfish fisheries regardless of the level of scientific data demonstrating the sustainability of such a fishery. Such a policy runs counter to the MSA requirement that conservation and management measures prevent overfishing while achieving on a continuing basis OY from each fishery for the U.S. fishing industry (16 USC 1851(a)(1)). In contrast, Alternative 4 establishes an extremely precautionary policy to fisheries management that permits fishing when it can be demonstrated that the fishery will not have a detrimental effect on the environment and that relieves restrictions on fishing when new scientific data support such a change.

Alternatives that Result in Specific Fishery Regulations

A number of public comments received during the scoping process or on the 2001 and 2003 Draft Programmatic SEISs requested that alternatives be developed that go beyond policy and actually include regulatory changes to the fisheries. NOAA Fisheries rejected these requests as being beyond the scope and purpose of a Programmatic EIS. As explained previously in this document, NOAA Fisheries is preparing this programmatic document of the Alaska groundfish fisheries and their management in compliance with a court order and with CEQ and NOAA regulations.

A Programmatic SEIS on the Alaska groundfish fisheries that included specific regulatory changes would require an intricate level of detailed alternatives and a commensurately detailed analysis. However, neither NEPA nor the court require NOAA Fisheries to prepare such a document. NOAA's own NEPA guidelines (NAO 216-6 Section 5.09a) state that "a programmatic environmental review should analyze the broad scope of actions within a policy or programmatic context by defining the various programs and analyzing the policy alternatives under consideration and the general environmental consequences of each" (emphasis added). Furthermore, the court stated that ". . . a programmatic analysis would not require consideration of detailed alternatives with respect to each aspect of the plan—otherwise a programmatic analysis would be impossible to prepare and would merely be a vast series of site-specific analyses. See Robertson, 35 F3d at 1306 ('specific analysis is better done when a specific development action is to be taken, at the programmatic level.')" *Greenpeace v. National Marine Fisheries Service*, 55 F. Supp. 2d 1248, 1276 (W.D. Wash. 1999).

NOAA Fisheries has determined that a Programmatic SEIS for the Alaska groundfish fisheries should essentially be a broad environmental review of the GOA and BSAI groundfish FMPs and alternatives to them. The Programmatic SEIS includes a cumulative impact analysis of management actions as a whole, and examines policies and potential future actions from a variety of environmental perspectives. The Programmatic SEIS therefore provides a broad look at the alternatives and the issues and is somewhat qualitative in nature.

Findings contained within this analysis could result in FMP amendments that, in turn, could lead to formal rule-making and implementation of changes to the current management regime governing the groundfish fisheries off Alaska. Such specific proposed regulatory changes can be expected in the future, and will be attended by case-specific, detailed analyses in subsequent second-level tiered EAs or EISs. In this Programmatic SEIS, however, NOAA Fisheries intends to provide the public with insight into the environmental effects that result from the current management regime as well as from alternative management regimes.

2.6.8 The Environmentally Preferred Alternative

The environmentally PA [40 CFR 1505.2(b)] will promote the national environmental policy as expressed in Section 101 of NEPA. Ordinarily, this means that the alternative causes the least damage to the physical and biological environment and is the alternative that best protects, preserves, and enhances historic, cultural, and natural resources. In this case, the environmentally PA is Alternative 4, the alternative that represents a highly precautionary management policy. As stated in this Programmatic SEIS, Alternative 4 is the only policy alternative that explicitly shifts the burden of proof from the resource to the managers and users of the Alaska groundfish resource. This alternative, as illustrated by its FMPs, would substantially reduce the harvest levels in the fisheries, establish a system of marine reserves where a large portion of the continental shelf would be closed to all commercial fishing, phase out bottom trawl gear, and establish lower bycatch limits. As a result, this alternative would produce the lowest amount of fish harvest, the least amount of bycatch, the least adverse impact to marine mammals, seabirds, and species listed under the ESA, and the least adverse impact to benthic habitat.

2.6.9 The Preferred Alternative

2.6.9.1 Development of the Preferred Alternative

The PA for the management policy to govern the BSAI and GOA groundfish fisheries was recommended by the NPFMC after careful consideration of public comments and the analyses of the alternatives in the PSEIS. The analyses in the PSEIS were based on the best scientific information available. The PA is based on the policy goals and objectives described under Alternative 3, with refinements incorporated from both Alternatives 1 and 4 as well as suggestions taken from public comments. NOAA Fisheries has reviewed the NPFMC recommendation, and has endorsed it as the Agency’s PA.

The management approach and the objectives in the PA reflect a conservative, precautionary approach to ecosystem-based fisheries management, and communicate a policy direction for the future. The PA is a realistic and responsible approach that addresses and complies with the various goals, objectives and requirements of the MSA and other applicable law. The policy elements contained in the PA are consistent with, and also achieve a reasonable balance between the competing interests reflected in, the National Standards. The PA continues the commitment by the NPFMC and NOAA Fisheries to prevent overfishing, reduce bycatch and habitat impacts, and to the extent practicable, protect seabirds and marine mammals. The PA incorporates ecosystem-based management principles into a management approach that recognizes the need to both promote sustainable fisheries and protect fishery-dependent communities. It also retains the strong role of science in fishery management, and fosters a transparent and effective regulatory process where all stakeholders have a meaningful role. The PA is an adaptive management policy which will guide and inform fisheries management decisions made by the NPFMC and NOAA Fisheries. The adaptive nature of the PA also gives the NPFMC and NOAA Fisheries the flexibility to modify policy elements in response to new information or changing circumstances in order to continue to adequately manage the fisheries.

The example FMP bookends PA.1 and PA.2 serve to illustrate management concepts and future actions that logically flow from the PA policy and provide sufficient detail to allow for focused analysis of their environmental consequences. The NPFMC and NOAA Fisheries believe that this final Programmatic SEIS provides the public and decision-makers with the information they need to understand the challenges in managing a complex fishery, the uncertainties being faced and how managers are addressing those uncertainties, and the value of the Alaska groundfish fisheries to the residents of Alaska, the Pacific Northwest, and the nation.

2.6.9.2 The Preferred Alternative

The following has been identified as the NPFMC's and NOAA Fisheries' PA. The management approach and the objectives in the PA reflect a conservative, precautionary approach to fisheries management.

Management Approach

The productivity of the North Pacific ecosystem is acknowledged to be among the highest in the world. For the past 25 years, the NPFMC's adopted management approach has incorporated forward looking conservation measures that address differing levels of uncertainty. This management approach has, in recent years, been labeled the precautionary approach. The NPFMC's precautionary approach is about applying judicious and responsible fisheries management practices, based on sound scientific research and analysis, proactively rather than reactively, to ensure the sustainability of fishery resources and associated ecosystems for the benefit of future and current generations. Recognizing that potential changes in productivity may be caused by fluctuations in natural oceanographic conditions, fisheries, and other, non-fishing activities, the NPFMC intends to continue to recommend appropriate measures to ensure the continued sustainability of the managed species. It will carry out this objective by considering reasonable, adaptive management measures as described in the MSA and in conformance with the National Standards, the ESA, the NEPA and other applicable law. This management approach takes into account the NAS' recommendations on SF Policy.

As part of its policy, the NPFMC intends to consider and recommend, as appropriate, measures that accelerate the NPFMC's precautionary, adaptive management approach through community- or rights-based management, ecosystem-based management principles that protect managed species from overfishing, and where appropriate and practicable, increase habitat protection and bycatch constraints. All management measures will be based on the best scientific information available. Given this intent, the fishery management goal is to provide sound conservation of the living marine resources; provide socially and economically viable fisheries and fishing communities; minimize human-caused threats to protected species; maintain a healthy marine resource habitat; and incorporate ecosystem-based considerations into management decisions.

This management approach recognizes the need to balance many competing uses of marine resources and different social and economic goals for sustainable fishery management including protection of the long-term health of the resource and the optimization of yield. This policy will utilize and improve upon the NPFMC's existing open and transparent process to involve the public in decision-making.

Adaptive management requires regular and periodic review. Objectives identified in this policy statement will be reviewed annually by the NPFMC. The NPFMC will also review, modify, eliminate, or consider new issues as appropriate to best carry out the goals and objectives of this management policy.

To meet the goals of this overall management approach, the NPFMC and NOAA Fisheries will use the Programmatic SEIS as a planning document. To help focus its consideration of potential management measures, it will use the following objectives as guideposts to be re-evaluated as amendments to the FMP are considered over the life of the Programmatic SEIS.

Prevent Overfishing

1. Adopt conservative harvest levels for multi-species and single-species fisheries and specify OY.
2. Continue to use existing OY cap for BSAI (as stated in current law) and GOA groundfish fisheries.
3. Provide for adaptive management by continuing to specify OY as a range.
4. Initiate a scientific review of the adequacy of F_{40} and adopt improvements as appropriate (refer to Appendix B).
5. Continue to improve the management of species through species categories.

Promote Sustainable Fisheries and Communities

6. Promote conservation while providing for OY in terms of providing the greatest overall benefit to the nation with particular reference to food production, and sustainable opportunities for recreational, subsistence and commercial fishing participants and fishing communities.
7. Promote management measures that, while meeting conservation objectives, are also designed to avoid significant disruption of existing social and economic structures.

8. Promote fair and equitable allocation of identified available resources in a manner such that no particular sector, group, or entity acquires an excessive share of the privileges.

9. Promote increased safety at sea.

Preserve Food Web

10. Develop indices of ecosystem health as targets for management.

11. Improve the procedure to adjust ABCs as necessary to account for uncertainty and ecosystem factors.

12. Continue to protect the integrity of the food web through limits on harvest of forage species.

13. Incorporate ecosystem-based considerations into fishery management decisions as appropriate.

Manage Incidental Catch, and Reduce Bycatch and Waste

14. Continue and improve current incidental catch and bycatch management programs.

15. Develop incentive programs for bycatch reduction including the development of mechanisms to facilitate the formation of bycatch pools, vessel bycatch allowances, or other bycatch incentive systems.

16. Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits as information becomes available.

17. Continue program to reduce discards by developing management measures that encourage the use of gear and fishing techniques that reduce bycatch, which includes economic discards.

18. Continue to manage incidental catch and bycatch through seasonal distribution of TAC and geographical gear restrictions.

19. Continue to account for bycatch mortality in TAC accounting and improve the accuracy of mortality assessments for target, PSC bycatch, and non-commercial species.

20. Control the bycatch of prohibited species through PSC limits or other appropriate measures.

21. Reduce waste to biologically and socially acceptable levels.

Avoid Impacts to Seabirds and Marine Mammals

22. Continue to cooperate with USFWS to protect ESA-listed species, and if appropriate practicable, other seabird species.

23. Maintain or adjust current protection measures as appropriate to avoid jeopardy to ESA-listed Steller sea lions.

24. Encourage programs to review status of endangered or threatened marine mammal stocks and fishing interactions and develop fishery management measures as appropriate.

25. Continue to cooperate with NMFS and USFWS to protect ESA-listed marine mammal species, and if appropriate and practicable, other marine mammal species.

Reduce and Avoid Impacts to Habitat

26. Review and evaluate efficacy of existing habitat protection measures for managed species.

27. Identify and designate EFH and habitat area of particular concern (HAPC) pursuant to MSA rules, and mitigate fishery impacts as necessary and practicable to continue the sustainability of managed species.

28. Develop an MPA policy in coordination with national and state policies..

29. Encourage development of a research program to identify regional baseline habitat information and mapping, subject to funding and staff availability.

30. Develop goals, objectives, and criteria to evaluate the efficacy and suitable design of MPAs and no-take marine reserves as tools to maintain abundance, diversity, and productivity, and implement MPAs if and where appropriate.

Promote Equitable and Efficient Use of Fishery Resources

31. Provide economic and community stability to harvesting and processing sectors through fair allocation of fishery resources.

32. Maintain LLP program and modify as necessary and further decrease excess fishing capacity and overcapitalization by eliminating latent licences and extending programs such as community or rights-based management to some or all groundfish fisheries.

33. Provide for adaptive management by periodically evaluating the effectiveness of rationalization programs and the allocation of access rights based on performance.

34. Develop management measures that, when practicable, consider the efficient use of fishery resources and account for the interest of harvesters, processors, and communities.

Increase Alaska Native Consultation

35. Continue to incorporate local and Traditional Knowledge in fishery management.

36. Consider ways to enhance collection of local and Traditional Knowledge from communities, and incorporate such knowledge in fishery management where appropriate.

37. Increase Alaska Native participation and consultation in fishery management.

Improve Data Quality, Monitoring, and Enforcement

38. Increase the utility of Groundfish Fishery Observer data for the conservation and management of living marine resources.

39. Improve the Groundfish Observer Program, and consider ways to address the disproportionate costs associated with the current funding mechanism.

40. Improve community and regional economic impact costs and benefits through increased data reporting requirements.

41. Increase the quality of monitoring and enforcement data through improved technological means.

42. Encourage a coordinated, long-term ecosystem monitoring program to collect baseline information and compile existing information from a variety of ongoing research initiatives, subject to funding and staff availability.

43. Cooperate with research institutions such as the North Pacific Research Board (NPRB) in identifying research needs to address pressing fishery issues.

44. Promote enhanced enforceability.

45. Continue to cooperate and coordinate management and enforcement programs with the Alaska Board of Fish, Department of Fish and Game, and Alaska Fish and Wildlife Protection, the USCG, NMFS Enforcement, IPHC, federal agencies, and other organizations to meet conservation requirements, promote economically healthy and sustainable fisheries and fishing communities, and to maximize efficiencies in management and enforcement programs through continued consultation, coordination, and cooperation.

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Chapter 3

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Chapter 3 Affected Environment

This chapter describes the physical, biological, and socioeconomic resources of the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) and the ecosystems of the eastern Bering Sea (EBS) and northeastern North Pacific Ocean. These descriptions present the relevant history, natural history, and current status of the groundfish resources and their environments and are intended to establish an environmental baseline that will serve as a starting point for the direct, indirect, and cumulative effects analysis to come in Chapter 4.

We begin the chapter by explaining the approach and methods that have been used in gathering and presenting this information and by discussing the methodology used to analyze the environmental and socioeconomic effects of past amendments to the current BSAI and GOA groundfish Fishery Management Plans (FMPs).

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3.1 Approach and Methods

The current status of any given resource is the result of the interplay between many natural events and human actions and influences over time. An analysis of cumulative effects on a resource must necessarily begin by identifying the events and actions that have affected the resource in the past and continue to exert an influence in the present. To this end, the present chapter describes each resource, reviews historical trends, and conducts a past/present effects analysis of the actions and events that have altered the resource from its original, pre-development condition. These descriptions, reviews, and analyses combine to form a baseline that represents current conditions of the resources and environment of the groundfish fisheries in the Exclusive Economic Zone (EEZ) off Alaska. This baseline will serve as the starting point for the direct, indirect, and cumulative effects analyses to come in Chapter 4.

The methods described below comply with Council on Environmental Quality (CEQ) guidance for scoping and organizing processes associated with cumulative effects analyses (CEQ 1997), as well as United States (U.S.) Environmental Protection Act (EPA) guidance for the consideration of cumulative effects (EPA 1999). The reader should refer to Section 4.1.4 for a comprehensive description of how the past/present effects analyses feed into the direct, indirect, and cumulative effects analyses in Chapter 4.

3.1.1 Scoping

Scoping defines the issues, actions, and geographic and chronological boundaries for the past/present effects analyses. The scoping process for the analyses of this chapter has entailed the following:

- Reviewing public and agency comments;
- Identifying the issues and events connected with the groundfish fisheries since their implementation;
- Identifying internal Magnuson-Stevens Fishery Conservation and Management Act (MSA) management actions and their potential effects (see Section 3.2 for a discussion of this analysis)
- Identifying issues and events (natural and human-influenced) external to the groundfish fisheries; and
- Identifying management actions external to the MSA process and their potential effects.

The overall geographic scope of the analyses has been broadly defined as the Bering Sea and North Pacific Ocean. This broad geographic scope was necessitated by the transboundary movements of a number of fish species. Such a broad area, however, is not relevant to all resource categories discussed in this section. When the overall geographic scope is not applicable to a given resource, a relevant geographic sub-area in the analysis of that particular resource is defined. Likewise, when events outside the overall geographic scope have strongly influenced the baseline condition for a given resource, such as with some migratory seabirds and marine mammals, we define an extended geographic scope for analysis of effects on that resource.

EPA guidance (1999) recommends establishing a chronological reference point to mark the beginning of a historical review, or past effects analysis. For our present purposes, that environmental reference point in time is defined as 1740, one year prior to first contact of non-indigenous people. This assumes that at that time the BSAI and GOA ecosystems existed in an ecologically sustainable condition; hence, the environmental reference point of 1740 is a logical starting point for the ecosystem discussion. The overall time frame for the past/present effects analyses thus spans the period from 1740 to 2002. For many of the resources under consideration here, however, the lack of data requires that the discussion use a later point in time as a starting point. In these cases, we define the relevant environmental reference point in each particular analysis.

3.1.2 Organizing

The organizing step characterizes and consolidates the issues and actions defined during the scoping process. The following steps have been taken to organize the information of this chapter accordingly:

- Identifying the relevant physical, biological, and socioeconomic resources;
- Reviewing the literature, personal communications with resource specialists, and documentation of available information on identified resources (i.e., descriptive, trend, and impact information);
- Identifying indicators for direct/indirect effects that could cause population and/or ecosystem level effects to occur;
- Conducting a past/present effects analysis; and
- Defining a baseline condition for identified resources.

3.1.3 Identifying Effects, Events, and Actions

A cumulative effects analysis takes into account the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions (40 Code of Federal Regulations [CFR] 1508.7). For the purposes of this Programmatic Supplemental Environmental Impact Statement (SEIS), the definition of other actions includes human-controlled, natural, and climatic events.

To identify direct/indirect effect indicators and external events and management actions, we have produced a comprehensive checklist for each resource category. Information presented in the checklists was obtained from reviewing environmental impact statements (EIS), reports and resource studies, peer-reviewed literature, and from conferring with expert contributors to the Programmatic SEIS. The checklists have been entered into the administrative record.

Direct/Indirect Effect Indicators

Direct/indirect effect indicators are specific to each resource category and are presented in the past/present effects analysis for each resource.

Past/Present External Events and Actions

The detailed checklists identify the following human-controlled external event and action categories and natural and climatic events relevant to the past/present effects analysis:

- Past and present foreign fisheries (inside the U.S. EEZ prior to the MSA and, after passage of the MSA in 1976, outside the EEZ). Appendix B of this document provides a detailed discussion of the historical foreign fisheries and pertinent management actions;

- Fisheries managed by the International Pacific Halibut Commission (IPHC).
- Fisheries managed by the State of Alaska.
- Native subsistence fisheries.
- Commercial harvesting of marine mammals and seabirds.
- Subsistence hunting of marine mammals and seabirds.
- Pollution and toxic contamination, including the *Exxon Valdez* Oil Spill (EVOS).
- Introduction of mammalian predators to seabird colonies.
- Natural events and phenomena.
- Long- and short-term climatic events.

Internal Events and Actions

These include post-MSA foreign fisheries inside the U.S. EEZ, Joint Venture (JV) fisheries, and domestic fisheries. Management actions include the BSAI and GOA FMPs and associated amendments. Also included are the Endangered Species Act (ESA) Section 7 consultations (Biological Opinions [BiOps]) of National Marine Fishery Service (NMFS or National Oceanic and Atmospheric Administration [NOAA] Fisheries) and the U.S. Fish and Wildlife Service (USFWS), and the resulting Reasonable and Prudent Alternatives (RPAs) that have been implemented to protect endangered or threatened species. Appendix B of this document provides a detailed discussion of the evolution of the fisheries management plans in use today and an analysis of FMP amendment actions.

3.1.4 Past/Present Effects Analysis

There are two reasons for describing and evaluating past and present effects on the environment. First, this process is necessary to build the picture of the baseline–the status as of 2001 or 2002–for each resource component (for example, walleye pollock, Steller sea lion, the ecosystem, per capita income). In other words, *it helps to explain how the baseline got to be the way it is.* And second, the past/present effects analysis identifies past effects of human actions and natural events that may persist in the present *and continue to exert an influence in the future*.

To evaluate the significance of potential impacts, it is necessary to establish a baseline, or benchmark, against which the predicted direct, indirect, and cumulative effects of the alternatives can be compared. For comparative purposes, the baseline is a slice through time, a snapshot, that represents the affected environment at a fixed point in time. The description of the comparative baseline was prepared utilizing data available through 2001 or 2002, depending on the type of data. With the exception of socioeconomics and seabirds, the comparative baseline for environmental factors utilize data through 2002. For the socioeconomic comparative baseline and socioeconomic model used for analysis in Chapter 4, 2001 data were used because 2002 were not available prior to the release of the 2003 Draft PSEIS. These years were chosen because they were the most recent years for which a wide range of fishery-related and other resource data were available to the analysts preparing the draft document. The National Environmental Policy Act (NEPA) does not contain a standard rule that prescribes how the baseline should be defined, but the standard practice is to select the most recent year for which nearly complete environmental data are available when starting the analyses. In Chapter 4, the authors have updated some impact analyses between the draft and final documents in cases where new data that might affect the significance determinations were available. As a practical matter, the document preparation and review process makes it infeasible to move the baseline continuously forward in time, and the use of 2001 and 2002 as the baseline remains relevant and appropriate to the baseline characterization and impact assessments as of 2004.

The baseline characterization of current conditions is more, however, than simply a snapshot through time. It takes into account past human actions and natural events that have influenced resources in various ways, leading, for example, to population declines or increases, or changes in distribution. To characterize such dynamic processes, it is necessary to identify trends that began in the past and have continued to affect resources through the years leading up to the baseline. This allows the baseline description to distinguish features that are continuously changing from those that are static, an important factor in assessing the potential environmental impacts of the alternatives. In addition, the identification of trends is necessary to make future projections regarding a particular resource component, because trends from the past and present may continue into the future. This aspect is especially relevant to the cumulative effects analyses in Chapter 4, because those assessments must take into account past, present, and reasonably foreseeable future human actions and natural events that might add to or interact with the predicted direct and indirect effects of the alternatives (CEQ 1997).

Accordingly, the text descriptions of the affected environment for each of the resource components described in this chapter take past effects and trends into account. A two-tier table structure is used for summarizing the written discussions and for organizing the information used in the cumulative effects analyses. For each resource, a first table organizes the information from the past/present effects analysis used in defining baseline conditions for a resource. This baseline information then feeds into a second table, which is the cumulative effects table. Chapter 4 provides a detailed discussion of the cumulative effects tables. The first-tier, past/present effects tables are explained below.

The main column headings in the past/present effects analysis table are as follows:

Direct/Indirect Effects: Effects identified for each resource that have the potential to cause population and/or ecosystem level effects are listed, as follows.

- **Past/Present Events:** Events that produce or have the potential to produce the identified direct/indirect effects, listed in relation to direct/indirect effects listed in the first column. This column heading is further divided into two sub-columns:
  - External: Natural, climatic, and human controlled events and actions not directly associated with management of the groundfish fisheries.
  - Internal: Events and actions directly associated with management of the groundfish fisheries.

- **Past/Present Management Actions:** Management actions that regulate the events, listed in relation to the direct/indirect effects listed in the first column. This column heading is further divided into two sub-columns:

- External: actions self-imposed by management and industry related to the direct/indirect effects listed in the first column and not directly associated with management of the groundfish fisheries)
- Internal: Management actions related to the direct/indirect effects listed in the first column and directly associated with groundfish fisheries management

In addition, a text box is provided with each past/present effects table that summarizes the comparative baseline of a resource. All of the information in the past/present effects tables is also discussed in each resource category sub-section.

By using this approach the Programmatic SEIS provides two ways of viewing the analyses, in text and tabular formats. The information in the tables is supported by the text, so that the reader can refer to the text description to get more information on any aspect of a table. Conversely, the reader can use the tables to gain a quick summary of the conclusions in the text. To facilitate this, the text discussions and related tables are cross-referenced.

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3.2 Assessment of the Fishery Management Plan Amendments

The BSAI and GOA FMPs were implemented in 1979 and 1981, respectively. Since that time, the BSAI FMP has been amended 65 times, and the GOA FMP has been amended 55 times. Each FMP amendment was supported by the required level of analysis under NEPA, Executive Order (EO) 12866, and the Regulatory Flexibility Analysis. As part of the programmatic review, it is necessary to analyze the cumulative impacts of the groundfish fisheries on the human environment. This includes reviewing the incremental impacts of the FMP amendments, the impact of groundfish fishery management, and the impact of other past external events, in order to establish a baseline condition against which to compare the Programmatic SEIS alternatives for direct, indirect and cumulative effects.

Appendix B provides a description and detailed discussion of the nature of the fisheries and the lingering influences of pre-MSA fisheries in the North Pacific. Later sections of Chapter 3 discuss other ongoing external influences on the human environment that may be impacting synergistically with the groundfish fisheries. Appendix E summarizes the regulatory amendments that regulate the fisheries within the guidelines of the amended FMPs. This section deals specifically with the incremental amendments to groundfish fishery management. Section 3.2.1 describes the management actions contained within the BSAI and GOA amendments. Section 3.2.2 provides a description of the FMP amendments, objectives, implementing regulations, and results. Section 3.2.3 assesses the cumulative past effects of similar management actions in order to determine whether an impact occurred, and if so, whether it was adverse or beneficial. This evaluation is an important element in assessing the baseline condition for the groundfish fisheries.

3.2.1 Fishery Management Plan Amendments

The management measures implemented through the BSAI and GOA FMPs, and their amendments, are categorized and summarized in Tables 3.2-1 and 3.2-2 for the BSAI and GOA, respectively. The management actions have been grouped into six categories: management and monitoring, groundfish yield/sustainability, bycatch and incidental catch, habitat conservation, seabird and marine mammal conservation, and socioeconomic issues. Many of the amendments initiate multiple management changes, and the amendment number may appear in more than one category. However, each specific measure only appears once in the table. The categorization is based on the primary objective of the management action. For example, although a particular management action may have achieved a secondary objective of providing incidental benefits for habitat conservation, if the primary intent of the action (as stated in the supporting analysis) was to control bycatch, the management action is listed in the 'Bycatch and Incidental Catch' category.

The six categories of management actions and their concomitant objectives are as follows:

- Management and Monitoring
  - To continue authorization of the groundfish fisheries
  - To establish a structured process for administering groundfish fisheries
  - To correct inefficiency in administration of the fishery management process
  - To make the management process more understandable to users
  - To facilitate enforcement of fishery regulations
  - To enhance data collection and record keeping
  - To improve reporting
  - To clarify the intent of past regulations

- Groundfish Yield/Sustainability
  - To protect target groundfish stocks
  - To ensure productivity of groundfish stocks
  - To control the rate of groundfish harvest
  - To maintain long-term yield from groundfish stocks
  - To improve the quality of groundfish products
  - To protect groundfish habitat

- Bycatch and Incidental Catch
  - To reduce discards to the extent practicable
  - To minimize the incidental catch of non-target groundfish species, undersized target groundfish, and prohibited species
  - To avoid waste of marine resources
  - To facilitate full utilization of catches taken in groundfish fisheries
  - To avoid gear loss and subsequent "ghost fishing" of lost gear

- Habitat, Seabird and Marine Mammal Conservation
  - To reduce fishing gear effects on the marine environment
  - To avoid fishing effects on marine mammals, birds, or habitat areas of critical concern
  - To avoid disturbance, injury, or mortality to marine mammals or seabirds
  - To protect marine mammal and seabird food sources

- Socioeconomic Issues
  - To manage effort in groundfish fisheries
  - To make prosecution of groundfish fisheries more fair to user groups
  - To avoid gear conflicts, gear entanglement, or gear damage
  - To enhance safety at sea

3.2.2 Description of Fishery Management Plan Amendments, Objectives, Implementing Regulations, and Results

A detailed summary of the amendments to the BSAI and GOA FMPs may be found in Appendix C and Appendix D respectively. The amendments are listed numerically, and for each, the following information is included: the dates of decision-making and implementation, the purpose and need of each amendment, a summary of implementing regulations, a description of the supporting analysis, and a statement of the results of the amendment.

3.2.3 Cumulative Past Effects of Fishery Management Plan Amendments

The following section summarizes the results of the historical review of the North Pacific fishery management incremental decision-making process. The FMP amendments are assessed below. Section 3.2.3.1 examines the FMP amendment actions by determining the degree to which they were effective at resolving the stated management objective. Section 3.2.3.2 summarizes the impact of the FMP amendments on particular resources or resource categories. It directs the reader to the more detailed analysis of the contribution that groundfish fishery management has made to the comparative baseline condition of the resources in question.

3.2.3.1 Fishery Management Plan Amendments Assessed by Management Objective

As described in Section 3.2.1, the historical FMP amendments have been organized into six categories based on the objective of the management action: management and monitoring actions, groundfish yield and sustainability actions, bycatch and incidental catch actions, habitat actions, seabird and marine mammal actions, and socioeconomic actions. The BSAI and GOA FMP amendments are assessed below in terms of their efficacy in achieving the management objective and mitigating adverse effects of groundfish fishery prosecution.

Management and Monitoring Actions

Various GOA and BSAI FMP amendments implemented administrative changes. FMP amendments are denoted in the following manner: GOA FMP Amendment 1 is listed as GOA 1. GOA 1, 7, and 8 extended the GOA FMP and eliminating the expiration date. GOA 16 and 34 corrected previous FMP language. GOA 14, 15, and 18 and BSAI 1, 11, 12, 13, and 21 added framework measures to remove the setting of target quotas, incidental catch and prohibited species catch (PSC) limits, and fishing season dates from the FMP amendment process, and to conform the GOA FMP with the BSAI FMP. GOA 21 and BSAI 16 established procedures for setting interim total allowable catch (TACs), so that the fisheries could open on January 1. Since these actions provided for more effective fishery management, they are considered to have had a non-conditional beneficial effect on the groundfish fisheries.

Clarifications and definitions of terms and standards are management actions that form part of the FMP amendments. Target and prohibited species are defined in GOA 16 and 21 to be consistent with the BSAI FMP. GOA 14, 16, 21 and 24 and BSAI 9, 16, and 19 also specify and define legal gear and clarify directed fishing definitions. GOA 21, 44 and 56, and BSAI 16, 44 and 56 define overfishing levels for the groundfish fishery resources, allowing for improved conservation of target groundfish stocks. Additionally, GOA 15 revised the goals and objectives for the GOA FMP. Unambiguous standards, definitions and policies assist the efficient prosecution of the groundfish fisheries and are considered to have had a beneficial effect.

The GOA and BSAI FMPs, GOA 4, 11, 14, 15, 16, 17, and 18 and BSAI 9, 10, 11a, 12, and 13 established and revised recordkeeping and reporting requirements for vessels participating in the groundfish fisheries. The GOA and BSAI FMPs included provisions for observers on foreign fishing boats, while GOA 18 and 30 and BSAI 10, 13, 27, and 37 initiated and redefined the domestic fisheries observer program. Data from catch and observer reports are important components of the fisheries management processes. Therefore, we consider the establishment of these programs and their continuing implementation to have had a non-conditional beneficial effect on the groundfish fisheries.

Various GOA and BSAI FMP amendments were intended for conservation purposes or to increase the ability of managers to respond quickly to situations to resolve gear conflict issues. The GOA FMP, GOA 8 and 15 and BSAI 1, 10, 16a, 19, 21 and 24 all authorize the NOAA Fisheries Regional Administrator to use inseason management measures to react responsively to fishery issues. The intent of these actions, the issuance of rapid field orders in response to newly developing issues, has not necessarily been fulfilled; however, to the extent that it has allowed flexibility in management, these actions are considered beneficial.

The original GOA FMP, GOA 22, and BSAI 17 allowed the issuing of experimental fishing permits for the purpose of testing gear efficiency, fishing techniques, bycatch mortality reduction techniques, and other methodologies. It is inferred that information gained from activities conducted under experimental fishing permits leads to gains in the effectiveness of the groundfish fisheries. Therefore, these actions are considered to have had a conditionally beneficial effect on the groundfish fisheries.

Groundfish Yield and Sustainability Actions

The BSAI and GOA FMPs establish annual harvest levels for groundfish species. For foreign fishermen, exceeding a nation's allocation in a management area or district triggered closure of that area to fishermen from that nation. These actions are considered beneficial as they prevented overfishing of the stocks by foreign fishermen.

The GOA FMP establishes optimum yield (OY) levels for each groundfish species, with revisions to squid, Atka mackerel, Pacific cod, pollock, sablefish, 'other rockfish', and 'other species' determinations made in GOA 4, 7, 10, 11, 13, 14. Available data on stock biomass indicated that the given target groundfish stocks were appropriate. Therefore, these actions are considered to have had a neutral to beneficial effect on the given target groundfish stocks. As discussed in the Management and Monitoring Actions above, GOA 15 revised the process for setting target species quotas, resulting in the establishment of an OY range, and an annual TAC-setting process implemented by regulatory amendment. Harvest levels were established in the BSAI FMP also; however BSAI 1 established a multi-year, multi-species OY (a range from 1.4-2.0 million metric tons [mt]) for the BSAI groundfish complex as a whole. Prior to the implementation of this amendment, BSAI 4 adjusted the Pacific cod harvest levels from the harvest levels set in the BSAI FMP. The TAC framework has had a beneficial impact due to the increased management flexibility, and the incorporation of an annual status of stock review that sets catch quotas based on the best available science.

The GOA and BSAI FMPs managed specific species targeted by the groundfish fisheries, and identified requirements for some incidentally caught species (see prohibited species discussions in the following section). Various FMP amendments made alterations to the management categories identified in the FMPs. GOA 5, 7, and 8 established new management categories for grenadiers, and for idiot rockfish, and non-specified species. GOA 14 gave the Secretary of Commerce the authority to split or combine species within the target species category. GOA 31 established Atka mackerel as a separate target species category. BSAI 12 established a separate rock sole target species category separate from the 'other flatfish' category. Since these actions provided for more species-specific management and thus reduced the risk of overfishing the stocks, they are considered to have had a beneficial effect.

The GOA FMP apportioned quota over five subareas, which were reduced to three by GOA 4, GOA 8, 11, and 22. They divided and modified the eastern GOA districts for sablefish management. GOA 13 combined the western and central management areas for pollock allocations. GOA 14 created a new regulatory district for 'other rockfish', and recognized the State of Alaska management areas for demersal shelf rockfish. GOA 18 and BSAI 17 established the Shelikof District in the GOA (which was rescinded in favor of other measures in GOA 25 as part of Steller sea lion protection measures) and the Bogoslof district in the Bering Sea, respectively, in order to manage the fisheries' catch of spawning pollock. GOA 4, 8, and 22 modified the GOA regulatory districts. BSAI 28 divided the Aleutian Islands subarea into three management districts for the immediate purpose of spatially allocating Atka mackerel in order to address localized depletion. The creation of subareas and species-specific districts has allowed managers to control for uneven exploitation and is considered beneficial.

GOA 21 and 46 deferred demersal shelf, blue, and black rockfish management to the State of Alaska. The management shift is considered to have had a conditionally beneficial effect, since state management has allowed more consistent management of these species throughout federal and state waters, minimizing the risk of localized depletion and the possibility of exceeding TAC.

GOA 19 and BSAI 14 allocated the pollock TAC seasonally, over four seasons in the GOA and two in the BSAI, in order to reduce the potential for fishing on spawning aggregations to adversely impact the sustainability of the stock. Limiting the amount of quota available during spawning seasons is effective at reducing fishing on spawning populations, although it also decreases the value of the fishery.

GOA 10, 32, and 38 were conservation measures taken to rebuild depressed Pacific ocean perch stocks. These measures were implemented specifically to conserve stocks, and have succeeded at rebuilding the Pacific ocean perch stocks. They are considered to be beneficial.

Bycatch and Incidental Catch Actions

Species that must be discarded at sea are specified in the GOA and BSAI FMPs, and limits on the catch of these prohibited species are established in the FMP amendments as a way to minimize the bycatch and encourage the use of more selective gear. Once a limit is achieved, a closure is triggered either of a fishery, fisheries, or a specified fishing area. GOA 14, 15, 18, and 21 specify halibut PSC limits for the GOA groundfish fisheries, and apportion them by season and gear. BSAI 1a, 3, 8, 12, 12a, 16, 19, 25, 37, 40, 41, 57 and 58 all establish or modify PSC limits in the BSAI for halibut, crab, salmon and herring, by sector and fishery. PSC limits have been consistently used as a bycatch management tool, have been extended from applying to halibut to most prohibited species in the BSAI, and have consistently decreased over the years. It is inferred from this that PSC limits are successful in decreasing the bycatch of these species in the groundfish fisheries. As a result, these actions are considered beneficial in minimizing the impact of the groundfish fisheries.

Many measures identify gear specific closure areas to reduce bycatch. The GOA and BSAI FMPs, GOA 9 and 10 and BSAI 4, 7, and 10 specified foreign bottom trawl and trawl closures to reduce crab and halibut bycatch. Although GOA 4 and BSAI 1 exempted the domestic fleet from some of the domestic bottom trawl restrictions in the GOA and BSAI FMPs, GOA 15, 18, 26, and 60 reinstituted specific non-pelagic trawl prohibitions around Kodiak and in Cook Inlet to lower bycatch of crab species. BSAI 10, 12a , 21a, 35, 37, 40, and 57 established restricted seasonal, year-round or PSC limit-triggered areas to decrease crab bycatch. BSAI 10, 12a, 16a, and 57 established protections to lower the bycatch of halibut. BSAI 1a, 3, and 8 were early measures to reduce salmon PSC limits over time, as referred to above, whereas BSAI 21b, 35, and 58 attempted to address salmon bycatch using trigger amounts and area closures. BSAI 16 established herring savings areas. It is inferred that these measures improved the efficiency of groundfish harvest, and decreased the incidental take of species in bottom trawls. Therefore, these measures are considered to have had a conditionally beneficial effect.

Various other measures were adopted to control bycatch and incidental catch. GOA 24 and BSAI 19 delayed the start of the groundfish trawl fisheries in order to avoid excessive bycatch. Also, GOA 45 adjusted the seasonal pollock allowance schedule in order to avoid high salmon bycatch in the summer months. Bycatch reduction was also encouraged through gear modifications. GOA 21 and 16 required halibut excluder devices on pots, and FMP amendment actions were specifically implemented to reduce ghost fishing by lost gear. GOA 8 and 21 and BSAI 16 required biodegradable panels on sablefish pots. Any reduction in ghost fishing or increase in gear selectivity is considered to have a conditionally beneficial effect.

Additionally, incentive programs were introduced in GOA 21 and 24 and BSAI 16 and 19 to penalize vessels with excessive bycatch. Vessel sanctions under the incentive programs have proved very difficult to enforce, and these actions have not achieved bycatch reductions in the groundfish fisheries.

Another goal of bycatch-related measures is the minimization of waste. BSAI 11 minimized waste by splitting the annual JV pollock quota into two seasons, and GOA 19 and BSAI 14 prohibited roe stripping of pollock in the groundfish fisheries. Both amendments encouraged greater utilization of fish fit for human consumption and mitigated the potential for overharvest of spawning stocks to affect the sustainability of the pollock resource. BSAI 26 and 50 and GOA 29 and 50 were implemented to reduce post-harvest waste of incidentally-caught Pacific halibut and salmon in specified groundfish fisheries by donating the bycatch to social service food banks. Since Pacific halibut and salmon bycatch would typically be discarded in federal waters, these actions help provide for the needy and have a non-conditional beneficial effect. The retention of Pacific halibut and salmon bycatch also provides an additional opportunity to collect biological samples and scientific data to support long-term solutions to bycatch of these species. Therefore, these actions are also considered to have had a beneficial effect on groundfish fisheries.

GOA 49 and BSAI 49 were implemented to reduce discards in the groundfish fisheries, and encourage full utilization. The amendments required 100 percent retention of pollock and Pacific cod and, as of January 1, 2003, for rock sole and yellowfin sole as well, regardless of how or where the fish were caught unless the fish were unfit for human consumption. These measures, beginning in 1998, have dramatically reduced the discard rates of pollock and Pacific cod. Therefore, they are considered to have had a conditionally beneficial effect on groundfish fisheries. BSAI 75 repealed the implementation of Improved Retention/Improved Utilization (IR/IU) for flatfish due to the excessive cost it would have imposed on flatfish fishermen. Because IR/IU was never implemented for flatfish, this action has had no effect.

Habitat Actions

GOA 14 and 55 and BSAI 9 and 55 defined and established habitat protection policies for the future conservation of groundfish stocks. GOA 55 and BSAI 55 identified and described essential fish habitat (EFH) for species managed under the FMPs. Habitat areas of particular concern were identified as living substrates in shallow and deep waters, and freshwater habitats used by anadromous fish. To the extent that such policies increase awareness of sensitive habitat and influence other management decisions, they have provided a conditionally beneficial effect to marine habitat. However, no concrete measures were proposed in conjunction with these FMP amendments to mitigate adverse habitat impacts from fishing activities.

GOA 59 established the Sitka Pinnacles Marine Reserve encompassing a 2.5 square nautical miles (nm^2) area off the Cape Edgecumbe pinnacles as a protected area for rockfish and lingcod habitat. This action is anticipated to be beneficial to these long-lived, vulnerable species.

Seabirds and Marine Mammal Actions

Forage fish (e.g., capelin, eulachon, and sand lance) are an important food source for seabirds and marine mammals. GOA 39 and BSAI 36 prohibited the establishment of a commercial fishery targeting forage fish, thereby preserving the food resource. These FMP amendments are considered to have had a conditionally beneficial effect on seabirds and marine mammals.

Several FMP amendments have been implemented specifically for the direct protection and conservation of marine mammals. No-fishing buffer zones were established around rookeries and haulouts deemed critical to walrus (BSAI 13 and 17) and Steller sea lions (BSAI 20 and GOA 25). GOA 25 also modified pollock management districts in the western/central GOA, to reduce the effects of prey competition from the groundfish fisheries. While the impact of the fisheries on walrus has not reasserted itself as a problem, the population levels of the western stock of Steller sea lions continued to decline even after the protection measures adopted in GOA 25. Further protection measures have been implemented by emergency rules and regulatory amendments since 1999; however, the degree to which the Steller sea lion population levels are impacted by the groundfish fisheries is still a matter of scientific controversy. As such, the effect of the FMP amendments relating to Steller sea lion protection measures cannot be determined.

Socioeconomic Actions

The establishment of groundfish quotas and spatial and seasonal allocation was discussed previously in the groundfish yield and sustainability actions section.

The GOA and BSAI FMPs established specific allocations for foreign and domestic fisheries, with reserves providing for growth of the domestic fisheries. The program was modified in GOA 7, 8, and 11; and GOA 2 and 6, BSAI 2 and 4 increased domestic groundfish quota and correspondingly decreased foreign allocations. To the extent that the MSA called for domestication of the fisheries, the amendments were beneficial in promoting domestic groundfish harvests. The establishment of foreign closure areas, particularly in areas likely to be utilized by domestic fishermen (such as the Aleutian Islands and southeast Alaska) under the FMPs, was also effective in preventing gear conflict between domestic and foreign fishermen and promoting domestic fisheries (although certain foreign and domestic restrictions were relaxed in GOA 4 after they were found to be unnecessary).

The GOA and BSAI FMPs specified allocations between gear types for foreign fishermen. Management measures favoring foreign longliners were adopted in GOA 3, which modified restrictions on foreign Pacific cod quota in the Chirikof District in order to allow the foreign longline fleet to take a higher percentage of the allocated foreign quota, and GOA 4, which separated longliners from trawlers for quota closures. The greater selectivity of longline gear over trawl gear resulted in beneficial impacts on bycatch rates and habitat.

Allocation by gear type was first adopted for the domestic fisheries in GOA 14. In order to address excess capacity in the sablefish fishery, fixed allocations were assigned over a four-year adjustment period, to longline, trawl, and pot fisheries, with pot fisheries being phased out of the GOA sablefish fishery by the end of that time. Additionally, the amendment delayed the sablefish fishery start date to allow smaller vessels more opportunity to participate in the fishery. The FMP amendment slowed the growth in capacity and diminished the possibility of gear conflicts and grounds preemption, but did not solve the problem of overcapacity in the fishery.

The sablefish fishery was further modified by GOA 20 and BSAI 15, which implemented the sablefish Individual Fishing Quota (IFQ) program and eliminated the derby-style fishing associated with these fisheries. While the framework of the IFQ program was set out in GOA 20 and BSAI 15, modifications were made to ownership, transfer, and processing restrictions in GOA 35, 36, 37, 42, 43, 54, and 64 and BSAI 31, 32, 33, 42, 43, 54, and 72. The sablefish IFQ program has been successful in diminishing the number of participants in the sablefish fishery, and has succeeded at reducing bycatch (particularly of Pacific halibut), improving safety, reducing gear conflicts and fishing mortality due to lost gear, and increasing the economic value of the fishery.

Quota allocation between gear types continued to be used to address socioeconomic issues in the groundfish fisheries. BSAI 34 allocated two percent Atka mackerel TAC in the eastern Aleutian Islands to jig gear, in order to promote a local, small vessel fishery without direct competition from the large, high-capacity trawl fleet. Although the amendment was successful in creating a quota allocation for the jig gear fishery, the fishery has not taken advantage of the quota to harvest Atka mackerel. Therefore the amendment has had no appreciable effect. BSAI 53 allocated shortraker/rougheye rockfish between trawl and non-trawl gear in the Aleutian Islands, as the potential overfishing of shortraker/rougheye by the trawl fleet was also threatening to close non-trawl fisheries, resulting in loss of economic opportunity. The gear allocation was successful in limiting the scope of the problem.

In the pollock fishery, allocation of quota was further divided between processing sectors, namely trawl catcher processors and trawl catcher vessels delivering to catcher processors (the offshore sector), and trawl catcher vessels delivering to inshore processors. BSAI 18 established a 35/65 percent allocation of pollock between the inshore and offshore sectors, which was extended through 1998 in BSAI 38. BSAI 18, 38, and 51 established, adjusted, and extended the catcher vessel operational area, to a designated area off of Dutch Harbor to which the offshore sector was allowed only minimal access. GOA 23 allocated 100 percent of GOA pollock to inshore processors, which allocation was extended in GOA 40, 51, and 61. The amendments were successful in preventing the grounds preemption that occurred in 1991 and prompted development of the inshore/offshore allocations.

BSAI 61 implemented the provisions of the American Fisheries Act (AFA), establishing sector and cooperative allocations of pollock. The amendment defined specific vessel and processor cooperative linkages, and defined 'sideboards' that limited the participation of AFA pollock vessels in other fisheries in the BSAI and the GOA (implemented in the GOA in GOA 61). BSAI 69 further modified the BSAI pollock cooperative program. The establishment of cooperatives, and the buyout of nine vessels participating in the pollock fishery, was considered beneficial as it served to reduce excess capacity in the BSAI pollock fishery, resulting in increased economic efficiencies.

In conjunction with the BSAI and GOA pollock inshore/offshore allocations, Pacific cod was identified in GOA 23 with 90 percent allocated to inshore processors and 10 percent to offshore processors. This allocation was extended through 2004 in GOA 40, 51, and 61. In the BSAI, Pacific cod was initially allocated by gear type in BSAI 24 between trawl, hook-and-line, pot, and jig gear. BSAI 46 modified the percentage allocation between trawl and fixed gear, and extended the two percent jig allocation. The specific allocation to jig gear was beneficial in that it gave coastal communities a way to compete in the valuable fishery. However, the allocation is not fully utilized by the jig fleet. BSAI 64 further divided the fixed gear allocation between hook-and-line catcher processors, and hook-and-line catcher vessels, pot vessels, and vessels less than 60 feet (ft) length overall (LOA). In order to avoid a substantial number of new entrants into the Pacific cod fishery, BSAI 67 specified eligibility requirements and required a limited entry permit Pacific cod species and gear endorsement for participation in the Pacific cod fishery. To the extent that the amendment avoided excess capacity in the fishery, it is considered beneficial.

GOA 28 and BSAI 23 established a vessel moratorium on new vessels entering into the groundfish fisheries, and was supplemented in GOA 41 and BSAI 39 with a License Limitation Program (LLP) for participating groundfish vessels. This program was modified and extended in GOA 57 and 58 and BSAI 59 and 60. The moratorium and LLP have reduced excess capacity in the groundfish fisheries, and prevented further growth, resulting in a beneficial impact.

The Community Development Quota (CDQ) program was established in conjunction with the sablefish and Pacific halibut IFQ programs in BSAI 15; however, due to delays in the implementation of that program, the CDQ program was first actualized in the pollock fishery as a result of BSAI 18. The CDQ quota for sablefish was increased in BSAI 30. BSAI 38 and 45 extended the pollock CDQ allocation, and BSAI 39 established a multi-species CDQ program for all groundfish species managed under the BSAI FMP. This was subsequently modified in BSAI 66 which removed squid from the CDQ program in order to allow more efficient use of the small squid quota allocation. The CDQ program was created in order to provide fishermen who reside in western Alaska communities a fair and reasonable opportunity to participate in the groundfish fisheries, to expand their participation in nearshore fisheries, and to help alleviate the growing social economic crisis in these communities. The FMP amendments are considered beneficial in their impact on western Alaska communities, as they have created revenues and employment in many of the communities.

GOA 27 and BSAI 22 established gear test areas in the Bering Sea that could be used to ensure that gear was in working order prior to season opening dates. It is inferred that this action likely resulted in reduced gear loss and entanglement on the fishing grounds, which would increase economic efficiency and reduce adverse habitat and mortality impacts due to ghost fishing.

Vessel safety was addressed in the GOA FMP in GOA 16, which formally incorporated safety considerations in accordance with the MSA. The amendment had little effect, other than to reinforce fishery managers' awareness of vessel safety considerations in decision-making.

3.2.3.2 Fishery Management Plan Amendments – Assessed by Impact to Resource Category

Although adopted to achieve a particular management objective, the FMP amendments have had secondary and indirect impacts as a result of their implementation. The impacts of the FMP amendments on the resources or resource categories that are components of the human environment affected by the groundfish fisheries, are discussed in detail in the remainder of Chapter 3. Specifically, the contribution of internal groundfish fishery management and the amended FMPs is assessed as part of the analysis of the cumulative past effects influencing the baseline condition of each resource. This section provides a brief summary of the FMP amendment impacts, and includes a reference to the relevant section later in Chapter 3 for more detailed discussion.

Target Species

Since the implementation of TAC frameworking removed the adjustments and modification of OY from the need for an FMP amendment, the amendments relating directly to target species have primarily been allocative (allocating TAC among seasons, areas or gear types, or implementing rationalization programs for target species). These amendments result primarily in socioeconomic impacts, rather than affecting the sustainability of the stocks. Some amendments have directly impacted the stocks. For example, BSAI 14 and GOA 19 dispersed directed fishing on pollock spawning aggregations, and GOA 59 established a protection area for rockfish and lingcod habitat. Other amendments have had ancillary impacts on target stocks. These impacts are discussed in further detail in the species subsections in Section 3.5.1, under internal effects from foreign, JV and domestic groundfish fisheries from 1976 to the present.

Prohibited Species and Non-Target Species

Many amendments have been implemented since the original FMPs to minimize bycatch of target and non-target species. PSC limits, with triggered closures upon exceeding the limits, have been the most popular and effective method for addressing prohibited species concerns.

Other measures that were implemented for other reasons have had incidental benefits for non-target species. BSAI 13, 15, and 46 and GOA 3 and 20 increased apportionment of target groundfish quotas to the longline fleet, which equated to a decrease in bottom trawl quotas. It is inferred that these measures improved the efficiency of groundfish harvest and as a consequence decreased the incidental take of species in bottom trawls. Therefore, these measures are considered to have had a conditionally beneficial effect.

BSAI 13, 15, and 46 and GOA 3 and 20 increased apportionment of target groundfish quotas to the longline fleet, which equated to a decrease in bottom trawl quotas. GOA 12 prohibited the use of longline pot gear for the harvest of sablefish in favor of hook-and-line gear. It is inferred that these measures may have had offsetting results such as decreased grenadier bycatch from bottom trawls, and increased grenadier and skate bycatch in the longline fishery. Therefore, these measures are considered to have had a conditionally insignificant effect on grenadier and skate stocks.

The impact of the FMP amendments on prohibited species is discussed in detail in Section 3.5.2, under the individual species headings. The impact on non-target species is discussed in the species subsections in Sections 3.5.3, 3.5.4, and 3.5.5, under internal effects from foreign, JV and domestic groundfish fisheries from 1976 to the present (also referred to as post-MSA fisheries).

Habitat

Many FMP amendments whose purpose was primarily to reduce bycatch or incidental take or to address allocation issues have also mitigated fishing impacts on habitat. GOA 3 and 20 and BSAI 15 increased apportionment of target fish quotas to the longline fleet, equating to a decrease in bottom trawl quotas. BSAI 10 and 21a and GOA 9, 15, 18, and 26 closed specific geographic areas to bottom trawling, primarily for the protection of prohibited species. The reduction of bottom trawling due to these measures could provide conditionally beneficial effects to benthic habitat in localized areas.

In contrast, BSAI 4 allowed fishing within 3 to 12 nautical miles (nm) of the Aleutian Islands on the narrow margin of the continental shelf. The potential offsetting effects would be increased benthic damage around the Aleutian Islands and less damage in other areas. With BSAI 4, it is inferred that since more productive fishing grounds were being accessed, fewer trawls would be required to reach harvest quotas resulting in less overall trawl damage to the marine habitat. However, trawl damage tends to be most severe in areas of highly localized fishing where the benthos is repeatedly disrupted. Decreased, but more localized fishing effort might actually be more damaging. The net habitat effect resulting from BSAI 4 could not be determined.

Further discussion of the impact of past amendment and management actions on habitat is contained in Section 3.6.5.

Seabirds and Marine Mammals

Interactions of the groundfish fisheries with seabirds and marine mammals may involve direct injury or mortality of these animals, or may result from prey competition where the groundfish fisheries catch species that form the prey base for marine mammals or seabirds. Efforts have been made to minimize the interaction in both of these areas. BSAI 36 and GOA 39 banned a directed fishery on forage fish, which are preyed upon by seabirds, marine mammals, and commercially important groundfish species. Forage fish are the principal diet of more than two thirds of Alaskan seabirds.

Other efforts to avert prey competition with the Steller sea lion are amendments dispersing Steller sea lion prey species, pollock, Pacific cod and Atka mackerel, in space and time. These actions were precipitated by the rapid decline in the western stock of Steller sea lions. Although scientific evidence of the relationship between the groundfish fisheries and Steller sea lion decline is a matter of controversy, measures were put in place in various FMP amendments to disperse the fishery and to prevent disturbance of the animals at rookeries and haulouts.

For further discussion of the effect of FMP amendments on seabirds and marine mammals, refer to Section 3.7.1 for seabirds, and to individual marine mammals species subsections in Section 3.8, under the headings relating internal effects from the MSA groundfish fisheries).

Socioeconomic Factors

Section 3.9.1 contains a historical overview of the fisheries that includes changes since the implementation of the FMPs. Impacts of the FMP amendments on harvesting and processing sectors are discussed in detail in Section 3.9.2.2.

Impacts of other amendments on communities are discussed in Section 3.9.3. Impacts of the CDQ program are discussed in detail in Section 3.9.4.3.

Ecosystem

Section 3.10.1.4 discusses the FMP management changes since the implementation of the FMPs, and the impact of the amendments on the ecosystem.

3.2.4 Significant Changes to Bering Sea and Aleutian Islands and Gulf of Alaska Groundfish Fishery Management

Since the implementation of the BSAI and GOA FMPs in 1978 and 1981 respectively, the manner in which the groundfish fisheries have been managed has adapted and changed. These changes have been incrementally analyzed in terms of the specific actions implemented by the individual FMP amendments, and their impacts, as summarized above. When these changes are viewed cumulatively, however, it is apparent that the current fishery management philosophy is built upon the incremental responses of the last twenty years.

This section attempts to identify the significant changes to the way the groundfish fisheries are managed, since the implementation of the FMPs. The changes identified in this section have been deemed significant by NOAA Fisheries analysts; however, due to the qualitative nature of this discussion, the list may not be exhaustive. Additionally, the discussion of the amendments is primarily based on the NEPA documents that analyzed the action (Environmental Assessments [EAs] or EIS). While these documents do address the purpose and need for proposing a change to existing management conditions, and often include a rationale for selecting a preferred alternative, the full debate regarding the implementation of a particular amendment is not always apparent in the NEPA analysis, particularly if changes are made as a result of Secretarial disapproval. To the degree that the analysis below is based in large part on the analysis of the NEPA documentation, the discussion of significant changes may also be lacking.

The significant management changes since 1978 (GOA) and 1981 (BSAI) that have been identified by NOAA Fisheries analysts are changes to: 1) the OY framework and to the apportionment of quota; 2) methods to minimize bycatch particularly of prohibited species; 3) tools to deal with excess capacity; 4) means for protecting communities dependent on fishing; 5) monitoring and reporting programs; and 6) frameworking and flexible management.

The establishment of a multi-species groundfish OY range in the BSAI and GOA FMPs represented a significant shift in groundfish fishery management. Although the implementation of the BSAI OY range was Amendment 1 to the BSAI FMP, it was analyzed as part of the FMP EIS. The OY range in the GOA was established in GOA 15. This change allowed considerably more flexibility of management, as the annual quota for an individual species was no longer defined in the FMP and would be set annually, based on best available science and in accordance with the TAC frameworking procedures in the FMP, using the more streamlined regulatory amendment process. GOA 15 was implemented in 1987. In the eight years prior to its implementation, OY adjustments had been made in eight of the thirteen amendments.

The implementation of the OY range in the BSAI has had other impacts because the maximum limit of the FMP-defined OY range constrains the sum of groundfish acceptable biological catch (ABC). The sum of groundfish ABC for 2003 was approximately 3.5 million mt, while the maximum limit of the OY range is set at 2 million mt. As a result, the North Pacific Fishery Management Council (NPFMC) has leeway in making recommendations for TAC settings in the BSAI, and in determining which species should be fished to the level of their ABC and which should not. The cap on OY is believed by NPFMC to be an effective conservation measure that mitigates uncertainty, particularly in the BSAI. The use of the existing OY ranges has been reaffirmed by NPFMC in the Preferred Alternative (PA).

Another significant change since the implementation of the FMPs is to the apportionment of annual quota. In the original FMPs, the domestic fishery received a species-specific catch quota for the managed groundfish species that, in the GOA was spatially divided among five statistical areas. The foreign catch quota in the GOA was spatially distributed and had seasonal restrictions. Although not specified in the FMPs, the foreign catch quota was allocated among nations. Since the implementation of the original FMPs, the spatial, seasonal, directed fishery, and gear-specific subdivision of species quota allocation has increasingly become a management tool that is used to address a variety of problems. In the GOA FMP, quota was divided among the statistical areas to “reduce the likelihood of uneven exploitation on localized stocks or concentrations” (NMFS 1978). This issue was echoed in BSAI 28, where the ability to apportion the Atka mackerel TAC over subdivided BSAI districts allowed for a higher Atka mackerel ABC than would otherwise be recommended if the directed fishery were allowed to take the quota all from one spatially concentrated portion of the subarea (NMFS 1993b). Seasonal quota allocations (BSAI 14 and GOA 19) and the creation of species-specific management districts (BSAI 17 and GOA 18) were also used as tools to protect the pollock stock against intensive fishing on spawning aggregations.

The subdivision of allocation by gear type has also been used to resolve socioeconomic issues such as gear conflicts and grounds preemption disputes. Further discussion may be found under Socioeconomic Actions in Section 3.2.3.1. Due to the difference in selectivity and bycatch rates among different gear types, excessive groundfish bycatch by a particular gear-type may result in a target fishery being closed before the quota is reached, when that quota could safely be harvested by vessels of a different gear type without triggering a bycatch concern. To the extent that species allocation by gear type allows the fishery to achieve the optimum harvest levels and avoids gear conflict, it is a useful tool that will continue to be recommended by the NPFMC. The downside of subdividing allocations is that it requires increased attention from NOAA Fisheries managers in terms of the potential need to close fisheries, to reallocate incidental catch amounts, or to investigate overages. In 2003 in BSAI, there were 152 non-CDQ TAC allocations, and 29 TAC allocations for each of the six CDQ groups. This represents a 23-fold increase from 1995.

The use of PSC limits has also been a significant change in fisheries management since the implementation of the original FMPs. Although prohibited species, which must be discarded at sea, were specified in the original FMPs, limits on their catch were not formally included in the FMPs. Subsequent amendments first specified catch limits on foreign catch of halibut in the GOA, and chinook salmon, halibut and crab in the BSAI. Once its PSC limit was reached, the nation was prohibited from fishing in the management area or subarea. The application of PSC limits as a tool for reducing prohibited species bycatch was subsequently applied to the domestic fleet trawl sectors, and then to the fixed gear sectors, and apportioned by area or season. The NPFMC continues to find PSC limits to be an effective method for reducing bycatch, and the establishment of PSC limits for salmon, crab and herring in the GOA are included in the PA. Analysis to address salmon bycatch, and suggested PSC limits for the GOA, have already been initiated.

PSC limits have been implemented in response to increased concern as to the rate of prohibited species bycatch in the groundfish fisheries. Prior to the full domestication of the groundfish fisheries, domestic catch of prohibited species was not a matter of concern. Once the issue was raised at the NPFMC level, however, PSC limits have been demonstrably effective in reducing PSC in the groundfish fisheries. For details on the specific reductions in prohibited species bycatch, see Appendix C BSAI Amendment description for BSAI 21b, 25, 35, 37, 40, and 41.

Since the domestication of the groundfish fisheries, excess capacity has increasingly become an issue for the NPFMC. Programs such as the vessel monitoring program (VMP), the LLP, the IFQ program for sablefish, and the AFA cooperatives for BSAI pollock have all changed the nature of groundfish fisheries from their state as described in the original FMPs. The impact of these programs is described in detail in Section 3.9 of this document. The NPFMC has identified comprehensive rationalization as a policy goal since 1992. In the PA of this document, the NPFMC has reaffirmed its intention to further decrease excess capacity and overcapitalization through eliminating latent licenses and extending programs such as community or rights-based management to some or all groundfish fisheries.

The NPFMC has also specifically recommended prioritizing the implementation of management measures that provide stable economic opportunities for fishery-dependent coastal communities. This includes management measures that provide allocations to small vessels or particular gear types, such as allocations to jig gear (BSAI 24 and 34). Additionally, consideration for coastal communities is important during the development of area restrictions such as closure areas so that they still allow access for local vessels. The inshore-offshore issue in the pollock fleet included coastal community consideration, as communities hosting a processor were more likely to benefit from inshore allocations (BSAI 18, 38, and 61 and GOA 23, 40, and 51). The establishment of the CDQ program for western Alaska coastal communities illustrates a well-developed program for community protection, where a percentage of the TAC for each BSAI groundfish and crab species is allocated among six CDQ groups. The economic impacts of the CDQ program are discussed in detail in Section 3.9.4.3. The NPFMC is currently developing a program in the GOA for eligible communities to purchase sablefish quota share (GOA 66). The shift in emphasis to provide for sustainable fisheries-dependent communities influences all groundfish fishery management actions, and in particular is a major criterion in the development of future rationalization programs.

The original FMPs established specific monitoring and reporting requirements for the foreign fisheries, and minimal reporting requirements for the domestic fisheries. As the domestic fleet began to increase their proportion of the North Pacific TAC, however, the need for more timely and comprehensive domestic fishery data became apparent. Management and Monitoring Actions of Section 3.2.3.1 provides a summary of the various FMP amendments that increased observer coverage for domestic fishery operations and expanded recordkeeping and reporting requirements. These programs, in combination with NOAA Fisheries independent resource surveys, are part of one of the most comprehensive fishery data collection systems in the world (Appendix F-11). Acknowledged deficiencies of the system are the non-random observer coverage in the 60 ft to 125 ft sector of the groundfish fleet, and the lack of observer coverage on vessels smaller than 60 ft. Additionally, the economic data collected is mostly limited to price and revenue data. In order for fishery managers to assess the full economic impact of their decisions, it is necessary to expand the range of economic data collected to include, for example, expenditure, employment and earnings data. These deficiencies are addressed in policy objectives in the PA.

Since the implementation of the FMPs, a major management emphasis has been on frameworking of management measures. The process for implementing FMP amendments is time-consuming, and does not allow for quick responsiveness to new conservation or management issues. In contrast, the nature of fisheries management is variable, with stock sizes fluctuating naturally from year to year. As a result, when rapid reaction to a conservation issue is required, the immediate management response must often be implemented by NOAA Fisheries' emergency rule, and after the fact be supported by an FMP amendment and requisite analyses. As a result of the bureaucracy of this latter procedure, the NPFMC has attempted to framework those management measures that are reviewed and adjusted on a regular basis, so that their change does not trigger the procedure of an FMP amendment. Instead, the procedure for regular review and modification is outlined in the FMP, along with the NPFMC intent and authorization, and as a result, the actions can subsequently be implemented through regulatory amendments rather than FMP amendments. Various management measures have been frameworked in this manner, including the TAC-setting process as discussed above. Additionally, setting annual PSC limits for some prohibited species, setting season start dates, inseason management measures, and granting experimental fishing permits are all actions that are authorized in the FMPs, often with specific criteria and procedural requirements, but are implemented through regulatory amendments.

Another example of a framework procedure is the hot spot authority granted to NOAA Fisheries. The NPFMC has frequently recommended that the FMPs be amended to allow the NOAA Fisheries Regional Administrator the field authority to implement temporary time or area closures to specific areas for conservation reasons (known as hot spot authority), such as if a particular fishing ground seems to be producing high bycatch rates (BSAI 1, 4, 10, 16a, 19; GOA 15, 24). Although numerous efforts were made between 1983 and 1992 to refine the authorization language and enable temporary fishery closures by regulatory amendment, the original rapid reaction intent has not been met. The standards of evidence and public comment periods required for inseason management to close an area to fishing do not permit for flexible, temporary closures of the type envisioned by the NPFMC. The principle of hot spot closures has been used voluntarily in the BSAI pollock cooperatives to reportedly good effect. A review of the effectiveness of bycatch reduction in the BSAI pollock fishery is currently initiated in the PA.

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3.3 Physical Oceanography of the Fisheries Management Units

3.3.1 The Northeast Pacific Ocean

3.3.1.1 Description

Bounded on the north and east by the North America land mass, and essentially open to the west and south, the northeast "quadrant" of the Pacific Ocean includes the GOA and the Bering Sea (Figure 3.3-1). Although separated from the main ocean body by the Aleutian Islands, the Bering Sea is considered to be a northern extension of the northeast Pacific Ocean by virtue of hydraulic communication through the numerous passes and channels between the islands. On the west and south, the bounds of the northeast Pacific Ocean are generally considered to be the International Dateline and the northern 30th parallel, respectively.

Although dotted by numerous seamounts rising to within 1,000 meters (m) of the surface, seabed depths over most of the northeast Pacific Ocean tend to be greater than 4,000 m. Maximum depths of more than 7,000 m occur in the Aleutian Trench, which parallels and marks the southern base of the Aleutian Island chain (Figure 3.3-1). Along the land boundary, the continental shelf (depth less than or equal to [$\leq$] 200 m) is relatively narrow (less than [<] 50 kilometers [km]) along the British Columbia and southeast Alaska coasts, and then broadens to 100 km or more along southcentral Alaska coast. Along portions of the Kenai and Alaska Peninsulas, the continental shelf attains a width of nearly 200 km.

3.3.1.2 Circulation

Surface currents in the Pacific Ocean are driven by the trade winds and westerlies, such that surface flows are predominantly westward in low latitudes (10° - 30°North [N]) and eastward in high latitudes (35° - 50°N). When these flows encounter the continents they are diverted both north and south to form coastal currents, which further serve to establish rotating water masses (gyres) that characterize the overall circulation patterns of the ocean (Figure 3.3-1).

The seaward "boundaries" of the northeast Pacific Ocean are arbitrarily, if not practically, determined by large-scale circulation features that result from these planetary driving forces. On the south, the North Pacific Drift transports surface waters eastward along (approximately) the 45th parallel. Upon reaching the North American continent, this flow splits into northbound and southbound branches known, respectively, as the Alaska Current and the California Current. As the Alaska Current tracks anti-clockwise along the continental margin, portions of it are known as the Alaska Coastal Current (ACC) and the Alaskan Stream (Figure 3.3-1). The anti-clockwise loop is closed by the Aleutian Current, which is a south-to-southeasterly extension of the Alaska Current (Figure 3.3-2). The resulting anti-clockwise circulation pattern is known as the Alaskan Gyre.

Winter intensification of the Aleutian Low leads to strong southeasterly winds along the southeast Alaska coast, which produce onshore Ekman transport and downwelling of coastal waters (Royer 1975). During summer, the North Pacific High tends to dominate the region such that lighter, more variable winds result in a relaxation of the coastal convergence. The overall anti-clockwise circulation is maintained by the introduction of fresh water along the coastline, as described in the following section.

3.3.1.3 Water Mass Characteristics

In the North Pacific high latitudes, surface waters have relatively low salinities because of the excess of precipitation and runoff over evaporation. Cooling these surface waters even to the freezing point does not make them sufficiently dense to cause them to descend any deeper than 200 m in the water column. Consequently, the deeper water in the North Pacific must originate elsewhere, and must flow in through the South Pacific because the connection with the Arctic Ocean, through the Bering Strait, is too narrow and shallow to be of consequence.

These deeper waters of the North Pacific originate in the southern (i.e. Antarctic) and North Atlantic Oceans, where the combination of surface temperatures and salinities produces very dense waters that subsequently sink to the sea floor. The Pacific Ocean has been described as a vast estuary, with low-salinity surface outflow from the North Pacific mixing with deeper, more saline water flowing in at depth through the south Pacific. Ultimately, the increasingly dense North Pacific water returns to the areas of sinking in the North Atlantic to complete the circuit, which is estimated to take centuries to complete.

Nutrients are distributed throughout the world's oceans by this system of deep circulation. For example, inorganic phosphates are consumed by plant growth at the surface and are regenerated at greater depths as the plants die, sink, and decay. Consequently, nutrients are in greater concentrations at depths of one to two km than at the surface. Inflow of the deeper water into the Pacific Ocean brings in water that is high in phosphate compared to the average concentration in the Atlantic Ocean. As a result, the accumulated phosphate in the Pacific Ocean has a concentration about twice that of the Atlantic.

The next two subsections describe in greater detail the physical oceanography of the two federal fisheries management units (FMUs) of the northeast Pacific Ocean. A final subsection addresses the sources and magnitude of variability in oceanic parameters.

3.3.2 Gulf of Alaska Fishery Management Unit

3.3.2.1 Description

The GOA FMU includes all waters within the EEZ along the southeastern, southcentral, and southwestern coasts of Alaska from Dixon Entrance to Unimak Pass, a distance along the Alaskan coastline of more than 2,500 km (Figure 1.2-3). Greatest depths within the GOA FMU range from 3,000 m off southeast Alaska, to 4,000 m off southcentral, and to 7,000 m at the west end of the FMU, where the Aleutian Trench begins. However, the continental shelf areas (depths < 200 m) are of greatest importance in the context of fishery management issues.

As noted previously, the continental shelf within the GOA FMU is narrowest in southeast Alaska, ranging in width from less than 50 km between Dixon Entrance and Cape Spencer, and then broadening to 100 km or more along the southcentral coast to Seward. South of the Kenai Peninsula and west of Kodiak Island, the continental shelf is broadest, about 200 km, on Portlock Bank. Proceeding westward from Kodiak along the Alaska Peninsula, the shelf narrows gradually from 150 km to about 50 km at Unimak Pass. The progressive broadening and narrowing of the continental shelf from east to west plays an important role in the circulation of waters through the GOA FMU.

3.3.2.2 Circulation

Water movements within the GOA FMU are dominated by the ACC which changes character and direction three times and is joined by other narrower currents as it is forced by the coastline to change direction from northwestward to westward to southwestward as it flows through the unit (Figure 3.3-1). Starting off southeast Alaska like a wide river with imbedded eddies the main flow turns westward with the coastline and becomes two currents as it is joined by the faster ACC close to shore. As the coastline turns southwestward the flow seaward of the shelf break accelerates taking on the dynamics of a western boundary current, the Alaskan Stream, which reaches speeds of 60 to 100 centimeters per second (cm/sec) staying in a narrow jet over the continental slope to the end of the unit. This broad southwestward flow is now in four bands; the weak offshore portion, the swift Alaskan Stream, a weak tidally and bathymetry influenced flow on the outer shelf, and the moderate ACC inshore. Some of the offshore flow recirculates to the south then east forming the western branch of the GOA Gyre. This coastal circulation is driven in winter by the persistent anti-clockwise wind stress over the GOA and in summer by the immense fresh water input from coastal sources in British Columbia and southeast Alaska.

During the winter, when coastal runoff is minimal, anti-clockwise atmospheric circulation is most intense over the GOA, and wind stress maintains the coastal circulation with strong onshore convergence or downwelling. During summer when winds over the GOA slacken considerably, coastal runoff increases dramatically and creates a density gradient in nearshore waters that serves to maintain the anti-clockwise coastal circulation. Thus seasonal variations in wind stress and coastal runoff are balanced so that together they serve to maintain the generally steady westward movement of water through the GOA FMU.

Circulation near the continental shelf break (approximately [~] 200 m depth) generally follows the isobaths, with frequent eddies and meanders. Closer to shore the flow is more stable with fewer eddies and is more closely aligned with the coastline. Within the broader Alaska Current, the narrow and intense coastal current ACC extends from southeast Alaska to Kodiak Island. The ACC results from the density gradient produced by prodigious amounts of freshwater runoff that varies with the annual hydrologic cycle (Royer 1979 and 1983). The width of the ACC varies from only 5 to 10 km wide to as much as 40 to 50 km, depending on the rate of freshwater input. Current speeds within the ACC occasionally exceed 100 cm/sec, which has caused occasional reference to it as a coastal jet. The dilutional effects of the freshwater input are generally confined to the top layers (50 to 100 m) of the water column. The western segment of the ACC has been called the Kenai Current (Schumacher 1980).

West of Kodiak Island, where freshwater input is much reduced, the Alaska Current is driven more by prevailing winds. Accordingly, in winter a westward flow is maintained by wind stress, but in summer this driving force is somewhat lessened so current reversals and eddies occasionally occur (Schumacher and Reed 1986).

3.3.2.3 Water Column

The density structure of the water column is determined by its physical properties, most notably its temperature and salinity, as they vary with depth. At the temperatures typical of the northern GOA water (i.e., < 10 degrees Celsius [° C]), salinity is the dominant determinant of water density. Because of the plentiful coastal runoff and the excess of precipitation over evaporation, coastal waters of the GOA have salinities that are significantly lower than those of the North Pacific, which are already low relative to the world's oceans. Salinities at depths less than about 10 m in the GOA FMU are typically 25 to 30 practical salinity units (psu).

Salinity and density increase with depth, but the greatest rate of increase occurs within the pycnocline, which extends from about 30 m to 200 m depth. Above the pycnocline is the surface mixed-layer, in which the salinity is 32 to 33 psu. Below the pycnocline, salinity increases slowly to about 34.4 psu at a depth of 1,500 m. Temperatures in the mixed layer vary from 3° to 12°C seasonally. Below the pycnocline the temperature decreases slowly from 3° to 2.5°C near 1,500 m. These are relatively permanent features so significant changes occur only rarely, and then only as a result of large-scale changes in circulation. Ranges of physical properties of GOA waters are listed in Table 3.3-1.

Small horizontal changes in water properties occur as the flow proceeds westward, but mainly in the mixed layer. Nearshore salinities in the eastern and northern GOA can be as low as 26.0 psu in the ACC in the fall, when precipitation is at its maximum. Along the edge of the shelf in the Alaskan Stream a low-salinity (<32.0 psu) tongue like feature protrudes westward. In Shelikof Strait and to the east, the range of temperatures (0° to 15°C) can be substantially greater than those farther west. Whereas surface salinity increases toward the west as sources of fresh water from the land diminish, salinity values at 1,500 m decrease very slightly. Temperatures at all depths tend to decrease toward the west.

Some chemical properties of GOA water make it unique in the world ocean. Compared to other ocean waters at similar latitudes, the deep water of the GOA has higher concentrations of silicate, phosphate, and nitrate and its well-developed oxygen minimum. The oxygen and phosphate distributions result from the decomposition of particulate organic matter sinking from the surface, as elsewhere, but the higher concentrations arise because of accumulation resulting from poor circulation of the deep water. Reeburgh and Kipphut (1986) examined GOA chemical profiles for dissolved oxygen, silicate, phosphate, and nitrate, and summarized available historical data in three distinct oceanographic domains: 1) the deep sea, 2) the continental shelf, and 3) fjords and estuaries. Of the three, the shelf domain has the least data.

Deep sea profiles show temperature decreasing continuously with depth, first in the main thermocline from 10°C at the surface to 6°C at 100 m, then gradually to 4°C at 350 m and even more slowly to 1.8°C at 2,500 m (Reeburgh and Kipphut 1986). Dissolved oxygen decreases from about 300 micromoles (μM) oxygen/kilogram (kg) at the surface to less than 50 μM oxygen/kg at 400 m, followed by a minimum near 900 m then a gradual rise to about 120 μM oxygen/kg at 4,000 m. Phosphate increases from 0.5 μM phosphoric acid-phosphorus/kg at the surface to a maximum of almost 3 μM phosphoric acid-phosphorus/kg from 500 to 1,500 m, then decreasing slightly to about 2.6 μM phosphoric acid-phosphorus/kg near 2,500 m. Nitrate increases from about 0.3 μM nitrate-nitrogen/kg at the surface to a maximum of about 40 μM nitrate-nitrogen/kg from 500 to 1,500 m, then decreases only slightly to about 35 μM nitrate-nitrogen/kg near 2,500 m. Silicate increases from about 5 μM dissolved silica-silica/kg to 150 μM dissolved silica-silica/kg at 500 m, then continues to increase slightly to 175 μM dissolved silica-silica/kg at 2,500 m. The dissolved oxygen minimum and the phosphate and nitrate maxima occupy similar depth zones. Some studies have investigated long-term variability in the deep sea using Ocean Station P data. Surface nitrate was never less than 10 μM, even during peak uptake. Hokkaido University (1981) confirmed measurable nitrate was always present and probably does not limit surface productivity. A well-established population of pelagic grazers appears to be responsible for the relatively high surface-nutrient concentrations (Miller *et al.* 1984).

The nutrients in the shelf waters interact horizontally and thus have similar properties to the shallow (< 250 m) range of the oceanic water described above. Seasonal changes depend upon the seasonal variations in the meteorological regime (Royer 1975). In the winter, southeasterly winds bring convergence and downwelling (Royer 1981) along with the winter cooling and replacement of warm, high-saline bottom waters. In the summer, the wind field reverses, bringing relatively warm, high-saline, low-oxygen, high-nutrient waters from the central GOA back onto the shelf at depths of 100 to 200 m. Nitrate profiles from near the mouth of Resurrection Bay show values 20 to 40 µM between 0 and 250 m depth during winter, and summer values of 1 to 30 µM over the same depth range.

Few nutrient studies have been done in fjords and estuaries, but exchange with the shelf water has been determined from a few localized intensive studies to be a function of sill depth. No anoxic conditions were observed in Alaskan fjords, indicating at least annual bottom water renewal (Muench and Heggie 1978). Shallow-silled (< 50 m) fjords renewed between February and April when surface waters were most dense. Intermediate sill depth (120 to 160 m) fjords followed shelf water density changes and led to fairly continuous flushing. Deep or unrestricted sill (greater than [>] 180 m) fjords are flushed between July and October, when warm, saline, higher-nutrient water returns to the shelf after the relaxation of convergence.

3.3.3 Bering Sea and Aleutian Islands Fishery Management Unit

3.3.3.1 Description

The Bering Sea is a semi-enclosed, high-latitude, subarctic sea and is considered to be a northern extension of the North Pacific Ocean. Shaped somewhat like a sector of a circle with its apex at the Bering Strait, the Bering Sea has a total area of 2.3 million square kilometers (km^2). Forty-four percent is continental shelf (depth < 200 m), 13 percent is continental slope, and 43 percent is deepwater basin where depths reach as much as 3800 m along the western margin of the sea. The broad continental shelf on the east side of the Bering Sea is one of the most biologically productive areas of the world. The BSAI FMU comprises most of the continental shelf and consists of the entire EBS from the Alaskan coastline westward to the international boundary. Also, those waters within the EEZ south of the Aleutian Islands from Unimak Pass to the international boundary are included in the BSAI FMU (Figure 1.2-2).

3.3.3.2 Circulation

Numerous straits and passes through the 2,000-km arc-shaped Aleutian-Komandorski archipelago connect the Bering Sea to the North Pacific Ocean. The amount of water exchanged between the North Pacific Ocean and the Bering Sea through passes between the various Aleutian Islands is uncertain. Waters from the Alaska Current enter the Bering Sea at Unimak Pass and, to a lesser extent, through other passes between Aleutian Islands. Major exchanges of water occur at the west end of the Aleutian-Komandorski archipelago, with large inflow to the Bering Sea through Near Strait and outflow through Kamchatka Strait. Some additional leakage into the Bering Sea occurs through passes between the islands just east of Near Strait.

As the warm Alaska Stream water enters the Bering Sea and is cooled and transported through the anti-clockwise Bering Sea Gyre, large upwellings occur bringing cold deep waters to the surface (Ohtani 1970). Eddies, ranging in diameter from 10 to 200 km, can be found throughout the Bering Sea and contribute to the vertical mixing of waters. These eddies are thought to be caused by instabilities, wind forcing, strong flow through passes in the U.S., and topography (Schumacher and Stabeno 1998).

To the north, the Bering Sea is connected with the Chukchi Sea and Arctic Ocean through the Bering Strait which separates the Seward Peninsula (Alaska) from the Chukotka Peninsula (Russia). At the Bering Strait, there is a relatively small net annual outflow of water (Coachman and Aagaard 1988), although this flow can be reversed by relatively rare combinations of meteorological conditions (Coachman and Aagaard 1981).

Patterns of circulation in the Bering Sea have been inferred mostly from distributions of water properties, but some knowledge has also been obtained from drifter studies (Stabeno and Reed 1994). The overall circulation pattern is generally anti-clockwise within the basin, with the most prominent feature on the east side being a weak and variable northwestward flow over the broad continental shelf adjacent to Alaska. Along the edge of this shelf the Bering Slope Current transports water northwest at speeds of 10 to 20 cm/sec (Kinder *et al.* 1975, 1986), although Royer and Emery (1984) found this flow to be somewhat slower in winter. The Bering Slope Current intensifies as it approaches the Asian continent, bifurcating into a northerly flow through the Gulf of Anadyr and a southwesterly flow that is the origin of the Kamchatka Current. The Kamchatka Current is an intense western boundary current that continues southwestward along the Russian coast (Figure 3.3-2).

Flow over the North Aleutian Shelf (adjacent to Alaska) is characterized by Schumacher and Reed (1992) as weak and variable, with low current speeds (< 5 cm/sec). Mean speeds observed in the central shelf area are less than 1.0 cm/sec and reveal no organized circulation (Kinder and Schumacher 1981). Within Bristol Bay the *mean* flow is weak and shows an anti-clockwise tendency along the perimeter of the bay. Maximum speeds (~ 3.5 cm/sec) occur near the 50-m isobath and near the coast. However, the vast majority of the velocity variance within the bay is tidal, with tidal currents an order of magnitude larger than the mean flow. For example, on the north Aleutian shelf, where net currents are 1-5 cm/sec and the typical wind-driven currents are approximately 10 cm/sec at 5-m depth, the tidal currents are 40-80 cm/sec or more (Thorsteinson 1984). Turbulence resulting from these tidal currents causes mixing of the water column from the seabed to about 50 m above it.

3.3.3.3 Hydrography

Hydrographic structure over the U.S. is well-defined and consists of three domains that are separated by physical fronts (Kinder and Coachman 1978, Schumacher *et al.* 1979, Kinder and Schumacher 1981). The inner front is aligned approximately with the 50-m isobath, the middle with the 100-m isobath, and the outer at the shelf break (~ 200 m). The associated oceanographic domains are referred to as the coastal domain, middle domain, and outer domain. Two other distinct domains exist off the shelf: a narrow, energetic shelf break domain and the deep-ocean domain. The Pribilof Islands and the Unimak Islands provide distinct separate habitats within the Bering Sea. These domains will be referred to repeatedly in the following sections that describe the characteristics of the Bering Sea.

Circulation over the shelf is related to domain structure (Coachman 1986). In the outer domain (100 to 200 m), tidal currents account for about 80 percent of the flow, with a mean of about 5 cm/sec along shore to the northwest, and an onshore-offshore flow of 1 to 5 cm/sec that is quite variable. Tidal mixing is very important in the outer domain. In the middle domain (50 to 100 m) the important flow is due to tides and inertial currents. There is little net motion, and vertical mixing due to tides is important here. Tidal currents account for about 95 percent of the flow energy in the coastal domain (< 50 m), but as already noted, the mean flow has a speed of 1 to 5 cm/sec in a generally northwest direction. In contrast to circulation of the GOA, the circulation of the Bering Sea shelf has relatively small net flows and relatively large tidal forcing.

There are two main water masses on the shelf: Alaska Coastal water and central Bering water. Coastal water is found shoreward of the 50-m isobath in the south U.S., while central Bering water is found in the middle domain, from the inner front (~ 50 m) to the middle front (~ 100 m). Alaska Coastal water is a combination of coastal freshwater discharge and more saline water from the deep basin, and is generally well-mixed by winds and tides. The central Bering water in the middle domain has a lower layer that is isolated from seasonal heating and thus has temperatures that reflect prior winter conditions. Water of the outer domain

(100 to 200 m) is not really an identifiable water mass, but instead is a mixture of central shelf and deep Bering Sea water. Because of greater tidal and advective energy, it is less strongly stratified than the middle domain, but exhibits considerable small-scale vertical variation in properties that originate in the middle domain. These vertical variations, known as vertical "fine structure," are important to the flux of water properties horizontally and vertically through the water column.

Hattori and Goering (1986) summarized the available data on the distribution of salinity, temperature, phosphate-phosphorous, nitrate-nitrogen and ammonia-nitrogen, and silicic acid (Table 3.3-2) and characterized the four domains according to nutrients. Because the fronts inhibit lateral fluxes of water and dissolved materials between the four domains, nutrient zones are consistent with the physical domains. The vertical physical system also regulates the biological processes that lead to separate cycles of nutrient regeneration. The source of nutrients for the outer domain is the deep oceanic water, and for the middle domain, it is the shelf-bottom water. Starting in winter, surface waters across the shelf are high in nutrients. Spring surface heating stabilizes the water column, then the spring bloom commences and consumes the nutrients. Steep seasonal thermoclines over the deep Bering Sea at depth of 30 to 50 m, the outer domain at 20 to 50 m, and the middle domain at 10 to 50 m restrict vertical mixing of water between the upper and lower layers. Below these seasonal thermoclines nutrient concentrations in the outer domain are invariably higher than those in the deep Bering Sea water with the same salinity. Winter values for nitrate-nitrogen/phosphate-phosphorous ratios are similar to the summer ratios which suggests that, even in winter, the mixing of water between the middle and outer domains is substantially restricted (Hattori and Goering 1986).

Spring and summer storms can increase the total seasonal productivity by mixing to depths sufficient to resupply nutrients to the euphotic zone, but by the end of summer, nutrient depletion in the euphotic zone is common all across the shelf. Year-to-year consistency of trends between summer nutrient distributions in 1975 and 1978 was shown by Hattori (1979).

3.3.3.4 Effects of Sea Ice

Oceanic conditions, both physical and biological, can be profoundly influenced by the presence of sea ice. During extreme winter conditions, sea ice covers the entire eastern shelf of the Bering Sea; however, interannual variability of coverage can be as great as 40 percent (Niebauer 1988). The growth of ice over deep water is limited by relatively warm water in the central basin, so the maximum extent of the ice is restricted to the shelf.

The ice generally begins its seasonal southward formation in November. It is estimated that about 97 percent of the ice in the Bering Sea is formed within the Bering Sea itself (Leonov 1960). Very little ice is transported south through the Bering Strait (Tabata 1974). The ice apparently forms like a giant conveyor belt, being generated along the south-facing coasts in the Bering Sea and moving southward at as much as 0.5 meters per second before finally melting at its southern limit (Pease 1981). On average, seasonal ice formation progresses at an average rate of 12 to 13 percent per month over the area of the eastern shelf, reaching 60-65 percent coverage by late March (Niebauer 1981). The ice advance generally consists of a short, rapid advance (approximately 24 percent per month) in November-December, before slowing to approximately 6 to 7 percent in December-March. With the exception of the rapid advance in November and part of December, the ice appears to dissipate faster than it forms, at about 18-20 percent per month in late March to early July. Lisitsyn (1966) reported that, during the period of ice retreat, 63 percent of the ice melts within the Bering Sea basin. The remainder leaves the Bering Sea by way of various straits and passes.

The sea ice affects exchanges with the atmosphere and inhibits the transfer of freshwater (salt) and heat. It changes the coupling of the oceanic and atmospheric momentum exchanges by altering the surface roughness. The creation and melting of the sea ice alters the horizontal and vertical density gradients in the water column. Increases or decreases in the vertical density gradient affect the mixing and transport of nutrients and organisms in the euphotic zone. The ice edge also serves as both a source and sink of freshwater that can affect productivity. In fall during freeze-up, freshwater is extracted from the seawater, while during the spring, melting supplies freshwater to the ice edge.

One might reasonably assume that primary productivity in a winter ocean covered to a large extent by ice would be low and uncomplicated. However, McRoy and Goering (1974) reported on studies that revealed a complex productivity system in the water column and ice that makes a measurable contribution to the total annual production of the Bering Sea. The annual increase in production in the Bering Sea begins in late February with the development of the algal community in the sea ice. The production of this community increases with the passing of winter and probably reaches a maximum just before the ice melts completely. The ice algae comprise the first spring bloom that occurs in the Bering Sea, preceding the bloom that occurs in the open water farther south.

In April, as the ice melts, a second spring bloom develops in the wake of the receding ice. This begins along the southern ice front, coinciding approximately with the edge of the continental shelf. This bloom is promoted by the stability associated with the low-density water around the melting ice. As a result of the seasonal ice cover, the annual primary production of the Bering Sea is actually increased. Furthermore, the annual spring increase in algal standing stock begins in the middle and northern Bering Sea rather than the expected southern waters. Niebauer *et al.* (1990) subsequently estimated that the ice edge bloom of phytoplankton accounts for between ten percent and 65 percent of the total annual primary production.

Sea ice also influences bottom temperatures, and hence influences many species on the shelf. In winter, there is little stratification, and the sea is cold from top to bottom. In colder years there is more sea ice than in warmer years. The ice helps to cause and maintain density stratification when it melts. After the ice has melted, solar heating causes further stratification, and thus bottom temperature changes very slowly. Consequently, in cold years—years with extensive sea ice—the colder-than-normal bottom temperature is even more persistent than usual (Coachman 1986). Thus, the distribution and abundance of temperature-sensitive bottom-dwelling species and some nearshore species are related to the extent of sea ice. Variability (1972-1998) of sea ice arriving and departing the southern middle shelf is discussed by Stabeno *et al.* (2001).

3.3.4 Sources and Magnitude of Oceanic Variability

3.3.4.1 Atmosphere-Ocean Time Scales and Forcing Mechanisms

Atmospheric and oceanic parameters in the North Pacific and Bering Sea have variability that exists on several time scales and is due to many different forcing mechanisms (Table 3.3-3). Short-term (daily to annual) fluctuations in atmospheric and oceanic conditions are familiar and generally well-understood, to the extent that cause-and-effect relationships are well established. Fluctuations having longer (interannual) time scales are becoming better documented, due to extensive environmental monitoring activities, but definition of causal relationships for most remains an elusive challenge. The focus of this section is on atmosphere-ocean interactions that occur on time scales of several months to several years, or even decades. No attempt is made to catalogue all possible sources of variability. Rather, only the few that are well-known are identified and their possible influences are described.

3.3.4.2 Mesoscale Eddies

Eddies are rotating masses of water that are formed when an ocean current is deflected or pinched off by a topographic feature on the seabed or at the continental margin. Eddies can also form as a result of velocity shear on the fluid boundary between a relatively swift current and a much slower moving water mass. Rotating around generally vertical axes, mesoscale eddies have diameters of tens to hundreds of kilometers and, depending on their size, have rotational periods measured in days, or even weeks. Because they dissipate their energy only very slowly, these eddies can have lives measured in months to years, and their trajectories can be traced by the persistence of water properties in their cores. Movement of an eddy past a fixed current meter is evidenced by a cycle of flow acceleration, deceleration, and then acceleration back to the mean flow speed (or vice versa).

Mesoscale eddies are ubiquitous features of oceanic circulation and occur frequently on continental shelves and slopes. Kinder and Coachman (1977) described observations of an isolated eddy of high-salinity water nestled in the outer reaches of the Pribilof Canyon and partially in water depths greater than 1,000 m. The temperature-salinity characteristics of the eddy were those of the Bering Slope Current. The authors attribute its formation as evolving from a pinching off of a meander of this current in a manner similar to that which occurs when the Gulf Stream (Atlantic Ocean) forms warm eddies that travel northward along the U.S. east coast. Similar eddy events have been observed in the northern GOA and reported by Royer *et al.* (1979). They describe a persistent clockwise 100-km feature lying off the continental shelf and attribute its formation to instabilities of the Alaska Current.

The role of mesoscale eddies in the ocean and, more specifically, in the GOA and Bering Sea, is not determined. However, eddies could play an important role in controlling exchange of water between the North Pacific and Bering Sea (Okkonen 1993). Eddies have an important role in mixing water masses, so they might be providing microclimates that enhance or deter productivity. The interaction of eddies with other longer-term oceanic processes can serve to confound further comprehension of the overall circulation and its ecosystem-level effects. Accordingly, mesoscale eddies are essentially noise that is superimposed over the combined signal of longer-term quasi-periodic processes that are evident in the overall picture of oceanic variability.

3.3.4.3 Interannual Variability

The phenomenon known as El Niño – Southern Oscillation (ENSO), as described by Philander (1990), has long been recognized as a significant factor in the interannual variability of atmospheric-oceanic response. ENSO events radiate from the equatorial regions at irregular intervals, but ranging most commonly from three to seven years between events. ENSO events account for approximately one-third of the ice and sea surface temperature variability in the Bering Sea (Niebauer and Day 1989). ENSO forcing in the oceans at high latitudes is primarily through poleward propagation of Kelvin waves (Jacobs *et al.* 1994). This conclusion is supported by data of Enfield and Allen (1980) who found poleward-propagating, coastal-trapped disturbances along the west coast of North America that were correlated with equatorial disturbances. Royer (1994) reported that ocean temperature fluctuations at depth at GAK 1 (an oceanographic observation station near Seward) are well-correlated with ENSO events.

In addition to fluctuations associated with ENSO forcing, the water temperature variations at GAK 1 have been found to be associated with the lunar nodal tide component, which has a period of 18.6 years (Royer 1994). This tide component is the twelfth largest of all tidal components and is related to the 18.6-year periodicity of the lunar declination. Equilibrium tide theory predicts that this tidal component will vary with latitude, with amplitudes increasing with latitude (Parker *et al.* 1995). Because the interdecadal sea surface variability seems to occur simultaneously in the GOA and Bering Sea, it is expected that this component forces Bering Sea parameters in a similar fashion as in the GOA. Temperature anomaly patterns are similar with no phase shift, which suggests that the forcing is simultaneous.

3.3.4.4 Interdecadal Variability

A chronology of interdecadal climatic changes affecting the North Pacific Ocean was compiled from available measured atmospheric pressure data by Minobe (1997) for the period 1899-1997. A climatic regime shift was defined as a transition from one climatic state to another within a period substantially shorter than the lengths of the individual epochs of each of the (two) climatic states. Data used included the North Pacific index (NPI). The NPI is the area- and time-averaged sea level pressure anomalies in the region of 160°East (E) to 140°West (W) by 30° to 60°N for winter to spring (December to May), which illustrated rapid strength changes in the Aleutian low in the winter and spring seasons. Bidecadal pressure averages during 1899-1924 showed that the Aleutian low was about one millibar (mb) weaker than average, then strengthened to one mb below normal during 1925-1947. Similar behavior occurred in the later part of the Twentieth century as the Aleutian low shifted back to one mb above normal from 1948 to 1976, then strengthened back to one mb below normal during 1977-1997.

Using late-nineteenth century data for spring air temperature in western North America, Minobe (1997) identified 1890 to be the first regime shift. This extended the length of the first period to 34 years in comparison to the 22-, 26-, and 20+-year regimes to follow. The 50- to 70-year interdecadal variability, a two-regime cycle, has been prevalent from the nineteenth century to the present in North America. Minobe (1997) speculated that the likely cause of this variability is an internal oscillation in the coupled atmosphere-ocean system. This suggests that the next climatic regime shift is likely to occur between 2000 and 2007.

Long-term changes in fish populations around the North Pacific Ocean have apparently been influenced by climatic change of the same 50- to 70-year variability. Alaska salmon decreased in the 1940s and increased in the 1970s. Larger Japanese sardine catch amounts occurred in the regimes with the deepened Aleutian low. Baumgartner *et al.* (1992) found evidence of an approximately 60-year variability in sardine and northern anchovy populations in the eastern North Pacific from sediments in the Santa Barbara basin dating back to A.D. 270.

3.3.4.5 Regime Shifts

An update of evidence for regime shifts in the North Pacific Ocean in the 1920s, the 1940s, a major one in the winter of 1976/1977, and a minor one in 1988/1989 was presented recently at the North Pacific Marine Science Organization (PICES) symposium (Hare *et al.*, Hare and Mantua, McFarlane *et al.*, Zhang *et al.*, Park and Oh, Kang *et al.*, Suga *et al.*, Yasuda *et al.*, Savelieva *et al.*, Rogachev, Overland *et al.*, Miller and Schneider, and Minobe 2000). Coincidentally, the beginnings of another large change in 1998/1999 were mentioned at the symposium; these are discussed in more recent papers by Minobe (2002), Conners *et al.* (2002), Mantua and Hare (2002), and Schwing *et al.* (2002).

In the late 1970s a step change in climate, referred to as a regime shift, occurred in the North Pacific Ocean. While there is evidence to suggest that there have been previous regime shifts, as noted in the previous section, it was the 1970s regime shift that stimulated extensive research on the topic, and especially how oceanic ecosystems were responding to these phenomena. Although more than a decade was required to recognize the pattern, the regime shift of 1976/1977 is now widely acknowledged, as well as its associated far-reaching consequences for the large marine ecosystems of the North Pacific Ocean. The 1989 regime shift has been studied extensively by Hare and Mantua (2000) who assembled and examined 100 environmental time series of indices (31 climatic and 69 biological) to obtain evidence of regime shift signals. A few examples of these illustrate that such signals are evident in the BSAI and GOA data.

Sea surface temperature anomalies, relative to long-term averages, around the Pribilof Islands indicate that the BSAI environmental regime appears to have shifted. The dominance of positive anomalies (warmer than average) from 1977 to 1988 switched abruptly to negative anomalies (colder than average) in 1989, which prevailed at least through 1997. Further evidence of a regime shift is seen in the time series of the southern extent of sea ice in the Bering Sea.

Niebauer (1998) reports that prior to the late 1970s ENSO regime shift below-normal sea ice cover in the Bering Sea was typically associated with ENSO conditions. These conditions caused the Aleutian Low atmospheric pressure center to move east of its average or normal position, with the result that warm Pacific air was directed over the Bering Sea. Conversely, above-normal sea ice cover was associated with La Niña conditions, during which the Aleutian Low moves west of its normal position, allowing higher pressure and colder weather in the Bering Sea. However, since the1970s regime shift, ENSO conditions are causing the Aleutian Low to move even farther east, causing winds to blow from the east and north off Alaska, and resulting in above-normal ice cover in the Bering Sea.

Before the regime shift, ENSO and La Niña conditions occurred with about the same frequency. Since the regime shift, ENSO conditions are about three times more prevalent. Both Mantua *et al.* (1997) and Minobe (1997) present evidence that this regime shift is the latest in a series of climate shifts that date back at least to the late 1800s and might be attributable to a 50- to 70-year oscillation in a North Pacific atmospheric-ocean coupled system.

Abundant evidence suggests that the coupled atmospheric-oceanic system of the North Pacific is subject to multiple forcing factors, each having characteristic behaviors and different frequencies of occurrence. The evidence also indicates that, rather than there being a single average or normal condition, the overall system appears to stabilize periodically around two or more normal states, changing from one to another abruptly in what has been termed a regime shift. These are the characteristics of systems whose dynamics are addressed by chaos theory, which is a body of mathematical theory that focuses on systems that have multiple states of equilibrium. Chaos theory attempts to define the mechanisms that cause the systems to change from one equilibrium state to another and to predict all such equilibrium conditions.

Using available sea level pressure and sea surface temperature data, along with coastal air temperature data from Sitka, Overland *et al.* (2000) formulated a conceptual chaotic model for the North Pacific. They were able to determine that the energy content of North Pacific time series of these parameters is broad-banded (i.e. over a broad frequency range) and temporally irregular (i.e. non-steady with respect to time). They reported that their conceptual model reflects the observed irregular behavior and suggests that the transitions from one equilibrium state to another are rapid rather than gradual.

Use of the word chaos in this context is not to imply the more common definition of great confusion or disorder. Rather, its use invokes the mathematical implication that there is order behind the irregularity of the system. A chaotic model may lead to a better understanding of the low-frequency relationship between the physical and biological systems in the North Pacific. One characteristic of a chaotic system is that , near the time of major interdecadal transition, there could be several years of extreme, and perhaps opposite, anomalies in the physical system. These extremes provide opportunities for change in the biological system. Recent experience with North Pacific fisheries may provide examples of such transition periods.

Although the Bering Sea is not discussed, a new review paper summarizes many details and the big picture of multidecadal (about 50 years) change in the Pacific Ocean (Chavez *et al.* 2003) characterized by about 25-year boom and 25-year bust cycles in the opposing anchovy-sardine populations. In the mid-1970s the change was from a cool anchovy regime to the warm sardine regime. Satellites have recently confirmed an increase in basin-wide sea-level slope after the 1997/1998 ENSO coincident with a dramatic increase in chlorophyl off California, indicating a shift back to a cool anchovy regime that occurred in the middle to late 1990s. The effects of ENSO in the tropics which radiate north on a shorter cycle of three to seven years and some unmeasured anthropogenic effects may tend to mask some of the synchronicity of changes in the physical and biological systems.

3.4 Threatened and Endangered Species

The ESA of 1973 as amended (16 United States Code [USC] 1531 et seq.), provides for the conservation of endangered and threatened species of fish, wildlife, and plants. The program is administered jointly by the NOAA Fisheries for most marine mammal species, marine and anadromous fish species, and marine plants species and by the USFWS for bird species, and terrestrial and freshwater wildlife and plant species.

The designation of an ESA-listed species is based on the biological health of that species. The status determination is either threatened or endangered. Threatened species are those likely to become endangered in the foreseeable future (16 USC 1532(20)). Endangered species are those in danger of becoming extinct throughout all or a significant portion of their range (16 USC 1532(20)). Species can be listed as endangered without first being listed as threatened. The Secretary of Commerce, acting through NOAA Fisheries, is authorized to list marine and anadromous fish species, plants, and mammals (except for walrus and sea otter). The Secretary of the Interior, acting through the USFWS, is authorized to list walrus and sea otter, seabirds, terrestrial plants and wildlife, and freshwater fishes and plants.

In addition to listing species under the ESA, the critical habitat of a newly listed species must be designated concurrent with its listing to the "maximum extent prudent and determinable" (16 USC 1533(b)(1)(a)). The ESA defines critical habitat as those specific areas that are essential to the conservation of a listed species and that may be in need of special consideration. Federal agencies are prohibited from undertaking actions that destroy or adversely modify designated critical habitat. Some species, primarily the cetaceans, which were listed in 1969 under the Endangered Species Conservation Act and carried forward as endangered under the ESA, have not received critical habitat designations.

Federal agencies have an affirmative mandate to conserve listed species (Rohlf 1989). One assurance of this is federal actions, activities or authorizations (hereafter referred to as federal action) must be in compliance with the provisions of the ESA. Section 7 of the ESA provides a mechanism for consultation by the federal action agency with the appropriate expert agency, NOAA Fisheries or USFWS. Informal consultations, resulting in letters of concurrence, are conducted for federal actions that have no adverse affects on the listed species. Formal consultations, resulting in BiOps, are conducted for federal actions that may have an adverse affect on the listed species. Through the BiOps, a determination is made as to whether the proposed action poses jeopardy or no jeopardy of extinction to the listed species. If the determination is that the action proposed, or ongoing, will cause jeopardy, RPAs may be suggested that, if implemented, would modify the action to no longer pose the jeopardy of extinction to the listed species. The RPAs must be incorporated into the federal action if it is to proceed. A BiOp with the conclusion of no jeopardy may contain a series of management measures intended to further reduce negative impacts to the listed species. These management alternatives are advisory to the action agency (50 CFR 402.24(j)). If a likelihood exists of any taking occurring during promulgation of the action, an incidental take statement may be appended to a BiOp to provide for the amount of take that is expected to occur from normal promulgation of the action. An incidental take statement is not the equivalent of a permit to take. The term take under the ESA means "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct" (16 USC 1538(a)(1)(B)).

Twenty-five species occurring in the BSAI and/or GOA groundfish management areas are currently listed as endangered or threatened under the ESA (Table 3.4-1): seven great whales, one pinniped, 13 Pacific salmon, three birds, and one turtle.

In summary, species listed under the ESA are present within the management area. Some may be negatively affected by groundfish fishing, the subject of this Programmatic SEIS federal activity. NOAA Fisheries is the expert agency for ESA-listed marine mammals. The USFWS is the expert agency for ESA-listed seabirds. The proposed action, continuation of the federal groundfish fisheries in the 200-mile EEZ off Alaska, must be in compliance with the ESA.

The material presented in the subsections that follow further explains the ESA and ESA Section 7 consultations that have occurred prior to preparation of this Programmatic SEIS. Sections 3.4.1 and 3.4.2 describe certain listed species present in the management (e.g., action) area. All other ESA-listed species are described in their own independent sections (e.g., marine mammals, seabirds, etc.) in Chapters 3 and 4 of this document.

Section 7 Consultations

Because groundfish fisheries are federally regulated, any negative effects of the fisheries on ESA-listed species or critical habitat, and any takings that may occur are subject to ESA Section 7 consultation. NOAA Fisheries initiates the consultation with itself for marine mammals and anadromous fish and with the USFWS for birds. The resulting letters of concurrence and BiOps are issued to NOAA Fisheries. NPFMC may be invited to participate in the compilation, review, and analysis of data used in the consultations. The determination of whether the action "is likely to jeopardize the continued existence of" endangered or threatened species, or to result in the destruction or modification of critical habitat, however, is the responsibility of either NOAA Fisheries or USFWS. If the action is determined to result in jeopardy, the opinion includes reasonable and prudent measures that are necessary to alter the action to avoid jeopardy. If an incidental take of a listed species is expected to occur under normal promulgation of the action, an incidental take statement is appended to the BiOp.

For all ESA-listed species, Section 7 consultation must be reinitiated if the amount or extent of taking specified in the incidental take statement is exceeded; new information reveals effects of the action that may affect listed species in a way not previously considered; the action is subsequently modified in a manner that causes an effect to listed species that was not considered in the BiOp; or a new species is listed or critical habitat is designated that may be affected by the action.

Section 7 consultations have been done for all the listed species in Table 3.4-1— some individually and some as groups. Below are summaries of species that are not described in their own independent section (e.g., marine mammals, seabirds, etc.), and Section 7 consultations have been included in the descriptions.

3.4.1 Leatherback Turtle (*Dermochelys coriacea)*

Life History and Distribution

Leatherback turtles are the largest sea turtles in the world, reaching a shell length of 1.6 m and a mass of 700 kg. They reach sexual maturity at an estimated age of 13 to 14 years for females and live for more than 30 years (Zug and Parham 1996). Leatherbacks must surface to breathe air, but can stay submerged for 2 hours and dive to 1,000 m. Males do not leave the ocean, but females come ashore on open, sandy beaches to dig nests and lay eggs. Nestlings emerge from the sand at night and attempt to make their way to the sea. Very little is known about the distribution and natural history of these young turtles after they leave their natal beaches.

Leatherback turtles are widely distributed throughout the world's oceans (Ernst and Barbour 1989). In the Pacific Ocean, they range as far north as Alaska and as far south as Chile and New Zealand. In Alaska, leatherback turtles are found as far north as 60°34'N, 145°38'W (Copper River delta) and as far west as the Aleutian Islands (Hodge 1979, Stinson 1984). Leatherback turtles have also been found in the Bering Sea along the coast of Russia (Bannikov *et al.* 1971). The Pacific coast of Mexico is generally regarded as the most important breeding ground for nesting leatherback turtles in the world. No nesting is known to occur in U.S. waters of the Pacific. Nesting is widely reported from the western Pacific, including China, southeast Asia, Indonesia, and Australia.

Leatherback turtles undertake the longest migrations and exhibit the broadest thermal tolerances among sea turtles (NMFS and USFWS 1992). Leatherback turtles have been found in waters ranging from 7° to 27° C in temperature (Shoop and Kenney 1992). They are typically associated with continental shelf habitats and pelagic environments and are sighted regularly in offshore waters at depths greater than 328 ft.

Estimating the population size of this species is especially difficult because individuals are widely dispersed and males never come ashore. Population estimates are usually based on the number of females seen on nesting beaches. These counts are problematic because females frequently change beaches. In spite of the difficulty in censussing their numbers, it is clear that the population of leatherback turtles is declining significantly. The global leatherback turtle population was estimated to number approximately 115,000 adult females in 1980 (Pritchard 1982), but only 34,500 in 1995 (Spotila *et al.* 1996). The Pacific leatherback population appears to be in a critical state of decline. The eastern Pacific leatherback population was estimated to be over 91,000 adults in 1980 (Spotila *et al.* 1996), but is now estimated to number less than 3,000 total adult and subadult animals (Spotila *et al.* 2000). Leatherback turtles have experienced major declines at all major Pacific basin rookeries (Sarti *et al.* 1996, Spotila *et al.* 2000). In the western Pacific, the decline is equally severe. Current nestings at Terengganu, Malaysia, represent one percent of the levels recorded in the 1950s (Chan and Liew 1996).

Trophic Interactions

Leatherback turtles feed predominately on jellyfish and other large planktonic species (siphonophores and salpae) in temperate and boreal latitudes (NMFS and USFWS 1998). There is little information available on their diet in subarctic waters. To a large extent, the oceanic distribution of leatherback turtles may reflect the distribution and abundance of their planktonic prey. Adult leatherbacks do not have many natural predators although killer whales are known to eat adult leatherbacks off the coast of Mexico (Sarti *et al.* 1996). Nestling and juvenile turtles fall prey to a host of bird, mammal, and fish species throughout their range, especially coastal and pelagic sharks.

Wildlife Management Responsibility

NOAA Fisheries and the USFWS share responsibilities at the federal level for the research, management, and recovery of Pacific sea turtle populations under U.S. jurisdiction. The leatherback turtle was listed as endangered under the ESA in June of 1970. NOAA Fisheries and USFWS have created a joint Pacific Sea Turtle Recovery team to develop a recovery plan for the species (NMFS and USFWS 1998). Under the requirements of the ESA, these agencies are responsible for issuing Section 7 consultations (BiOps) for federal actions that may impact the species, such as the BSAI and GOA groundfish FMPs.

Leatherback turtles are classified as Critically Endangered in the International Union for Conservation of Nature's (IUCN) *Red List of Threatened Species* (IUCN 2000), where taxa so classified are considered to be "facing an extremely high risk of extinction in the wild in the immediate future ." In October of 2000, the U.S. ratified the Inter-American Convention for the Protection and Conservation of Sea Turtles. This treaty is the first international agreement dedicated solely to raising standards for the protection of sea turtles.

Past/Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Nesting on open, sandy beaches, leatherback turtles are susceptible to a number of human activities including beachfront development that results in habitat loss. In some areas, adults are taken for meat and oil. The poaching of eggs from nests continues in many areas including the U.S. Virgin Islands and Puerto Rico. On some beaches, nearly 100 percent of the eggs laid have been harvested (Eckert 1996). Many of these eggs end up on the black market for sale as aphrodisiacs.

The setting of large mesh nets suitable for turtling is common in the waters off Puerto Rico. Although the practice was outlawed in 1984, it still continues illegally. The nets are intended for hawksbills and green turtles, but leatherbacks occasionally become entangled (NMFS and USFWS 1998).

Direct and Indirect Effects of External Fisheries

Leatherback turtles have been strongly impacted by commercial fisheries. The primary threats are entanglement in fishing gear (e.g., driftnets, longlines, lobster pots, weirs), boat collisions, contamination by oil spills, and ingestion of marine debris (Eckert 1996, Spotila *et al.* 1996, NMFS and USFWS 1998). Although some driftnet fisheries, particularly shrimp trawlers, are required to use Turtle Exclusion Devices, leatherbacks are too big for most commercially available devices and are drowned in nets even if they are equipped with these devices. Spotila *et al.* (2000) state that a conservative estimate of annual leatherback fishery-related mortality (from longlines, trawls, and gillnets) in the Pacific during the 1990s was 1,500 animals. They estimate that this represented about a 23 percent mortality rate (or 33 percent if mortality was focused on the east Pacific population). Based on recent modeling efforts, the leatherback turtle population cannot withstand more than a one percent human-related mortality level, which translates to 150 nesting females (Spotila *et al.* 1996; Spotila, personal communication). The model simulations indicated that leatherbacks could maintain a stable population if both juvenile and adult survivorship remained high, and other life history stages (i.e., egg, hatchling, and juvenile) remained static. Characterizations of this population suggest that it has a very low likelihood of survival and recovery in the wild under current conditions.

Direct and Indirect Effects of the BSAI/GOA groundfish Fisheries

NOAA Fisheries Protected Resources Division (PRD) issued a BiOp in November 2000 on the interaction of leatherback turtles and the BSAI and GOA groundfish fishery (NMFS 2000a). In that document, NOAA Fisheries noted that the GOA groundfish FMP area is at the extreme edge of the leatherback turtle's historic range. They occur generally as stranded animals along the coastlines of southeast Alaska and are not considered to be frequent visitors to the GOA fishing grounds or found in the BSAI FMP area at all. According to NOAA Fisheries, there have been no direct takes of leatherbacks in the commercial fisheries in the BSAI and GOA. No information is available to help NOAA Fisheries assess the potential competition or cascade effects of the fisheries on the trophic level of leatherbacks, either positively or negatively. There is no fishery that is targeting the prey of this species. NOAA Fisheries concludes that the direct and indirect effects of commercial fisheries in the BSAI and GOA on leatherback turtles is negligible and not likely to jeopardize its survival or recovery.

Comparative Baseline

Leatherback turtle populations are in serious decline around the world, largely due to many human-related sources of mortality. All of them must be addressed, if this species is to recover from the brink of extinction (NMFS and USFWS 1998). Although some commercial fisheries have played a major role in the decline of this species, NOAA Fisheries has concluded that the BSAI and GOA groundfish fisheries have negligible effects, if any, on the species (NMFS 2000a).

Status for Cumulative Effects Analysis

Leatherback turtles rarely enter the waters fished by the BSAI/GOA groundfish fisheries and do not appear to be affected in any direct or indirect manner by the fisheries. Since the groundfish fisheries do not contribute to the cumulative effects on the species, leatherback turtles will not be carried forward for analysis in Chapter 4.

3.4.2 Pacific Northwest Salmon

Five species of Pacific salmon, pink (*Oncorhynchus gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), coho (*O. kisutch*) and chinook salmon (*O. tshawytscha*), as well as steelhead trout (*O. mykiss*) occur in Alaska.

Refer to Section 3.5.2.2 for Pacific salmon life history and trophic interaction information. This section will explain the relationship between the BSAI and GOA groundfish fisheries and Pacific Northwest salmon. For a thorough description of Pacific Northwest salmon distribution, management and past/present effects within its habitat of origin, refer to the NOAA Fisheries Final Programmatic EIS for Pacific Salmon Fisheries Management off the Coasts of southeast Alaska, Washington, Oregon, and California and in the Columbia River Basin (NOAA Fisheries 2003).

Pacific Northwest Salmon Management

Pacific salmon off the Alaska coast are managed under a complex mixture of domestic and international bodies, treaties, regulations, and other agreements. Federal and state agencies cooperate in managing salmon fisheries. The Alaska Department of Fish & Game (ADF&G) manages salmon fisheries within jurisdictional waters where the majority of harvest occurs. Management in the EEZ is the responsibility of the NPFMC. Under Amendment 4 of the Federal Salmon FMP, regulation of the directed salmon fishery occurring in the EEZ off southeast Alaska is deferred to the State of Alaska (NPFMC 1990). Management of Alaska salmon fisheries is based primarily on regional stock groups of each species and on time and area harvesting by specific types of fishing gear. Over 25 different commercial salmon fisheries in Alaska are managed with a special limited-entry permit system that specifies when and what type of fishing gear can be used in each area. These fisheries, extending from Dixon Entrance in southeast Alaska to Norton Sound in the Bering Sea, are allowed to catch salmon in different fisheries, either with drift gillnets, set gillnets, beach seines, purse seines, hand troll, power troll, or fish wheel harvest gear. Sport fishing is limited to hook-and-line, while subsistence fishermen may use gillnets, dip nets, or hook-and-line. Some subsistence harvesting of salmon is also regulated by special permits.

The southeast Alaska salmon fisheries have the largest impact on the Pacific Northwest salmon, relative to other Alaska salmon fisheries. Only southeastern Area A is open to commercial salmon fishing, although there are three minor fisheries in the Yakutat Area D. These salmon fisheries are regulated by ADF&G and adhere to the FMP for the Salmon Fisheries off the Coast of Alaska (NPFMC 1990), the MSA, the Pacific Salmon Treaty (see below), and the ESA when applicable, along with other federal laws. Sport fisheries also occur in southeast Alaska, and are managed by ADF&G. Anglers are required to obtain a fishing license, restrictions vary for each salmon species. ADF&G also monitors subsistence and personal use permits in southeast Alaska.

Salmon fisheries are managed to meet an escapement goal of a certain number of spawners for each river system. Meeting escapement goals is considered equivalent to maintaining healthy stocks. In general, spawners are counted on their way upstream, after their numbers have already been reduced by natural mortality at sea, bycatch at sea, and directed fisheries downstream.

<u>International Management</u>

Some fisheries, including the southeast Alaska chinook, coho, and sockeye fisheries, have harvest limits that are subject to negotiations between the U.S. and Canada under the Pacific Salmon Treaty. This treaty originally signed in 1983 also covers salmon that are intercepted in fisheries that are returning to Idaho, Oregon, and Washington. In recent years, the treaty process was stalled due to disagreements between the two countries on allocations for certain fisheries and species. In 1999, a new harvest agreement was signed. The new treaty specified new harvest limits for both countries. In recent years, the treaty process was stalled due to disagreements between the two countries on allocations for certain fisheries and species. The new agreement provides stability to the fisheries of both countries. The agreements are complex and require continuous coordination between both countries to be successful. The new treaty will expire, unless renewed, in 2008.

On a broader international scope, the management of salmon harvest in the high seas of the North Pacific Ocean from 1957 to 1992 was authorized by the International North Pacific Fisheries Commission (INPFC), and via bilateral and multilateral agreements and negotiations with Taiwan and the Republic of Korea (South Korea). In 1993, the North Pacific Anadromous Fish Commission (NPAFC) was formed to replace the International North Pacific Fisheries Commission. This four-country commission (Canada, Japan, the Russian Federation, and the U.S.) now provides a framework for international cooperation in salmon management and research in the North Pacific Ocean. The NPAFC Convention prohibits high seas salmon fishing and trafficking of illegally caught salmon. Coupled with United Nations General Assembly Resolution 46/215, which bans large-scale pelagic driftnet fishing in the world's oceans, harvesting of Pacific salmon on the high seas, except for illegal fishing, no longer occurs. This allows for effective management control to fully return to the salmon-producing nations.

<u>NOAA Management</u>

There are no GOA FMP amendments that directly address salmon bycatch. However, while PSC limits have not been established for salmon, the timing of seasonal openings for the pollock fisheries in the central and western GOA have been adjusted to avoid periods of high chinook and chum salmon bycatch.

Endangered Species Act

No stocks of Pacific salmon originating from freshwater habitat in Alaska are listed under the ESA. The ESA-listed species or evolutionary significant units (ESUs) that migrate into marine waters off Alaska, originate in freshwater habitat in Washington, Oregon, Idaho, and California. In the marine waters off Alaska, the ESA-listed salmon stocks are mixed with hundreds to thousands of other stocks originating from the Columbia and Willamette Rivers, British Columbia, Alaska, and Asia. The ESA-listed fish are not visually distinguishable from the other, unlisted, stocks. Minimal take of them in the salmon bycatch portion of the fisheries is assumed based on limited abundance, timing, and migration pattern information gleaned from recovery locations of coded-wire-tagged (CWT) surrogate stocks (closely related hatchery stocks that are tagged with CWT). For information on PSC limits and commercial salmon fishery catch limits set in Alaska waters by NOAA Fisheries and ADF&G, see Section 3.5.2.2.

Pacific Northwest Salmonid Past/Present Effects Analysis

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document.

The following direct and indirect effect indicators were identified as potentially having population level effects on Pacific Northwest salmon:

- Catch/bycatch of Pacific Northwest salmon (direct effect).
- Reduced/increased recruitment due to hatchery programs (indirect effect).
- Reduced recruitment due to habitat degradation (indirect effect).
- Reduced/increased recruitment due to climate changes and regime shifts (indirect effect).

The past/present events determined to be applicable to the Pacific Northwest salmon past/present effects analysis include the following:

- Past/Present External Events:
  - State of Alaska directed salmon fisheries (commercial and sport fisheries)
  - Washington, Oregon, California Coast groundfish fisheries (NMFS 1999b)
  - Washington, Oregon and California state salmon fisheries (NMFS 1999b)
  - Alaska subsistence fisheries
  - Foreign fisheries (pre-MSA)
  - Hatchery programs (NMFS 1999b)
  - Habitat degradation (NMFS 1999b)
  - Hydro-development (NMFS 1999b)
  - Climate changes and regime shifts
- Past/Present Internal Events:
  - BSAI and GOA groundfish fisheries

- Past/Present Management Actions:
  - ADF&G management
  - Washington, Oregon, and California state management
  - International agreements
  - Endangered Species Act (Section 7 consultation)
  - Federal, state and local agencies associated with salmon habitat
  - Foreign fisheries management
  - Industry self-imposed management
  - FMP groundfish fisheries management

Washington, Oregon and California State salmon fisheries and groundfish fisheries and salmon hatchery programs have not been brought forward for past/present effects analysis. For a thorough description of these fisheries and their impacts on the salmon, see the November 1999 Endangered Species Act - Reinitiated Section 7 Consultation, BiOp (NMFS 1999b). According to the 1999 BiOp, open Pacific Ocean habitat was not considered a critical habitat to ESA-listed salmon species and special management considerations were not discussed further (58 CFR 68547).

The quality of salmon spawning habitat is influenced by land management practices (e.g., forestry practices, agricultural practices and urbanization) and climatic events (e.g., flooding that scours streams). Several agencies, entities, and groups exert control over watersheds used by spawning salmon. NOAA Fisheries designated critical habitat in 1993 (57 Federal Register [FR] 57051) for the Snake River sockeye, Snake River spring/summer chinook, and Snake River fall chinook salmon. The designations did not include any marine waters, and therefore, does not include any habitat where Alaska groundfish fisheries are promulgated. For a thorough analysis of habitat degradation and hydro-development impacts on Pacific Northwest salmon, see the November 1999 Endangered Species Act - Reinitiated Section 7 Consultation, BiOp (NMFS 1999b).

<u>External Mortality: Catch/bycatch by State of Alaska Directed Salmon Fisheries</u>

The commercial salmon fisheries in southeast Alaska began in the late 1870s, primarily targeting sockeye salmon. Pink salmon began to dominate in early 1900s and has continued to dominate into recent years. Salmon catch has increased since the mid-1970s with more diverse catches of salmon including pink, chum, coho and sockeye salmon. Catches of chinook salmon have been limited in recent years due to harvest limits imposed by the Pacific Salmon Treaty. Trawlers take a majority of the salmon catch in southeast; drift and set gillnet and purse seine fishermen only operate within state waters.

The list of ESA-listed salmon stocks as of 2002 is in Table 3.4-2. Those stocks that are likely to migrate into marine waters off Alaska are highlighted: they include six ESUs of chinook salmon, one ESU of chum salmon, and five ESUs of steelhead (i.e., Snake River fall chinook, Snake River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper Willamette River chinook, Upper Columbia River spring chinook, Columbia River chum, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and Snake River basin steelhead).

Incidental take of listed salmon species likely to range into Alaskan waters in the southeast Alaskan fisheries are limited by the Pacific Salmon Treaty. Bycatch varies from year to year and is dependent upon abundance of salmon stock and established catch limits. The November 1999 BiOp (NMFS 1999b) determined southeast Alaskan fishery bycatch is not at a level that is likely to jeopardize any of the Pacific Northwest salmon

ESUs. However, ADF&G is still required to implement reasonable and prudent measures under the ESA as follows:

- Management objectives (pre-season and inseason) established for the southeast Alaska fisheries must be consistent with the provision established by the Pacific Salmon Treaty.

- ADF&G must monitor catch and implementation of management measures in the southeast Alaska fisheries.

- ADF&G with NOAA Fisheries Alaska Region and NPFMC chair must sample the southeast Alaska fishery catch to determine stock composition and gather biological information intended to determine fishery-related impacts on listed ESUs.

External Mortality: Alaska Subsistence Fisheries

Harvest of Pacific Northwest salmon by Alaskan and Pacific Northwest subsistence groups probably occurs, although their impacts on the ESA-listed salmon stocks is likely to be minimal.

External Mortality: BSAI and GOA Foreign Groundfish Fisheries (pre-MSA) Bycatch

Although it is impossible to determine the number of Pacific Northwest salmon taken by the BSAI and GOA foreign groundfish fisheries prior to the MSA, it is assumed that bycatch of salmon per region per year was substantially higher than what occurs currently.

Internal Mortality: BSAI and GOA Groundfish Fisheries (post-MSA) Bycatch

Pacific Northwest chinook salmon stocks may compose a larger proportion of GOA bycatch than they do of BSAI bycatch (personal communication with Kate Myers, NOAA Fisheries Auke Bay, 2003). While some Pacific Northwest stocks are listed as endangered or threatened under the ESA (Table 3.4-2), none of the catches observed in Alaska would exceed the incidental take limit of 40,000 fish accepted under ESA Section 7 consultation.

The effects of the BSAI and GOA groundfish fisheries on listed salmon were considered through informal consultations with NOAA Fisheries (February 20, 1992; April 21, 1993; June 7, 1993; and September 22, 1993) and by formal consultations (NMFS 1994, 1995a, and 1999a). Each consultation is summarized below, beginning with the informals and moving through the formals in order of issuance. Informal consultations were done on fishing years 1992 and 1993 (February 20, 1992 and April 21, 1993, respectively), and on BSAI Amendment 28 (June 7, 1993) and GOA Amendment 31 (September 22, 1993).

In the latter two informal consultation memorandums, NOAA Fisheries stated that it was essential that monitoring efforts be continued and that NOAA Fisheries continue to seek additional information regarding potential impacts to listed fish.

The 1994 BiOp was the first formal consultation considering whether continuation of the groundfish fisheries in the BSAI and GOA in 1994 and beyond was likely to jeopardize the continued existence of Snake River sockeye salmon, Snake River spring/summer chinook salmon, or Snake River fall chinook salmon. Assessment of impacts in the BiOp established approaches for evaluating the proposed actions. Using those approaches, effects of the proposed action on the listed species were evaluated. Effects are expressed in terms of numerical catch assessment, base period analysis (1986 to 1990), cumulative effects analysis, and combined effects analysis. For purposes of the analysis, it was assumed that annual bycatch of chinook salmon in 1994 and for the foreseeable future would be 40,000 or fewer fish in each of the BSAI and GOA groundfish fisheries. Relative to the base period analysis question, the assumed maximum bycatch of 40,000 chinook salmon per region per year is substantially less than that which occurred in the foreign and JV fisheries in earlier years. No cumulative effects accruing to the listed species of activities occurring within the action areas are thought to exist (NMFS 1994).

In the BiOp, NOAA Fisheries "determined that it is highly unlikely that any Snake River sockeye salmon are taken in the groundfish fisheries." Based on that, "NOAA Fisheries concluded that the groundfish fisheries are not likely to adversely affect Snake River sockeye salmon and thus will not jeopardize their continued existence." For listed chinook salmon, "NOAA Fisheries concluded that the catch of Snake river spring/summer chinook salmon is unlikely to average more than one fish per year in each region, and that it is highly unlikely than any Snake River fall chinook salmon are taken in the BSAI groundfish fisheries." NOAA Fisheries concluded that the catch of Snake River fall chinook in the GOA groundfish fisheries "is unlikely to average more than five fish per year and may be substantially less." Based on available information, NOAA Fisheries concluded "the groundfish fisheries are not likely to jeopardize the continued existence of any of the ESA-listed salmon" (NMFS 1994). The 1994 BiOp contained four conservation recommendations:

- NPFMC and NOAA Fisheries, Alaska Region should monitor the bycatch of chinook salmon in the groundfish fisheries and take necessary actions to ensure that the bycatch is minimized to the extent possible and in any case does not exceed 40,000 chinook salmon per year in either the BSAI or GOA groundfish fisheries.

- NPFMC and NOAA Fisheries, Alaska Region should improve estimates of the region-of-origin and stock composition of the chinook salmon bycatch by increasing CWT sampling rates as part of the mandatory salmon retention program, collecting and analyzing scale samples, and employing additional stock identification techniques applicable to the problem.

- NPFMC and NOAA Fisheries, Alaska Region should use information collected during the observer monitoring program to identify times and areas of high salmon abundance that could be used to reduce salmon bycatch through regulatory action.

- NPFMC and NOAA Fisheries, Alaska Region should encourage development of incentive programs designed to reduce the bycatch of salmon in the BSAI and GOA groundfish fisheries.

The incidental take statement appended to the BiOp allowed for take of five Snake River fall chinook in the GOA, zero in the BSAI, one take of Snake River spring/summer chinook in the BSAI and GOA fisheries, and zero take of Snake River sockeye in either fishery, per year. As explained above, it is not technically possible to know if any have been taken. Compliance with the BiOp was stated in terms of limiting salmon bycatch per year to under 40,000 fish per year for chinook salmon, and 200 and 100 fish per year for sockeye salmon in the BSAI and GOA fisheries, respectively (NMFS 1994). Keeping salmon bycatch within these limits is presumed to reduce the probability of incidental catch of listed salmon to near-zero.

Three terms and conditions were to be implemented by NOAA Fisheries, Alaska Region to carry out the reasonable and prudent measures established under the incidental take statement.

- NOAA Fisheries, Alaska Region shall continue to implement the current observer program for the BSAI and GOA groundfish fisheries. Mothership processor vessels or shoreside processing facilities that process 1,000 mt per day or more must have a NOAA Fisheries certified observer on board the vessel or at the facility each day it receives or processes groundfish. Motherships or shoreside processing facilities that process 500 to 1,000 mt per day must have a NOAA Fisheries certified observer for at least 30 percent of the days it receives or processes fish. Catcher processor or catcher vessels 125 ft LOA or longer are required to have a groundfish observer onboard for 100 percent of their fishing days. Vessels from 60 to 124 ft LOA are required to have a groundfish observer aboard for 30 percent of their fishing days. Vessels under 50 ft LOA are not required to carry groundfish observers.

- NOAA Fisheries, Alaska Region shall monitor the year-to-date bycatch estimates of chinook salmon on a weekly basis. If it is anticipated inseason that the annual total bycatch of chinook salmon will exceed 40,000 fish in either the BSAI or GOA fisheries, NPFMC and NOAA Fisheries, Alaska Region should reinitiate consultation.

- NOAA Fisheries, Alaska Region shall estimate and report the bycatch of sockeye salmon annually as part of the post season analysis. If the annual bycatch of sockeye exceeds 200 fish in the BSAI or 100 fish in the GOA fishery, consultation shall be reinitiated (NMFS 1994).

A second BiOp was issued in 1995 (NMFS 1995a), to reflect new information pertinent to the assumption that the bycatch of chinook salmon in the BSAI and GOA would not exceed 40,000 fish per year in either region. The estimated bycatch of chinook in the BSAI area was 44,487 in 1994, and revised estimates for the number of chinook salmon taken in the years 1991-1993 were greater than 40,000 fish per year (in 1993, 46,014; 1992, 41,955; and 1991, 48,880), thus exceeding the terms of the incidental take statement. The purpose of the reinitiated consultation was to consider whether this new information affected the previous conclusion that the BSAI groundfish fisheries were not likely to jeopardize the continued existence of Snake River spring/summer or fall chinook salmon. Conclusions regarding impacts to sockeye salmon the BSAI and GOA groundfish fisheries and chinook salmon in the GOA were not reviewed because the new information did not pertain to those species or areas.

In the 1995 BiOp conclusions, NOAA Fisheries reiterated its previous conclusions that NPFMC regulated groundfish fisheries were not likely to adversely affect Snake River sockeye salmon and thus could not jeopardize their continued existence. Based on the available information, NOAA Fisheries also concluded that the groundfish fisheries were not likely to jeopardize the continued existence of Snake River spring/summer chinook salmon or Snake River fall chinook salmon (NMFS 1995a).

The first conservation recommendation contained in the January 19, 1994, BiOp was revised (as reproduced below). The remaining conservation recommendations (numbers 2 through 4) remain in effect.

1. NPFMC and NOAA Fisheries, Alaska Region should monitor the bycatch of chinook salmon in the groundfish fisheries and take necessary actions to ensure that the bycatch is minimized to the extent possible and in any case does not exceed 55,000 chinook per year in the BSAI fisheries or 40,000 chinook salmon per year in the GOA fisheries. (NMFS 1995a).

The second of the three terms and conditions to the incidental take statement was modified (as follows) to reflect the increase in the estimate of chinook bycatch in the BSAI.

2. NOAA Fisheries, Alaska Region shall monitor the year-to-date bycatch estimates of chinook salmon on a weekly basis. If it is anticipated inseason that the annual total bycatch of chinook salmon will exceed 55,000 fish in the BSAI fisheries or 40,000 fish in the GOA fisheries, NPFMC and NOAA Fisheries, Alaska Region should reinitiate consultation. (NMFS 1995a).

A third BiOp was issued on December 22, 1999 (NMFS 1999a). The reasons for reinitiation of consultation were the new (1997 and 1999) listings of a number of salmon ESUs under the ESA (Table 3.4- 2). NOAA reviewed the status of Snake River fall chinook, Snake River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper Willamette River chinook, Lower Columbia River chinook, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and Snake River basin steelhead; the environmental baseline for the action area; the effects of the proposed fishery; and the cumulative effects. After the review, NOAA Fisheries determined that the BSAI and GOA groundfish fisheries subject to the BSAI FMP groundfish fishery and the GOA groundfish FMP, as proposed, was not likely to jeopardize their continued existence.

The incidental take statement appended to the BiOp allowed for take of 55,000 chinook salmon in the BSAI and 40,000 chinook salmon in the GOA. No take of Hood Canal summer run chum or Lower Columbia River chum was expected in BSAI or GOA groundfish fisheries. NOAA Fisheries does not anticipate that the proposed fisheries will take any coho from the southern Oregon/northern California coast or central California ESUs, any Snake River or Lake Ozette sockeye salmon, or any steelhead ESUs (NMFS 1999a).

Two reasonable and prudent measures were provided to minimize and reduce the anticipated level of incidental take associated with NPFMC-regulated groundfish fisheries:

1. NPFMC and NOAA Fisheries, Alaska Region shall ensure there is sufficient NOAA Fisheries-certified observer coverage such that the bycatch of chinook salmon and other salmon in the BSAI and GOA groundfish fisheries can be monitored on an in season basis.

2. NPFMC and NOAA Fisheries, Alaska Region shall monitor bycatch reports inseason to ensure that the bycatch of chinook salmon does not exceed 55,000 fish per year in the BSAI fisheries and 40,000 fish per year in the GOA fisheries (NMFS 1999a).

In order to be exempt from the prohibitions of Section 7 of the ESA, the specified agencies must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

- NOAA Fisheries, Division of Sustainable Fisheries (Alaska Region) shall provide an annual report to the PRD (Alaska Region) that details the results of its monitoring of bycatch reports during each fishing season. These reports shall be submitted in writing within one month of the new fishing year (February 1) and will summarize all statistical information based on a January 1 through December 31 fishing year (NMFS 1999a).

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might result from the proposed action. If during the course of the groundfish fishery this level of incidental take is exceeded, the additional level of take would represent new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided above.

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further its purposes by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to develop additional information, or to assist federal agencies in complying with their obligations under ESA Section 7(a)(1). NOAA Fisheries believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented by NPFMC and NOAA Fisheries:

- NPFMC and NOAA Fisheries, Alaska Region should improve estimates of the region-of-origin and stock composition of the chinook salmon bycatch by increasing CWT sampling rates as part of the mandatory salmon retention program, collecting and analyzing scale samples, and employing additional stock identification techniques applicable to the problem.

- NPFMC and NOAA Fisheries, Alaska Region should use information collected during the observer monitoring program to identify times and areas of high salmon abundance that could be used to reduce salmon bycatch through regulatory action.

- NPFMC and NOAA Fisheries, Alaska Region should encourage development of incentive programs designed to reduce the bycatch of salmon in NPFMC groundfish fisheries (NMFS 1999a).

In order for NOAA Fisheries to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NOAA Fisheries requested notification of the implementation of any conservation recommendations.

External Reduced Recruitment: Commercial Seal Harvesting and Commercial Whaling

Currently, the effects of rebounding seal and whale populations on salmon mortality, especially chinook salmon, are not well understood. Commercial whale and seal harvest were banned in 1972 with the passing of the Marine Mammal Protection Act (MMPA). Presently, foreign and subsistence whale harvests are monitored by the International Whaling Commission (IWC) (NMFS 1999b).

External Increased/Reduced Recruitment: Climate Changes and Regime Shifts

Various climate factors, including ENSO, have had different affects on the Pacific Northwest salmon populations. Included climate factors are severe flooding, droughts, and change in ocean productivity. In the Pacific Northwest, researchers have found that salmon may be responding to the Pacific Decadal Oscillation, a 20- to 30-year cycle of climate conditions and ocean productivity (Mantua *et al.* 1997). Response to these climate changes depends upon the stock and its timing and distribution. Overall, it appears that Pacific Northwest salmon may have been negatively affected in this phase of the cycle. One example is the Puget Sound chinook stocks which dropped to half of their 1974 to 1977 broods in 1979 (Cramer *et al.* 1999).

Pacific Northwest Salmon Comparative Baseline

Southeast salmon stocks reached their highest levels in the 1980s and 1990s (Rogers *et al.* 1987, Wertheimer 1997); spawning escapement has increased since the 1970s and have reached escapement objectives in recent years. Of the 407 chinook stocks harvested in the southeast, 81 percent are classified as not threatened, and 15 percent are special concern or at risk (Slaney *et al.* 1996). Large portions of the southeast chinook harvest originate from the Columbia River upriver bright chinook, Middle Columbia River bright chinook, and north-migrating Oregon coastal chinook; these stocks are considered stable (NMFS 2002b). Chinook stocks listed under the ESA make up a small portion of the southeast harvest, and nearly all coho salmon harvested originate from Alaskan streams (Weitkamp *et al.* 1995).

For current status information on West Pacific Coast and Columbia River Basin salmon stocks, refer to the Final Programmatic EIS for Pacific Salmon Fisheries Management off the Coasts of southeast Alaska, Washington, Oregon, and California, and in the Columbia River Basin, Chapter 3 – Affected Environment, Section 3.4 and 3.5 (NOAA Fisheries 2003).

Pacific Northwest Salmon Cumulative Effects Analysis Status

Due to the limited impacts of the BSAI and GOA groundfish fisheries on Pacific Northwest salmon, these stocks will not be brought forward for cumulative effects analysis. For up-to-date information on the status of these stocks and their habitat, visit the NOAA Fisheries Northwest Region website at http://www.nwr.noaa.gov. Comments on the Northwest Region Draft Programmatic EIS for Pacific Salmon Fisheries Management off the Coasts of southeast Alaska, Washington, Oregon, and California, and in the Columbia River Basin were due November 22, 2002. BiOps, FMPs, EISs, and other informative documents involving these stocks are also available on the Northwest Region website.

3.5 Target Groundfish Species

3.5.1 Target Groundfish Species

Bering Sea and Aleutian Islands Target Groundfish Species

This section presents descriptions of major target species, summarizing important life history traits, their habitat environment, prey base, past effects, stock management, stock assessment, and current status and trends of the stocks. Additional information on life history and habitat features for each major groundfish species can be found in the following three documents: 1) EA of the EFH (NPFMC 1998a), 2) EFH assessment report for the groundfish resources of the BSAI region (NPFMC 1998b), and 3) EFH assessment report for the groundfish resources of the GOA region (NPFMC 1998c).

3.5.1.1 BSAI Walleye Pollock

Life History and Distribution

Walleye pollock (*Theragra chalcogramma)* is the most abundant groundfish species within the EBS. It is widely distributed throughout the NPO in temperate and subarctic waters (Wolotira *et al.* 1993). Pollock is a semidemersal schooling fish, which becomes increasingly demersal with age. Approximately 50 percent of female pollock reach maturity at age 4 years, at a length of approximately 40 centimeters (cm). Pollock spawning is pelagic and takes place in the early spring on the outer continental shelf. In the EBS, the largest concentrations occur in the southeast, north of Unimak Pass (Kendall *et al.* 1996). Pollock are comparatively short-lived (Hollowed *et al.* 1997, Wespestad and Terry 1984), with a maximum recorded age of around 22 years. Table 3.5-1 summarizes the biological and reproductive traits and habitat associations of pollock at its different life stages.

Trophic Interactions

The diet of pollock in the EBS and GOA has been studied extensively (Dwyer 1984, Lang and Livingston 1996, Livingston 1991b, Livingston and deReynier 1996, Livingston *et al.* 1993, Yang and Nelson 2000). These studies have shown that pollock feed on euphausiids and calanoid copepods and other crustaceans. As the pollock increase in size, their diet begins to include juvenile pollock and other teleosts. Other fish consumed by pollock include juveniles of Pacific herring, Pacific cod, arrowtooth flounder, flathead sole, rock sole, yellowfin sole, Greenland turbot, Pacific halibut, and Alaska plaice. On the shelf area, the contribution of these other fish prey to the diet of pollock tends to be very low, (i.e., usually less than 2 percent by weight of the diet) (Livingston 1991b, Livingston and deReynier 1996, Livingston *et al.* 1993). However, in the deeper slope waters, deep-sea fish (myctophids and bathylagids) are a relatively important diet component (12 percent by weight), along with euphausiids, pollock, pandalid shrimp, and squid (Lang and Livingston 1996).

The cannibalistic nature of pollock, particularly adults feeding on juveniles, is well documented by field studies in the EBS (Bailey 1989, Dwyer *et al.* 1987, Livingston 1989b, 1991b, Livingston and deReynier 1996, Livingston and Lang 1997, Livingston *et al.* 1993). Cannibalism rates in the EBS vary depending on year, season, area, and predator size (Dwyer *et al.* 1987, Livingston 1989b, Livingston and Lang 1997). Rates are highest in autumn, next highest in summer, and lowest in spring. Cannibalism rates by pollock larger than 40 cm are higher than those by pollock smaller than 40 cm. Most pollock cannibalized are age-0 and age-1 fish, with most age-1 pollock being consumed northwest of the Pribilof Islands where most age-1 pollock are found. Pollock larger than 50 cm tend to consume most of the age-1 fish. Smaller pollock consume mostly age-0 fish. Although age-2 and age-3 pollock are sometimes cannibalized, the frequency of occurrence of these age groups in stomach contents is quite low. Laboratory studies have shown the possibility of cannibalism among age-0 pollock (Sogard and Olla 1993a). Field samples have confirmed this interaction, but so far this interaction appears not to be very important. Cannibalism by pollock in the Aleutian Islands region has not yet been documented (Yang 1996).

Field and laboratory studies on juvenile pollock have examined behavioral and physical factors that may influence vulnerability of juveniles to cannibalism (Bailey 1989, Olla *et al.* 1995, Sogard and Olla 1993a and 1993b). Although it had previously been hypothesized that cannibalism occurred only in areas with no thermal stratification, these recent studies indicate that age-0 pollock can move below the thermocline into waters inhabited by adults. All age-0 fish tend to inhabit surface waters for feeding at night, but larger age-0 fish tend to move below the thermocline during the day. Most cannibalism may occur during the day. If food availability is high, all sizes tend to stay above the thermocline, but when food resources are low, even small age-0 fish move toward the colder waters as an energy-conserving mechanism. Thus, prediction of cannibalism rates may require knowledge of the thermal gradient and food availability to juveniles in an area.

Other groundfish predators of pollock include Greenland turbot, arrowtooth flounder, Pacific cod, Pacific halibut, and flathead sole (Livingston 1991a, Livingston and deReynier 1996, Livingston *et al.* 1993). These species are some of the more abundant groundfish in the EBS, and pollock constitute a large proportion of the diet for many of them. Other less abundant species that consume pollock include Alaska skate, sablefish, Pacific sandfish, and various sculpins (Livingston 1989a, Livingston and deReynier 1996). Small amounts of juvenile pollock are even eaten by small-mouthed flounders such as yellowfin sole and rock sole (Livingston 1991a, Livingston and deReynier 1996, Livingston *et al.* 1993). Age-0 and age-1 pollock are the targets of most of these groundfish predators, with the exception of Pacific cod, Pacific halibut, and Alaska skate, which may consume pollock ranging in age from age-0 to greater than age-6, depending on predator size.

Pollock is a significant prey item of marine mammals and birds in the EBS and has been the focus of many studies. Studies suggest that pollock is a primary prey item of northern fur seals when feeding on the shelf during summer (Sinclair *et al.* 1994 and 1997). The main sizes of pollock consumed by fur seals range from 3 to 20 cm for age-0 and age-1 fish. Older age groups of pollock may appear in the diet, during years of lower abundances of young pollock (Sinclair *et al.* 1997). Pollock has been noted as a prey item for other marine mammals including northern fur seals, harbor seals, fin whales, minke whales, and humpback whales. The importance of pollock in these species' diets has not been well-defined due to the limited number of collected stomach samples from the EBS (Kajimura and Fowler 1984). Pollock are among the most common prey in the diet of spotted seals and ribbon seals which feed on pollock in the winter and spring in the areas of drifting ice (Lowry *et al.* 1997).

Pollock can be the dominant component in the diets of northern fulmars, black-legged kittiwakes, common murres, and thick-billed murres, while red-legged kittiwakes tend to rely more heavily on myctophids (Hunt *et al.* 1981a, Kajimura and Fowler 1984, Shuntov 1993, Springer *et al.* 1986). Age-0 and age-1 pollock are consumed by these bird species, and the dominance of a particular pollock age-group in the diet varies by year and season.

Aydin *et al.* (2002) have conducted a mass-balance food-web model comparing the western and eastern Bering Sea (EBS) ecosystems. These researchers have found that on a per-unit-area measure, the western Bering Sea is more productive than the EBS. Pollock is a keystone species in both ecosystems, although the pathways of energy flow differ (Figure 3.5-1).

BSAI Pollock Management

Although stock structure of Bering Sea pollock is not well defined (Wespestad 1993), the U.S. portion of Bering Sea pollock is considered to form three stocks for management purposes: the EBS stock found on the EBS shelf from Unimak Pass to the U.S.-Russia Convention line; the Aleutian Islands region stock found on the Aleutian Islands shelf region from 170°W to the U.S.-Russia Convention line; and the central Bering Sea-Bogoslof Island pollock stock, which is a mixture of pollock that migrate from the U.S. and Russian shelves to the Aleutian Basin. In the Russian EEZ, the pollock population forms two stocks, one centered in the Gulf of Olyutorski (western Bering Sea stock) and the other, northern stock located along the Navarian shelf from 171°E to the U.S.-Russian Convention line. Researchers are currently investigating Bering Sea pollock stock structure using genetic analyses (Ianelli *et al.* 2001b).

Under current management, the general impacts of fishing mortality within BSAI FMP Amendment 56/GOA FMP Amendment 56 (Amendment 56/56) ABC and overfishing level (OFL) definitions discussed in Appendix B, apply to pollock in the BSAI. Pollock in the EBS fall within Tier 1a of the ABC/OFL definitions, and the Aleutian Islands and central Bering Sea-Bogoslof Island regions fall within Tier 5. In the Aleutian Islands region, no directed pollock fishing is allowed under current management, a strategy that eliminates the risk of overfishing the stock (Ianelli *et al.* 2001b).

In the EBS, based on Tier 1a, reliable estimates of biomass ($B_{40\%}$) and fishing mortality ($F_{40\%}$) are required to determine OFL and ABC values, respectively. Under the definitions and current stock conditions, the OFL value equals 3,530,000 mt for 2003 and the ABC for EBS pollock equals of 2,330,000 mt. The TAC will be set below this ABC value (Ianelli *et al.* 2002b).

The central Bering Sea-Bogoslof region stock is managed under Tier 5, and requires that the maximum permissible ABC is 75 percent of the product of the natural mortality rate (0.30) and biomass. Therefore, the ABC value for 2003 is 34,000 mt. The OFL is the product of the natural mortality rate and biomass, equating to 45,300 mt in 2003. However, following Alaska Fisheries Science Center (AFSC) recommendations, the 2003 ABC value is reduced to 4,074 mt (Ianelli *et al.* 2002b).

The Aleutian Island region stock is also managed under Tier 5. The 2002 Aleutian Islands bottom trawl survey yielded an estimated biomass of 175,280 mt, leading to an ABC of 39,438 mt. The OFL based on the 2002 biomass estimates is 52,585 mt (Ianelli *et al.* 2002b). See Table 3.5-2 for status and catch specifications (mt) of walleye pollock in the BSAI in recent years

In the EBS, pollock are assessed with an age-structured model incorporating fishery data and two types of survey catch data and age compositions. Bottom trawl surveys are conducted annually from June through August and provide a consistent time series of adult population abundance from 1982 to 2002. Echo-integrated-trawl (EIT) surveys are run every three years (typically) and provide an abundance index on more pelagic (typically younger) stock segments. Both surveys separate their catches into their relative age compositions prior to analyses. Fishery data include estimates of the total catch by area/time strata and the average body weight-at-age and relative age composition of the catch within each stratum. The results of the statistical model applied to these data are updated annually and presented in the BSAI pollock chapter of NPFMC's BSAI Stock Assessment and Fishery Evaluation (SAFE) report. Also included are separate analyses on pollock stocks in the Aleutian Islands and central Bering Sea-Bogoslof Island areas. In the Aleutian Islands, information comes from observer data and triennial bottom trawl surveys. The bottom trawl data may not provide an accurate view of pollock distribution, because a significant portion of the pollock biomass may be pelagic and not available to bottom trawls and much of the Aleutian Islands shelf is untrawlable due to rough bottom. These analyses are constrained by data limitations and are presented relative to the status of the EBS stock. This analysis focuses specifically on the EBS stock with the view that extensions to these other areas are equally applicable. The stock assessment is reviewed by both the BSAI Groundfish Plan Team and NPFMC's Scientific and Statistical Committee (SSC) before being presented to NPFMC.

The trend in more recent modeling efforts (Honkalehto 1989, Livingston 1993, 1994a and 1994b) has been to examine cannibalism using more standard stock assessment procedures such as virtual population analysis or integrated catch-age models such as Methot's (1990) synthesis model. The purpose is to obtain better estimates of juvenile pollock abundance and mortality rates, which can improve our knowledge of factors affecting recruitment of pollock into the commercial fishery at age-3 years. Effects of variable temperatures on pollock abundance and distribution have also been taken into account by modeling efforts in recent years (Ianelli *et al.* 2002b).

Past/Present Effects Analysis

The geographic scope for the BSAI pollock past/present effects analysis is the same as the BSAI FMP management area (Figure 1.2-2). The temporal scope for this effects analysis begins in 1958 with the start of intensive foreign fishing of pollock in the Bering Sea and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-3 provides a summary of the pollock past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on pollock:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to removal of predators, cannibalism, spatial/temporal concentration of fishery catch/bycatch, roe stripping, fishery selectivity of juveniles, and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery catch/bycatch of prey species, marine pollution and oil spills, introduction of exotic species, and climate changes and regime shifts (indirect effect).

- Change in important habitat due to fishery gear impacts, marine pollutants and oil spills, introduction of exotic species, and climate changes and regime shifts (indirect effect).

Mortality caused by marine pollution and oil spills was not brought forward for analysis. The NOAA National Status and Trends (NS&T) program has produced a summary of Alaska marine environmental quality through its research and sampling projects, including the Mussel Watch Project and the Benthic Surveillance Project. This report is available on the NOAA website at: <http://ccmaserver.nos.noaa.gov/NSandT/BrochurePDFs/Alaska.pdf>. This report was produced in 1999 and will be updated periodically. The document reports that the source of major and trace elements in sediments are likely from local mineralogy rather than human contaminants. The presence of chemicals such as *para*-dichlorodephenyltrichloroethane (DDTs) and metabolites found in fish liver and mussel tissue has shown a decreasing trend over time (1986-1995), probably due to the ban on those chemicals. No obvious trend in contaminant concentrations could be determined from the mussel tissue program over the duration of the monitoring program (Cantillo *et al.* 1999). Furthermore, international, federal and state laws and enforcement agencies are in place to monitor marine pollution.

Change in important habitat and prey availability due to the introduction of exotic species by way of ballast water and climate changes and regime shifts has not been brought forward since the impacts on pollock in the Bering Sea as a result of these events have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation on the occurrences of unusual species in the BSAI.

The past/present events determined to be applicable to the pollock past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (1958-1976)
  - Russian pollock fishery (1976-present)
  - State of Alaska groundfish fisheries
  - State of Alaska herring fisheries
  - Subsistence and personal use fisheries
  - Commercial whaling
  - Seal harvests
  - Cannibalism
  - Climate changes and regime shifts
  - Marine pollution and oil spills

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1991)
  - JV groundfish fisheries (1980-1991)
  - Domestic groundfish fisheries (1988-1991)

- Past/Present Management Actions
  - Bilateral agreements
  - IWC management
  - MMPA of 1972
  - Convention of the Conservation and Management of the Pollock Resources
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions

- Steller sea lion protection measures
- Preliminary groundfish FMPs (pre-MSA)
- FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1958-1976)

The earliest documented exploratory pollock fishery ran from 1933-1937 with a Japanese fleet fishing off Bristol Bay. Foreign groundfish fishing in the EBS did not resume until 1954 after the signing of the peace treaty between the U.S. and Japan in 1952. Following the overfishing of yellowfin sole in 1958, the Japanese pollock fishery developed, making up approximately 80 percent of the total Japanese catch by 1970 (Forrester *et al.* 1974).

The Russian fishery that would later develop into the Russian pollock fishery started in the EBS in 1967 along the outer continental shelf from Unimak Pass to northwest of the Pribilof Islands. This fishery focused on pollock by 1971 and has remained predominantly the same to the present. Russia has also trawled for pollock along the Aleutian Islands in recent years, although the effort has been relatively low (Chitwood 1969, Forrester *et al.* 1974, Office of Enforcement and Surveillance 1965, 1967-1970, and Law Enforcement Division 1974, 1975, and 1977).

A fleet from the Republic of Korea targeting pollock around the eastern Aleutian Islands, west of the Pribilof Islands, and the EBS began exploratory fishing in 1968, reaching its peak in 1976. A small Taiwanese fishery focusing on pollock and flounder and consisting of one or two independent stern trawlers began in 1974 along the continental shelf edge west and southwest of the Pribilof Islands (Office of Enforcement and Surveillance 1967-1970, Law Enforcement and Surveillance Division 1971, 1973, 1974, 1975, and 1977).

By 1972, foreign catch of pollock in the EBS had peaked at over 1.8 million mt. In 1973, a bilateral agreement between the U.S. and Japan and the then U.S.S.R. (Soviet Union) included annual catch quotas, which reduced the catch of pollock to 1.2 million by 1976. However, each country was still responsible for monitoring its catch quotas, the only internationally acceptable arrangement at the time. With the passing of the MSA and the increase of U.S. and JV groundfish fisheries, foreign groundfish catch in the Bering Sea had dropped below 1 million mt by 1985 (NPFMC 2002a).

Although large removals of pollock occurred during the foreign fisheries, there does not appear to be a lingering effect on the BSAI pollock populations.

External Russian Pollock Fishery (1967-present)

Harvests by Russian fishing vessels and Russia-licensed vessels from third countries of pollock originating from the EBS pollock stock are considered insufficient in magnitude to push the fishing effort close to the overfishing level threshold. Evidence that this may be occurring stems from the research showing that the pollock of the EBS range westward beyond the U.S. EEZ into waters under the jurisdiction of the Russian Federation and mix with Russian pollock stocks before returning to U.S. waters (Wespestad *et al.* 1996). Moreover, a Russian and a Russia-licensed fishery occurs on the U.S.-Russian Convention Line of 1867 targeting pollock stocks that straddle the boundary line (Pautzke 1997).

Internal Foreign, JV and Domestic Groundfish Fisheries (1976-present)

The U.S. began fishing for pollock in 1980 in the EBS in conjunction with foreign fisheries called JV groundfish fisheries. The U.S. fisheries worked with over 28 different countries, including Japan, South Korea, Poland, the Soviet Union, Portugal, and Iceland. The catch history of pollock in the EBS and Aleutian Islands from 1979-2002 is detailed in Ianelli *et al.* 2002b.

BSAI FMP Amendments 1, 2, 4, 6, and 11 were proposed partially in response to concerns that the domestic annual harvest (DAH) was being dominated by the foreign and JV groundfish fisheries. Since 1977, the pollock fishery in the BSAI evolved from an entirely foreign-harvested fishery to a predominantly domestic-harvested fishery. Yet the volume of fish delivered to foreign groundfish processors continued to largely exceed the amount delivered to domestic groundfish shore-based processors. In 1986, nearly 95 percent of the total 886,000 mt DAH was taken in JV groundfish operations.

Instead of relegating JV groundfish operations to specific areas and prohibiting roe-stripping, BSAI FMP Amendment 11 adopted a split-season proposal to reduce the amount of pollock harvested by the JV groundfish fisheries during the spawning season. This action was designed to prevent the further development of a pollock roe fishery, as well as allow for the expansion of the domestic groundfish processing fishery. Although there have been large removals of pollock by the JV and past domestic fisheries, there does not appear to be a lingering effect on the BSAI pollock populations.

By 1991, foreign groundfish fishing had been phased out of the EEZ and in that year the entire BSAI groundfish harvest (2,126,000 mt) was taken by 391 U.S. vessels. NPFMC has since prohibited the practice of roe-stripping of pollock. With the advent of the U.S. EEZ, DAH levels have ranged between 0.9 million to 1.5 million mt annually, with an average harvest of 1.2 million mt annually (Ianelli *et al.* 2001b).

Change in Reproductive Success

External Foreign Groundfish Fisheries (1958-1976)

Bycatch in the foreign groundfish fisheries has not been well documented; however, it is assumed that bycatch of pollock consisted mainly of juveniles. Few observers were allowed on Soviet vessels under the bilateral agreements, and the Soviets were well-known for under-reporting their catches of target species and, presumably, bycatch as well.

The fisheries could potentially have had a positive effect on the pollock recruitment by reducing the adult pollock biomass. Since mature pollock are known to cannibalize on juvenile pollock, a reduction of mature pollock biomass could actually increase juvenile recruitment.

Internal Foreign Groundfish Fisheries (1976-1991)

Foreign groundfish vessels began fishing the "Donut Hole," the international fishing zone of the Bering Sea, in the mid-1980s. Foreign groundfish vessels from Japan, South Korea, Poland, and China moved into the Donut Hole to fish pollock because they were displaced from U.S. waters by the growth of U.S. domestic groundfish fisheries. Pollock catch increased rapidly, peaking in 1989 at 1.45 million mt, and then declined more rapidly. A moratorium on fishing since 1993 has been observed by all countries including the U.S. and

Russia. The Convention on the Conservation and Management of the Pollock Resources in the central Bering Sea, which outlines the fishing moratorium and establishes an approach for future fishing operations if the stock is to become sustainable, was signed on June 16, 1994, by representatives of the People's Republic of China, and the Republic of Korea, and the Russian Federation (Colson 1994 as referenced by Pautzke 1997). The past foreign fisheries are considered to have overfished the Donut Hole and Bogoslof region pollock populations. Furthermore, these fisheries have changed the spatial/temporal distribution of those pollock populations through the spatial/temporal concentration of the fisheries.

In 1992, NPFMC passed BSAI FMP Amendment 17, establishing the Bogoslof District which was intended to protect the Aleutian Basin pollock stock associated with the Donut Hole. This amendment allowed for a separate TAC for pollock in this subarea, thereby providing regulatory protection of Aleutian Basin pollock during spawning to help rebuild the stock.

The fisheries could potentially have had a positive effect on the pollock recruitment by reducing the adult pollock biomass. Since mature pollock are known to cannibalize on juvenile pollock, a reduction of mature pollock biomass could actually increase juvenile recruitment.

External Russian Pollock Fishery (1967-present)

Scientists and managers are presently concerned that strong to moderate year-classes may reside in the Russian EEZ adjacent to the U.S. EEZ as juveniles. It has been acknowledged that potential large catches and discards of juvenile pollock may be occurring in the Russian EEZ and may effect the EBS stocks that migrate to that area, possibly requiring the reduction of U.S. TACs (Wespestad *et al.* 1996).

Internal Foreign, JV and Domestic Groundfish Fisheries (1976-present)

Fishery Selectivity

BSAI pollock are caught as bycatch in other directed fisheries (e.g., mostly trawl Pacific cod, rock sole and yellowfin sole fisheries). However, because they occur primarily in well-defined aggregations, the impact of this bycatch is typically minimal. The directed pollock fishery has a very low bycatch rate with discards of 10 percent or less since 1992. Most of the discards in the pollock fishery are juvenile pollock, or pollock too large to fit filleting machines. In the pelagic trawl fishery, the catch is almost exclusively pollock, but in the past bottom trawl pollock fishery the bycatch of other species has been higher. Bycatch in the directed fisheries has decreased in recent years due to regulatory amendments and self-imposed actions taken by the fishing industry (Ianelli *et al.* 2002b).

The EBS pollock fishery primarily harvests mature pollock. The 50 percent selectivity corresponds to the age of 50 percent maturity, age-4 years. Fishery selectivity increases to a maximum around age 7 to 8 and then declines. The reduced selectivity for older ages is due to pollock becoming increasingly demersal with age. Younger pollock form large schools and are semi-demersal, thereby being easier to locate by fishing vessels. Immature fish (ages-2 and -3) are usually caught in low numbers. Generally the catch of immature pollock increases when strong year-classes occur and the abundance of juveniles increases sharply. This occurred with the 1989 year-class, the second largest year-class on record. Juvenile bycatch increased sharply in 1991 and 1992 when this year-class was age-2 and -3 (Ianelli *et al.* 2001b).

BSAI FMP Amendment 13 established the Observer Program in the BSAI partially in an effort to reduce bycatch on non-target species. BSAI FMP Amendments 9, 11a, and others established reporting requirements to better track the catch and bycatch of target and non-target species in the BSAI.

BSAI FMP Amendment 49, passed in 1998, requires fishermen to land all pollock harvested, including juveniles and other unmarketable fractions. Because there is little value in small fish, it is hoped that fishermen will avoid areas where juveniles are caught in large concentrations, thus avoiding the economic costs of landing an unmarketable part of the resource. The overall intent of the program is to reduce bycatch and discarding of juveniles, and thus help the stocks remain robust. This measure has dramatically reduced overall discards of groundfish.

In both the BSAI and GOA, cumulative impacts of fishing mortality on age composition are influenced by the selectivity of the fishery. The current age composition of the stocks reflects a fished population with a long catch history. In any given year, the age composition of the stock is influenced by previous year-class strength. The reproductive potential of the stock in a given year depends on the biomass of spawners, as modified by abiotic and biotic conditions. Thus, the average age of unfished populations is likely to have varied interannually due to oceanic and climate conditions. The NOAA Fisheries' Fisheries Oceanography Coordinated Investigations (FOCI) (discussed below in GOA) and Coastal Ocean Program's southeast Bering Sea Carrying Capacity (SEBSCC) regional study focus research on improving understanding of mechanisms underlying annual production of pollock stocks in the GOA and EBS. NOAA's long-term goal is to improve the ability to assess quantitatively the long-term impact of commercial removals of adult pollock on future recruitment by combining the findings of process-oriented research programs such as FOCI and SEBSCC with NOAA Fisheries' ongoing studies of species interactions, fish distributions, and abundance trends. This Programmatic SEIS does not seek to evaluate the range of mean ages that could have occurred in the absence of fishing.

The fishery effects on age-at-maturity and fecundity of pollock stocks are a potential concern; investigations regarding this issue began with a new study in 2002 (Ianelli *et al.* 2002b).

Roe Fishery

BSAI Amendment 14 was passed in 1991 to address the pollock roe fishery and the following issues:

1. Roe stripping is a wasteful use of the pollock resource;

2. Roe stripping causes unintended allocation of pollock TAC among seasons and industry sectors;

3. Roe stripping may adversely affect the ecosystem;

4. Roe stripping may adversely affect the future productivity of the stock; and,

5. Roe stripping increases the difficulty of accurately monitoring the pollock TAC for inseason management.

In 1993, regulations were further tightened to close loopholes that could have potential undermined the intent of the roe stripping regulations (58 FR 57752).

The fisheries could potentially have a positive effect on the pollock recruitment by reducing the adult pollock biomass. Since mature pollock are known to cannibalize on juvenile pollock, a reduction of mature pollock biomass could actually increase juvenile recruitment.

Spatial/Temporal Concentration of Catch

The directed fishery for the BSAI pollock is conducted by catcher processors and catcher vessels using pelagic trawl gear, although bottom trawl gear was used prior to 1996. The season has traditionally been broken into two parts; a roe season during early winter, and a surimi (imitation crab) and filet season during the second half of the year. The pollock "A season" fishery, which historically focused on roe-bearing females, is concentrated mainly north and west of Unimak Island (Ianelli *et al.* 1998) and along the 100 m contour between Unimak and the Pribilof Islands. Following the closures of the Donut Hole and Bogoslof District in 1993, the fishing effort was further shifted eastward toward the southeast fishing grounds (Area 51). The 1999-2002 fishing seasons have seen a more equal take of males and females, with only slightly more females taken in this fishery in recent years. The pollock "B season" takes place west of 170°W (northwest fishing grounds, Area 52). Catches in this area have declined since 1990, although there has been a slight increase in recent years (2000-2001). Furthermore, there has been a decline in catch within the Steller sea lion conservation areas, except for the 2002 fishing season (Ianelli *et al.* 2002b).

The past JV and past domestic fisheries have overfished the Donut Hole and Bogoslof region pollock populations. Furthermore, these fisheries are found to have changed the spatial/temporal distribution of those populations through the spatial/temporal concentration of the fisheries.

Management of the pollock fishery has changed recently as NOAA Fisheries and NPFMC have taken measures to reduce the possibility of competitive interactions with Steller sea lions. In 1999, this led to further closures of critical habitat to pollock fisheries in the Aleutian Islands region, the EBS, and the GOA. A total of 210,350 km^2 (54 percent) of critical habitat was closed to the pollock fishery. Following 1998, catches of pollock and the proportion of seasonal TAC caught in the Steller Sea Lion Conservation Area and Steller sea lion critical habitat have been reduced. In the Aleutian Island region, directed fishery removals of pollock have been prohibited. Management has also attempted to disperse the fisheries temporally and spatially by means of seasonal TAC releases to further reduce fishery related impacts on the sea lion population of the EBS shelf (Ianelli *et al.* 2001b).

<u>External Commercial Whaling and Seal Harvests</u>

Whaling is identified as having a past beneficial effect on the recruitment of BSAI pollock stocks. Pollock has been noted as a prey item for fin whales, minke whales, and humpback whales (see Sections 3.8.12, 3.8.14, and 3.8.15). By removing the large predators, pollock recruitment is favored. In the EBS, past seal harvests are identified common prey in the diet of spotted seals and ribbon seals, which feed on pollock in the winter and spring in the areas of drifting ice (Lowry *et al.* 1997, see Section 3.8.5 and 3.8.8). The whale and seal harvests are no longer of concern with the banning of commercial whaling by the IWC and protection of marine mammals through the MMPA passed in 1972 (see Section 3.8). The continued harvest of marine mammals by subsistence users is unlikely to have a significant impact on the BSAI pollock population.

External Cannibalism

Adult pollock are known to cannibalize on juvenile pollock, especially on age-0 and age-1 pollock, the age classes in which cannibalism appears to be the most important source of predation mortality. Predation mortality rates for juvenile pollock are not constant, as assumed in most population assessment models, but vary across time mainly due to changes in predator abundance, but perhaps also because predators feed more heavily on more abundant year-classes. The decline in pollock recruitment observed at high pollock spawning biomasses appears to be due to cannibalism. There also appears to be an environmental component to juvenile pollock survival (Wespestad and Dawson 1992), wherein surface currents during the first three months of life may transport larvae to areas more favorable to survival (e.g., away from adult predators or in areas more favorable for feeding). Estimates of total amount of pollock consumed by important groundfish predators show that cannibalism is the largest source of removal of juvenile pollock by groundfish predation (Livingston 1991a, Livingston and deReynier 1996, Livingston *et al.* 1993).

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of pollock. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of the species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an in-depth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions, because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries.

Change in Prey Availability

External Foreign Groundfish Fisheries (1958 - 1976) and Internal Foreign, JV, and Domestic Groundfish Fisheries (1976 - present)

The fisheries bycatch of forage species consumed by pollock is unlikely to have a population-level effect. BSAI FMP Amendment 13 established the Observer Program in the BSAI partially in an effort to reduce bycatch on non-target species. BSAI FMP Amendments 9, 11a, and others established reporting requirements to better track the catch and bycatch of target and non-target species in the BSAI, and Amendment 36 was established to protect forage species from being marketed, thereby protecting the availability of pollock prey species.

External State of Alaska Groundfish Fisheries and Herring Fisheries

Bycatch of forage species in the BSAI State of Alaska groundfish fisheries is minimal and is unlikely to have population-level effects on the BSAI pollock stocks. Since pollock prey on a number of different species in addition to herring, it is unlikely that State of Alaska herring fisheries would have a significantly adverse impact on pollock prey availability.

External Subsistence and Personal Use Fisheries

Subsistence and personal use fishermen are known to fish a number of different species, including Pacific herring, Pacific cod, Pacific halibut, and many other target species. However, due to the small extent and localization of these users, it is unlikely that these fisheries would have a significantly adverse impact on pollock prey availability.

External Climate Change and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the prey availability of pollock. In general, a shift toward warmer waters favors recruitment and survival of pollock. In 1998/1999, the Pacific Decadal Oscillation shifted to negative, with cooler-than-average northeastern Pacific surface temperatures and warmer-than-average central Pacific surface temperatures. The Ocean Surface Current Simulations (OSCURS) model has also shown stronger on-shelf drift in the EBS from April-June in 1998, 1999, and 2002 (Ianelli *et al.* 2002b); indicating favorable conditions for pollock.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect they have on the important prey species of pollock.

Change in Important Habitat

External Foreign and JV Groundfish Fisheries (1958 - 1991)

Bottom trawl gear is the focus of most of the concerns regarding spawning habitat disruption in the NPO. Beginning in about 1960, the Bering Sea experienced rapid and intensive development of commercial bottom trawl fisheries. Between 1973 and 1997, a total of 412,040 records of observed bottom trawls were obtained from the NOAA Fisheries Observer Database (NORPAC). Note that the number of recorded observed bottom trawls is only a small portion of the total number of bottom trawls during that time period. Because gear information is not available, bottom trawls by the JV groundfish (1980–1990; 101,376 trawls) and foreign groundfish (1973–1989; 127,959 trawls) fleets were selected based on the presence of benthic organisms (e.g., crab, snails, and seastars) in the catch (see Section 3.6 for more information).

Due to intensive bottom trawling by the foreign groundfish and JV groundfish fisheries, a bottom trawling ban was initiated in pollock spawning habitats by the 1977 BSAI Preliminary FMP. Several of the foreign groundfish fisheries also imposed restrictions on themselves to reduce potential adverse effects on pollock spawning habitats.

External Climate Change and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the habitat suitability of pollock. In general, a shift toward warmer waters favors recruitment and survival of pollock. In 1998/1999, the Pacific Decadal Oscillation shifted to negative, with cooler-than-average northeastern Pacific surface temperature and warmer-than-average central Pacific surface temperatures. The OSCURS model has also shown stronger on-shelf drift in the EBS from April-June in 1998, 1999, and 2002 (Ianelli *et al.* 2002b); indicating favorable conditions for pollock.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of pollock.

Internal Domestic Groundfish Fisheries (1976 - present)

Bottom trawls by the domestic groundfish trawl fleet from 1986 to 1997 resulted in 182,705 records of observed bottom trawls obtained from the NORPAC. Note that the actual total number of unrecorded bottom trawls is much larger.

To minimize the potential interaction with other groundfish species and to reduce the magnitude of bottom disturbance, the domestic pollock fishery converted to mainly pelagic gear by 1996. Several industry-imposed restrictions also reduced bottom disturbance through modification of fishing gear. The BSAI FMP Amendment 57 went into effect in the 1999 and 2000 seasons, prohibiting the pollock fishery from using non-pelagic gear. Pelagic trawl gear, when used in mid-water, has no known direct effects on the substrate. Pelagic trawl gear can also be fished on the bottom, and sometimes is; however, the pelagic trawls used off Alaska are generally designed to fish downward from the depth of the doors, which are not designed for contact with the seafloor, although the footropes can come in contact with, and affect the bottom (see Section 3.6).

The 1991–1995 period saw broad implementation of closures to further protect Steller sea lions. For example, NOAA Fisheries closed areas year-round to trawling within 10 nm of 37 Steller sea lion rookeries, and to within 20 nm during the pollock A season (January 20 to April 15) around five rookeries in the BSAI. There were comparable closures in the GOA. These trawl closures indirectly protect pollock habitat, as well as protecting Steller sea lion habitat (Ianelli *et al.* 2001b).

BSAI FMP Amendments 55 and 65 were proposed in order to identify EFH, minimize practicable adverse effects on habitat from the fishery, and encourage conservation of Habitats of Particular Concern (HAPC) for all target species.

BSAI Pollock Comparative Baseline

The EBS bottom trawl surveys show an increasing trend in pollock abundance during the 1980s, due to strong 1978, 1982, and 1984 year-class recruitment. The population remained at a high and stable level from 1991 to 1995. As these strong year-classes were replaced by weaker year-classes, a sharp decrease in population resulted (1996), followed by an increase to the present. Most recently, there appears to be a higher-than-average year-class for 1995 and 1996; prior to that, the 1992 year-class was very high. The abundance of these year-classes is evident from the EIT and bottom trawl surveys, in addition to the extensive fishery age composition data that have been collected. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality. The fishery has tended to exhibit variable selectivity over time, but generally targets fish age-5 years and older (Ianelli *et al.* 2001b). The estimated 2002 age composition of EBS pollock from the stock assessment model is shown in Figure 3.5-2.

The statistical catch-age model exhibits a high level of exploitable biomass (age-3+) from 1982 to 1988, with a peak occurring in 1985, followed by a decline until 1991. Since then, exploitable biomass has varied around 10 million mt (Ianelli *et al.* 2002b).

The EBS pollock stock is neither overfished, nor approaching an overfished condition. The stock assessment model indicates that the 2003 age-3+ biomass is 11,100,000 mt, higher than the previous year's assessment. The 2002 bottom trawl and EIT surveys both show an increase in pollock biomass from the 2001 estimates, with 16 and 18 percent increases, respectively (Ianelli *et al.* 2002b).

Since the Aleutian Island and central Bering Sea-Bogoslof Island regions are managed under Tier 5, it is not possible to determine whether those stocks are overfished or approaching an overfished condition. However, the 2002 bottom trawl survey estimates indicate a 65 percent increase in biomass compared to the 2000 survey in the Aleutian Island region. Note that the increase in the 2002 survey biomass may be also be attributed to survey techniques and timing. The 2002 hydroacoustic survey of the Bogoslof Island region reported a biomass estimate of 227,000 mt (Ianelli *et al.* 2002b).

BSAI Pollock Cumulative Effects Analysis Status

The BSAI pollock will be brought forward for cumulative effects analysis.

3.5.1.2 BSAI Pacific Cod

Life History and Distribution

Pacific cod (*Gadus macrocephalus*) is a demersal species that occurs on the continental shelf and upper slope from Santa Monica Bay, California through the GOA, Aleutian Islands, and EBS to Norton Sound (Bakkala 1984). The Bering Sea represents the center of greatest abundance, although Pacific cod are also abundant in the GOA and Aleutian Islands. GOA, EBS, and Aleutian Island cod stocks are genetically indistinguishable (Grant *et al.* 1987), and tagging studies show that cod migrate seasonally over large areas (Shimada and Kimura 1994).

In the late winter, Pacific cod converge in large spawning masses over relatively small areas. Major aggregations occur between Unalaska and Unimak Islands, southwest of the Pribilof Islands, and near the Shumagin group in the western GOA (Shimada and Kimura 1994). Spawning takes place in the sublittoral–bathyal zone near the bottom, the area of the continental shelf and slope about 40 to 290 m deep. The eggs sink to the bottom and are somewhat adhesive (Hirschberger and Smith 1983). Table 3.5-4 summarizes the biological and reproductive traits and habitat associations of Pacific cod at its different life stages.

Pacific cod reach a maximum recorded age of 19 years. In the BSAI, 50 percent of Pacific cod is estimated to reach maturity by the time they reach 67 cm in length, or an age of about 5 years (Thompson and Dorn 1999). The same length in the GOA stock corresponds to an age of about 7 years (Thompson *et al.* 1999).

Trophic Interactions

Pacific cod is an opportunistic feeder that feeds both in the water column and in benthic areas (Yang and Nelson 2000). In the BSAI and GOA, in terms of percent occurrence in stomach contents, the most important items were polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important items were euphausiids, miscellaneous fish, and amphipods. In terms of weight of organisms consumed, the most important items were pollock, fishery offal, and yellowfin sole. Small Pacific cod were found to feed mostly on invertebrates, while large Pacific cod are mainly piscivorus (Livingston 1991b). In studies conducted on GOA Pacific cod, polychaetes and cephalopods were the most frequently found invertebrates in stomach contents. However, pandalid shrimp were more important in terms of percentage of total stomach contents weight. GOA Pacific cod also consumed large amounts of tanner crabs (Yang and Nelson 2000). Predators of Pacific cod include Pacific halibut, salmon shark, northern fur seals, Steller sea lions, harbor porpoises, various whale species, and tufted puffins (Westrheim 1996).

Pacific Cod Management

Pacific cod in the BSAI is currently managed under Tier 3a of NPFMC's ABC and OFL definitions (Appendix B). Management under Tier 3a requires reliable estimates of projected biomass, $B_{40\%}$, $F_{40\%}$ (for ABC), and $F_{35\%}$ (for OFL). Under Tier 3a, the maximum permissible ABC depends on the relationship of projected female spawning biomass to $B_{40\%}$. The 2002 assessment projected a 2003 female spawning biomass of 423,000 mt, essentially unchanged from the 2001 assessment's projection for 2002 corresponding to a maximum permissible 2003 ABC of 278,000 mt. NPFMC adopted a 2003 ABC of 223,000 mt, identical to the 2002 ABC and about 20 percent below the maximum permissible value. The 2003 OFL for the BSAI stock is 324,000 mt, up 10 percent from the 2002 OFL (Thompson and Dorn 2002) (Table 3.5-2).

Beginning with the 1993 BSAI SAFE report (Thompson and Methot 1993), a length-structured synthesis model (Methot 1990) has formed the primary analytical tool used to assess Pacific cod. No formal assessment model exists for the Aleutian Islands portion of the BSAI stock. Instead, results from the EBS assessment are inflated proportionally to account for the Aleutian Islands region fish.

Annual trawl surveys in the EBS and triennial (recently, biennial) trawl surveys in the Aleutian Islands are the primary fishery-independent sources of data for Pacific cod stock assessments (Thompson and Dorn 2002, Thompson *et al.* 2002). Other available data include catch size compositions and biomass by gear, for the years 1978 through the early part of 2002. Within each year, catches are divided according to three time periods: January-May, June-August, and September-December. This particular division, which was suggested by participants in the EBS fishery, is intended to reflect actual intra-annual differences in fleet operation (e.g., fishing operations during the spawning period may be different than at other times of year). Four fishery size composition components were included in the likelihood functions used to estimate model parameters: the January-May (early) trawl fishery, June-December (late) trawl fishery, the longline fishery, and the pot fishery. In order to account for differences in selectivity between mostly foreign, mostly domestic, and very recent fisheries, the fisheries data were split into pre-1989, 1989-1999, and post-1999 eras in the EBS. In addition to the fishery size composition components, likelihood components for the size composition and biomass trend from the bottom trawl surveys were included in the model. All components were weighted equally.

Quantities estimated in the most recent stock assessments include parameters governing the selectivity schedules for each fishery and survey in each portion of the time series, parameters governing the length-at-age relationship, population numbers at age for the initial year in the time series, and recruitments in each year of the time series. Given these quantities, plus parameters governing natural mortality, survey catchability, the maturity schedule, the weight-at-length relationship, and the amount of spread surrounding the length-at-age relationship, the stock assessments reconstruct the time series of numbers at age and the population biomass trends (measured in terms of both total and spawning biomass).

The model around which the Pacific cod assessments are structured uses an assumed survey catchability of 1.0 and an assumed natural mortality rate of 0.37 (see Appendix B). Several previous assessments included statistical analyses of the uncertainty surrounding the true values of the survey catchability and natural mortality rate. These analyses of uncertainty led to a risk-averse adjustment factor of 0.87 which is multiplied by the maximum permissible F_{ABC} to obtain the recommended F_{ABC}. Other outputs of the assessments include projections of biomass and harvest under a variety of reference fishing mortality rates.

BSAI Pacific Cod Past/Present Effects Analysis

The geographic scope for the BSAI Pacific cod past/present effects analysis is the same as the BSAI FMP management areas (Figure 1.2-2). The temporal scope for this analysis begins in 1864 when the BSAI domestic fishery begins and ends in 2002, the most recent year for which a stock assessment is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-5 provides a summary of the BSAI Pacific cod past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on BSAI Pacific cod:

- Mortality due to catch/bycatch and marine pollutants and oil spills (direct effect).

- Change in reproductive success due to fishery selectivity of juveniles, spatial/temporal concentration of catch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery catch/bycatch of prey species, introduction of exotic species, marine pollution and oil spills, and climate changes and regime shifts (indirect effect).

- Change in important habitat due to impacts of fishery gear, marine pollutants and oil spills, introduction of exotic species and climate changes and regime shifts (indirect effect).

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species by way of ballast water and climate changes and regime shifts has not been brought forward since the impacts on Pacific cod in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the Pacific cod past effects analysis include the following:

- Past/Present External Events
  - Subsistence and personal use
  - Foreign groundfish fisheries (1964-1976)
  - State of Alaska crab bait fishery
  - IPHC longline bait fishery
  - Marine pollution and oils spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1988-1991)
  - Domestic groundfish fisheries (1864-1950; 1981 - present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following section explains any amendments specific to the Pacific cod fishery. Amendments discussed in Section 3.2 which impact the target fisheries as a whole are not repeated here.

Mortality

External Subsistence and Personal Use

The earliest fisheries for groundfish in the EBS and Aleutian Islands were the Native subsistence fisheries. They are an important part of the life of Native people, and dependence on demersal species of fish may have been critical to their survival in periods of the year when other sources of food were scarce or lacking. Fishing often takes place in near-shore waters utilizing such species as Pacific cod, Pacific halibut, rockfish, and other species. These small-scale subsistence fisheries have continued through to the present time, although there is likely no impact on Pacific cod at a population-level (NPFMC 2002a).

External Foreign Groundfish Fisheries (1964-1976)

During the early 1960s, a Japanese longline fishery harvested BSAI Pacific cod for the frozen fish market. Beginning in 1964, the Japanese trawl fishery for pollock expanded and Pacific cod became an important bycatch and an occasional target species when concentrations were detected during pollock operations (NPFMC 2002a).

The Soviet groundfish fishery that would later develop into the Soviet pollock fishery targeted Pacific cod, rockfish, pollock and various flatfish species north of Dutch Harbor beginning in 1968. In 1969, the fishery became a year-round operation peaking in late winter when fishing vessels from the herring and flounder fishery joined the fleet. The emphasis of the fishery shifted mainly to pollock in 1971 (NPFMC 2002a).

Catches of Pacific cod in the EBS increased steadily in the earlier years of the fishery to reach levels of more than 50,000 mt by 1968. Annual catches remained relatively stable for several years thereafter, ranging around 50,000 mt with the largest catch of 70,000 mt taken in 1970. Catches in the Aleutian Island region were not recorded until the late 1960s, followed by a slight increase, probably due to better identification of Pacific cod in bycatch, although catch remained relatively low throughout the foreign engagement there (NPFMC 2002a).

The foreign fisheries contributed to fishing mortality in the BSAI. However, the foreign fisheries are thought to have had no observable effect on the BSAI Pacific cod populations.

<u>External State of Alaska Crab Bait Fisheries and IPHC Longline Bait Fisheries</u>

The State of Alaska crab bait fisheries and the IPHC longline bait fisheries contributed to fishing mortality in the BSAI through removal of Pacific cod as bycatch and removal to be used in the fisheries as bait. The influence of these removals is noted as adverse.

<u>Internal JV and Domestic Groundfish Fisheries (1864-present)</u>

The first commercial venture for bottomfish occurred in 1864 when a single schooner fished for Pacific cod in the Bering Sea (Cobb 1927). The cod fishery did not commence on a regular annual basis until 1882. This domestic groundfish fishery continued until 1950 when demand for cod declined and economic conditions caused the fishery to be discontinued (Alverson *et al.* 1964). Fishing areas in the EBS were from north of Unimak Island and the Alaska Peninsula to Bristol Bay (Cobb 1927). Vessels operated from home ports in Washington and California and from shore stations in the eastern Aleutian Islands. Canadian vessels also participated in the cod fishery to a limited extent.

The early domestic cod fishery reached its peak during World War I when the demand for cod was high. Numbers of schooners operating in the fishery ranged from 1-16 prior to 1915 and increased to 13-24 in the period from 1915 to 1920. Estimated catches during the peak of the fishery ranged annually from 12,000-14,000 mt (Pereyra *et al.* 1976). Numbers of vessels in the fishery declined following 1920 until the fishery was terminated in 1950. From 1930-1958, annual catch was less than 200 mt, then rose sharply to about 4,900 mt in 1963, and back down to 450 mt in 1977. The decline in catch since 1963 resulted from reduced abundance and restrictions on the fishery. In years of high production, the catch was split about evenly between Canadian and U.S. vessels up until 1972, after which the U.S. share was larger. There was no catch reported in the Aleutian area before 1960 (NPFMC 2002a). The catch history of Pacific cod in the EBS and Aleutian Islands regions is detailed in Thompson and Dorn 2002.

By 1981, a U.S. domestic groundfish trawl fishery and several JV groundfish fisheries had again begun operations in the BSAI. The foreign and JV sectors dominated catches through 1988, but by 1989 the domestic groundfish sector was dominant. The foreign and JV sectors had been displaced entirely by 1991.

Presently, the Pacific cod stock is exploited by a multiple-gear fishery, including trawl, longline, pot, and jig components (Thompson and Dorn 2001).

Allocation of the BSAI Pacific cod TAC among gear types began in 1993. Amendment 24 to the BSAI FMP established an explicit allocation of the Pacific cod TAC between gear types. The percentage allocations for the 1994, 1995, and 1996 fishing seasons were: trawl gear 54 percent, fixed gear 44 percent, and jig gear 2 percent. At that time, NPFMC was in the initial stages of developing its Comprehensive Rationalization Plan, which emphasized the allocation as a stabilizing mechanism and bridge to overall comprehensive rationalization (NPFMC 2002a).

Because FMP Amendment 24 Pacific cod allocations were scheduled to expire at the end of 1996, NPFMC placed discussion of this issue on the December 1995 meeting agenda, with the intent that an amendment be prepared to allow an allocation beyond 1996. At the December 1995 meeting, NPFMC identified changes which had taken place in the Pacific cod fishery since Amendment 24 went into effect on January 1, 1994. These changes were viewed as biological, economic, and regulatory in nature. Problems identified by NPFMC included compressed fishing seasons, periods of high bycatch, waste of resource, and new entrants competing for the resource due to crossovers allowed under NPFMC's Moratorium Program. NPFMC identified the need for management measures to ensure that the cod TAC was harvested in a manner which reduced discards in the target fisheries, reduced PSC mortality, reduced non-target bycatch of cod and other groundfish species, took into account the social and economic aspects of variable allocations, and addressed impacts of the fishery on habitat. In addition, the amendment would continue to promote stability in the fishery as NPFMC continues on the path towards comprehensive rationalization (NPFMC 2002a).

Beginning in 1997, Amendment 46 to the BSAI groundfish FMP allocated the TAC for BSAI Pacific cod among jig gear, trawl gear, and fixed gear (hook-and-line and pot). It reserved two percent of the TAC for jig gear, 51 percent for fixed gear, and 47 percent for trawl gear. The amendment also split the trawl apportionment between catcher vessels and catcher processors 50/50, but it did not split the fixed gear allocation between hook-and-line and pot vessels.

In October 1999, NPFMC approved BSAI FMP Amendment 64, which split the fixed gear allocation of Pacific cod between the hook-and-line catcher processors, hook-and-line catcher vessels, and pot sectors in the BSAI. NPFMC allocated 80 percent of the fixed gear share of the Pacific cod TAC to hook-and-line catcher processors, 0.3 percent to hook-and-line catcher vessels, 1.4 percent to pot and hook-and-line catcher vessels less than 60-foot length overall, and 18.3 percent to pot vessels. The amendment was approved by the Secretary of Commerce in July 2000, and implemented by final rule on August 24, 2000 (65 FR 51553) (NPFMC 2002a).

Amendment 64 became effective on September 1, 2000. At the time NPFMC approved Amendment 64, it acknowledged that a further split among the pot sector may be necessary to ensure the historical harvest distribution among pot catcher processors and pot catcher vessels in the BSAI Pacific cod fishery. Concern was expressed that the pot sector needed the stability of a direct gear allocation, as had been implemented for the hook-and-line catcher processors and catcher vessels under Amendment 64. However, because the public had not been given notice that this action might be taken under Amendment 64, NPFMC decided to delay action specific to the pot sector and include the proposal in a follow-up amendment (BSAI FMP Amendment 68) (NPFMC 2002a).

Further changes to the BSAI cod fishery occurred in April 2000 when NPFMC approved BSAI FMP Amendment 67. Amendment 67 requires that vessels fishing with hook-and-line and pot gear that are participating in the BSAI Pacific cod fishery must qualify for a Pacific cod endorsement, which would be part of the participant's license under the LLP. Eligibility for a cod endorsement is based on past participation in the BSAI fixed gear fisheries during specific combinations of the years 1995-1999. Amendment 67 effectively granted exclusive access to longtime participants in the BSAI fixed gear cod fishery, and thus reduced the number of allowable participants, including the number of eligible pot vessels. This amendment was approved by the Secretary on November 14, 2001, and the implementing regulations were in place for the 2003 fishing season (NPFMC 2002a).

An analysis of Amendment 68 (further allocation of Pacific cod among pot gear sectors) was initially reviewed by NPFMC in February 2001 and then was made available for public review with recommended revisions by NPFMC. However, because of the potential implications of Amendment 67 and the uncertainty of implications related to management measures being developed to protect the Steller sea lion, NPFMC decided to delay final action on Amendment 68 pending resolution of these issues. With both Secretarial approval of Amendment 67 and completion of the Steller Sea Lion Protection Measures Final SEIS in November 2001, NPFMC scheduled final action for Amendment 68 in June 2002. A draft EA/Regulatory Impact Review (RIR)/Initial Regulatory Flexibility Analysis (IRFA) was released for public review on May 14, 2002 (NPFMC 2002a). However, at its June 2002 meeting, NPFMC voted to take no action on BSAI FMP Amendment 68 partly due to the potential implications of the Pacific cod endorsement required under BSAI Amendment 67 and partly because BSAI Amendment 64 was scheduled to expire after the 2003 fishery anyway, meaning that continuation or modification of Pacific cod allocations among the hook-and-line and pot gear sectors in the BSAI would require a new amendment.

Past JV and pre- and post- MSA domestic fisheries contributed to the fishing mortality in the BSAI, however there are no observable lingering effects on the Pacific cod populations.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1964-1976)

Fishery Selectivity

In 1969 and 1970, the Soviet groundfish fishery targeted on arrowtooth flounder, sablefish, and pollock with bycatches of Pacific cod, rockfish, and other bottomfish. Data regarding the amount of bycatch and the age of the fish caught is not available; however, it is assumed that bycatch of juvenile Pacific cod took place. Whether fishery bycatch of juveniles has had an effect on the Pacific cod population is unknown, although it does not appear to have had a lingering adverse effect on the present Pacific cod population.

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of Pacific cod. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin

(1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries.

<u>Internal JV and Domestic Groundfish Fisheries (1864-present)</u>

Fishery Selectivity

Pacific cod are caught as bycatch and discarded in the Pacific cod fishery and other domestic groundfish trawl fisheries, including the fisheries for pollock, yellowfin sole, and rock sole in the EBS and in the shallow water flatfish, arrowtooth flounder, and flathead sole fisheries in the Aleutian Island trawl fisheries. Since 1998 (BSAI FMP Amendment 49), discarding of Pacific cod has been prohibited except for fisheries in which Pacific cod has a bycatch only status. BSAI FMP Amendments 9, 11a, 13 and others have been designed to limit bycatch and improve reporting of target and non-target species in the BSAI.

Spatial/Temporal Concentration of Catch/Bycatch

The Pacific cod fishery has changed recently due to management measures instituted to reduce possible adverse impacts on the western population of Steller sea lions. Some of these measures attempted to distribute catch more evenly throughout the year. On average during the period 1998-2000, 81 percent of annual trawl catch, 60 percent of annual longline catch, and 82 percent of annual pot catch was taken from January to May in the Bering Sea, while 89 percent of the annual trawl catch, 69 percent of annual longline catch and 89 percent of the annual pot catch was taken from January to May in the Aleutian Islands. The attempted redistribution of Bering Sea catch appears to have been at least somewhat successful, with January to May trawl, longline, and pot catches reduced to 64 percent, 43 percent and 71 percent of their respective year-end totals in 2001. Correspondingly, fishery activity increased during the remainder of the year in the Bering Sea. The Aleutian Islands fisheries saw comparatively little change in temporal distribution, with the most significant change taking place in the pot fishery, where the January to May catch decreased from 89 percent of the year-end total in 1998-2000 to 73 percent in 2001 (Thompson and Dorn 2002).

Change in Prey Availability

<u>External Foreign Groundfish Fisheries (1964-1976)</u>

Foreign past fisheries in the BSAI have had an adverse impact on prey availability for large Pacific cod. Large Pacific cod are mainly piscivorus consuming pollock ranging in age from age-0 to greater than age-6 depending on predator size. However, due to the opportunistic nature of Pacific cod, it is unlikely that the fisheries would have had a population-level effect. No observable lingering negative effects are apparent in the present Pacific cod populations.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse with respect to prey availability. In general, a shift toward warmer waters appears to favor recruitment and survival of Pacific cod. As described in Section 3.10.1.5 of the Programmatic SEIS, when the Aleutian Low was weak, resulting in colder water, shrimp dominated the catches. When the Aleutian Low was strong, water temperatures were higher, and the catches were dominated by Pacific cod, pollock, and flatfishes.

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes the majority of the diet of small Pacific cod.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of Pacific cod.

Internal JV and Domestic Groundfish Fisheries (1864-present)

Past JV fisheries in the BSAI have also had a negative impact on prey availability. However, as stated above, due to the opportunistic nature of Pacific cod, it is unlikely that these past fisheries have had a population-level effect on these stocks. There is no observable lingering negative impacts on the present Pacific cod population.

Change in Important Habitat

External Foreign Groundfish Fisheries (1964-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Habitat suitability has been negatively affected by the intensity of the past foreign fisheries; however, the effects are not considered to have had a lingering influence on Pacific cod populations.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse with respect to habitat suitability. In general, a shift toward warmer waters appears to favor recruitment and survival of Pacific cod. As described in Section 3.10.1.5 of this Programmatic SEIS, when the Aleutian Low was weak, resulting in colder water, shrimp dominated the catches. When the Aleutian Low was strong, water temperatures were higher, and the catches were dominated by Pacific cod, pollock, and flatfishes.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the habitat suitability of Pacific cod.

Internal JV and Domestic Groundfish Fisheries (1864-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Habitat suitability has been adversely affected by the intensity of the past JV fisheries; however, the effects are not considered to have had a lingering influence on Pacific cod populations. BSAI FMP Amendments 55 and 65 are designed to identify EFHs, minimize practicable adverse effects on habitat, and encourage conservation. Furthermore, domestic (post-MSA) bottom trawl fisheries have been limited by regulations and FMP amendments (BSAI FMP Amendments 20, 55, 57, 65 and Steller sea lion conservation measures).

BSAI Pacific Cod Comparative Baseline

The EBS shelf trawl surveys indicate that the Pacific cod biomass increased steadily from 1978 to 1983 and remained at relatively constant levels from 1983 to 1989. Biomass estimates peaked in 1994 and decreased steadily through 1998. Biomass estimates remained steady in the 520,000 to 620,000 mt range from 1998-2000, and increased by 57 percent in 2001 to 830,479 mt, which is very likely overestimated. The 2002 estimate is 616,923 mt. The 2002 Aleutian Islands survey shows a decline from the 2000 biomass estimates at 82,853 mt (Thompson and Dorn 2002).

The stock assessment model indicates a relatively steady decline in age-3+ biomass from 1987 to the present, with the lowest estimate since 1980 occurring in 2001. The female spawning biomass estimates also show a steady decline from 1987 to 2000 with a slight increase in 2001 and 2002, although recent years' estimates are still the lowest since 1981. Regardless, model projections indicate that the BSAI stock is neither overfished, nor approaching an overfished condition (Thompson and Dorn 2002).

BSAI Pacific Cod Cumulative Effects Analysis Status

BSAI and GOA Pacific cod will be brought forward for cumulative effects analysis.

3.5.1.3 BSAI Sablefish

Life History and Distribution

Sablefish (*Anoploma fimbria*) are found from northern Mexico to the GOA, westward to the Aleutian Islands, and into the Bering Sea (Wolotira *et al.* 1993). They are often found in gullies and deep fjords generally at depths greater than 200 m. Sablefish observed from a manned submersible were found on or within 1 m of the bottom (Krieger 1997). There appear to be two populations of sablefish: the Alaska population which inhabits waters near Alaska and northern British Columbia and the southern or west coast population which inhabits waters off of southern British Columbia, and Washington, Oregon, and California. Mixing of these populations occurs off southwest Vancouver Island and northwest Washington (McDevitt 1990, Saunders *et al.* 1996, Kimura *et al.* 1998). Studies have shown sablefish to be highly migratory for at least part of their life cycle (Heifetz and Fujioka 1991, Maloney and Heifetz 1997), and substantial movement between the BSAI and the GOA has been documented (Heifetz and Fujioka 1991). Thus, sablefish in Alaskan waters are assessed as a single stock (Sigler *et al.* 2001a).

Spawning is pelagic at depths of 300 to 500 m near the edges of the continental slope (McFarlane and Nagata 1988). Juveniles are pelagic and appear to move into comparatively shallow nearshore areas where they spend the first 1 to 2 years (Rutecki and Varosi 1997). After their second summer, juveniles begin moving offshore, eventually reaching the upper continental slope as adults. Sablefish reach maturity at 4 to 5 years (McFarlane and Beamish 1990). Sablefish are long-lived, with a maximum recorded age in Alaska of 94 years (Kimura *et al.* 1998). Table 3.5-6 summarizes the biological and reproductive traits and habitat associations of sablefish through its different life stages.

Trophic Interactions

Larval sablefish feed on a variety of small zooplankton, ranging from copepod nauplii to small amphipods. Young-of-the-year sablefish are epipelagic and feed primarily on macrozooplankton and micronekton (e.g., euphausiids) (Sigler *et al.* 2001b). Juveniles less than 60 cm feed primarily on euphausiids, shrimp, and cephlapods (Yang and Nelson 2000), while sablefish greater than 60 cm feed more on fish. Both juvenile and adult sablefish are considered opportunistic feeders. Fish most important to the sablefish diet include pollock, eulachon, capelin, Pacific herring, Pacific cod, Pacific sandlance, and some flatfish, with pollock being the most predominant (10 to 26 percent of prey weight, depending on year). Squid, euphasiids, and jellyfish were also found, squid being the most important of the invertebrates (Yang and Nelson 2000). Feeding studies conducted in Oregon and California found that fish made up 76 percent of the sablefish diet (Laidig *et al.* 1997). Off the southwest coast of Vancouver Island, euphausiids dominated (Tanasichuk 1997).

Adult coho and chinook salmon feed on young-of-the-year sablefish, the fourth most common reported species in the salmon troll logbook program from 1977 to 1984 (Wing 1985). Pacific halibut also feed on juvenile and adult sablefish, although sablefish make up less than one percent of the stomach contents (M.S. Yang, AFSC, personal communication, 14 October 1999).

Management Tier/Stock Assessment

Sablefish are managed under Tier 3b in the BSAI and GOA. The fishing mortality rate of 0.13 (Appendix B) leads to a maximum permissible ABC of 25,400 mt. In 2002, a decision analysis was conducted to determine what catch levels will likely avoid the historic low abundance of 1979; this is in contrast to past year's assessments which evaluated catch rates that would result in a stable or increasing spawning biomass. The switch in methodology came about due to an increase in sablefish abundance. The BSAI and GOA sablefish stock abundance is considered moderate and has increased from recent lows. The 2003 recommended ABC is 20,900 mt, a yield that has a 0.6 probability of reducing the 2007 spawning biomass below the historic low. This ABC is the 5-year average of catches under the $F_{40\%}$ policy. This ABC has been apportioned separately in the EBS, Aleutian Islands, and GOA at 2,900 mt, 3,110 mt, and 14,890 mt, respectively. The 2003 OFL is 4,290 mt, 4,590 mt, and 22,020 mt for the EBS, Aleutian Islands, and GOA for a total of 30,900 mt. GOA ABC and OFL are further allocated into management areas; western, central, west Yakutat, and east Yakutat/southeast outside (SEO) (eastern = west Yakutat + east Yakutat/southeast outside) (Sigler *et al.* 2002) (Tables 3.5-2 and 3.5-28).

Several studies have shown sablefish to be highly migratory for at least part of their life cycle (Heifetz and Fujioka 1991, Maloney and Heifetz 1997), and substantial movement between the BSAI and the GOA has been documented (Heifetz and Fujioka 1991). Thus, Alaskan sablefish are considered a single stock and assessed in a combined area (BSAI and GOA) with an age-structured model incorporating fishery and survey catch data and age and length compositions. Survey data come from annual sablefish longline surveys in the GOA, and biennial longline surveys in the BSAI. Sablefish are more abundant and easier to catch in the GOA. Longline survey catch rates in the EBS and Aleutian Islands from 1990-1999 average only about one-fifth of those in the GOA.

Sablefish Past/Present Effects Analysis

The geographic scope for the BSAI and GOA sablefish past/present effects analysis is the same as for the BSAI and GOA FMP management areas (Figure 1.2-2 and 1.2-3). The temporal scope for this analysis begins in 1906 when the North American sablefish fishery begins and ends in 2002, the most recent year of which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-7 provides a summary of the BSAI and GOA sablefish past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on BSAI and GOA sablefish:

- Mortality due to catch/bycatch and the EVOS (direct effect).
- Change in reproductive success due to fishery selectivity, spatial/temporal concentration of catch/bycatch, the EVOS, and climate changes and regime shifts (indirect effect).
- Change in prey availability due to fishery catch/bycatch of prey species, introduction of exotic species, the EVOS and climate changes and regime shifts (indirect effect).
- Change in important habitat due to fishery gear impacts, the EVOS, introduction of exotic species and climate changes and regime shifts (indirect effect).

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on sablefish in the BSAI and GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI and GOA.

The past/present event determined to be applicable to the sablefish past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (BSAI: 1958-1976, GOA: 1963-1976)
  - State of Alaska groundfish fisheries
  - IPHC halibut longline fishery
  - EVOS
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (BSAI: 1980-1991, GOA: 1976-1985)
  - JV groundfish fisheries (BSAI: 1980-1991, GOA: 1979-1991)
  - Domestic groundfish fisheries (BSAI: 1980-present, GOA: 1979-present)
  - GOA domestic U.S. National Pacific cod fisheries (1800s-1976)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following section explains any amendments specific to the sablefish fishery. Amendments discussed in Section 3.2 which have an impact on the target fisheries as a whole are not repeated here.

Mortality

External BSAI Foreign Groundfish Fisheries (1958-1976)

Japanese longline vessels began fishing in the Bering Sea in 1958, with peak catch in 1962 at 25,989 mt. Aleutian Island sablefish catch remained relatively low during the foreign fisheries. The bilateral agreement between the U.S., Japan and the Soviet Union began to include catch quotas in the EBS and Aleutian Islands regions beginning in 1973. Evidence of decline in sablefish abundance led to fishery restrictions starting in 1978, reducing total catches to about 12,200 mt by 1985 (NPFMC 2002a).

The Soviet Union caught sablefish from 1967 to 1973 in the EBS (McDevitt 1986) and the Republic of Korea from 1974 to 1983. The Republic of Poland, Taiwan, Mexico, Bulgaria, Federal Republic of Germany, and Portugal have all reported small catches of sablefish, as well (Low *et al.* 1976).

External GOA Foreign Groundfish Fisheries (1963-1976)

Already having started a sablefish fishery in the EBS, Japanese longline vessels began fishing in the GOA in 1963, which led to a rapid increase in annual harvests of sablefish. Harvests peaked in 1972 at 36,776 mt in the GOA. Sablefish were also caught by trawl vessels in the GOA, where sablefish were bycatch in the Japanese Pacific ocean perch fishery until 1972, when some vessels started targeting sablefish (Sasaki 1973).

The sablefish population was overexploited by foreign fisheries. However there is no lingering impact. The population recovered from overfishing starting in the late 1970s due to strong year-classes during 1977-1981.

External BSAI and GOA IPHC Longline Fishery and State of Alaska Directed Sablefish Fishery

Minor state fisheries were established in Alaska in 1995 primarily to provide open-access fisheries to fishermen who could not participate in the federal sablefish IFQ fishery. These fisheries occur in the northern GOA and in the Aleutian Island region, and averaged 180 mt from 1995-1998, with catches predominantly from the Aleutian Island region (ADF&G 2000b, Sigler *et al.* 2001a). In addition, three major state fisheries targeting sablefish operate in Prince William Sound (PWS), Chatham Strait, and Clarence Strait (Sigler *et al.* 2001a).

The past State of Alaska directed fishery and the IPHC longline fishery are found to have no lingering adverse effects on the sablefish population. Although mortality rates likely were higher in some state fisheries than the federal fishery during the 1990s, the effect on the population was low because catches in the state fisheries are small compared to the federal fishery.

Internal GOA Domestic Groundfish Fisheries (late 1800s -1976)

The North American fishery consisting of both the U.S. and Canada began as a secondary activity of the halibut fishery in the late 1800s. The first fishing grounds were off the coasts of Washington and British Columbia and had spread to Oregon, California, and Alaska by the 1920s. The fishery was exclusively North American from 1906 to 1957, taking place from northern California to Kodiak Island in the GOA. Annual catches of sablefish in Alaska averaged about 1,700 mt from 1930 to 1957 and generally were limited to areas near fishing ports (Low *et al.* 1976). The catch history of sablefish in the BSAI and GOA is detailed in Sigler *et al.* 2002.

The sablefish population in Canada was overexploited by foreign fisheries. However there is no lingering impact. The population recovered from overfishing starting in the late 1970s due to strong year-classes during 1977-1981.

Internal BSAI JV and Domestic Groundfish Fisheries (1980 - present)

In the late 1980s, a substantial increase in abundance in sablefish population and the expansion of the domestic fishery increased catches, peaking in 1987 at 8,012 mt (domestic only). Annual catch declined throughout the 1990s to the present at about 1,600 mt. Some catches were not reported during the late 1980s (Kinoshita *et al.* 1995).

BSAI FMP Amendments 1, 2, 4, 6, and 11 all worked to phase-out foreign and JV fisheries and encourage the growth of the domestic fishery.

NPFMC identified concerns regarding sablefish bycatch and the unrelated 50 percent decline in the number of observed walrus hauled out on Round Island. In addition to the changes described in Section 3.5.1.1, BSAI FMP Amendment 13 also 1) allocated sablefish by gear, 2) closed areas to groundfish fishing to protect walrus, 3) deleted fishing season dates from the FMPs but retained them in regulations, and 4) clarified the authority to recommend TACs for additional or fewer target species within the target species category.

Amendment 15 established an IFQ program for sablefish fixed gear fisheries in 1995, and allocated 20 percent of the fixed gear allocation of sablefish to a CDQ reserve for the BSAI. This program was designed to promote the conservation and management of sablefish fisheries by assigning a percentage of the sablefish harvest to certain individuals who have had a history of harvest in that fishery. Over time, this program has decreased the total number of quota shareholders, reduced the amount of bycatch, increased safety, reduced gear conflicts, reduced fishing mortality due to lost gear, increased product quality, and reduced the competition for fishing grounds. Management under the IFQ program also has increased the fishery catch rate 1.8 times, decreased harvest of immature fish so that spawning biomass per recruit increased nine percent, and decreased variable costs of catching the quota from eight to five percent of landed value (Sigler and Lunsford 2001).

A regulatory amendment was passed in the BSAI (57 CFR 37906) banning the use of longline pot gear for fishing of sablefish in 1992. This prohibition was later removed except from June 1 to June 30 to prevent gear conflicts with trawlers, effective September 12, 1996.

Past JV fisheries and domestic fisheries in the BSAI may have had a lingering adverse impact on fishing mortality. Catches were under reported during the late 1980s (Kinoshita *et al.* 1995), and this may have contributed to the substantial abundance decline in the 1990s.

Internal GOA JV and Domestic Groundfish Fisheries (1979 - present)

JV fisheries began in the GOA in 1979, peaking in 1984 at 411 mt (NPFMC 2002b). In 1983, GOA FMP Amendment 11 lowered the sablefish quota due to reduced abundance of sablefish, and also to encourage growth of the domestic fisheries. By 1986, the sablefish resource had recovered and the quota was again increased to 15,000 mt for the domestic fishery. GOA domestic harvests peaked in 1989 at 29,900 mt and have since declined to the 2002 harvest of 13,570 mt.

In 1980, GOA FMP Amendment 8 created four species management categories (target, other species, unallocated, and non-specified) and three regulatory districts for sablefish in southeast Alaska. Its purpose was to make the GOA FMP conform to the newly adopted BSAI FMP, to enhance target species management, and to protect incidentally caught species. Information on squid, rockfish, and several other species was found insufficient to warrant OYs for the three main regulatory areas in the GOA; therefore, their management was changed to a gulfwide management strategy. Changes in sablefish management were also needed because the growing U.S. fishery tended to fish in too localized an area off southeast Alaska. The eastern regulatory area thus was divided into three smaller areas to spread the fishery out, and biodegradable panels were required to reduce ghost fishing by lost pots. Lastly, the timing of reserve releases was modified to allow for increased catches by domestic fisheries.

Amendment 14 to the GOA FMP allocated sablefish quota by gear type, effective in 1985. This FMP amendment also banned the use of pots for fishing for sablefish in the GOA, effective November 18, 1985. Amendment 20 to the GOA FMP established an IFQ management for sablefish beginning in 1995 with the same benefits as described for BSAI in the previous section. In 1997, maximum retainable bycatch percentages for groundfish were revised. The percentage is dependent on the basis species: pollock one percent, Pacific cod one percent, deep flatfish 7 percent, rex sole 7 percent, flathead sole 7 percent, shallow flatfish one percent, arrowtooth flounder 0 percent, Pacific ocean perch 7 percent, shortraker and rougheye rockfish 7 percent, other rockfish 7 percent, northern rockfish 7 percent, pelagic shelf rockfish (PSR)7 percent, demersal shelf rockfish (DSR) in the SEO 7 percent, thornyhead rockfish 7 percent, Atka mackerel one percent, other species one percent, and aggregated amount of non-groundfish species one percent.

A draft EA/RIR/IRFA document was released for public review for Amendment 66 to the GOA groundfish FMP in May of 2002. This amendment would allow for the purchase of commercial halibut and sablefish catcher vessel quota share for lease by eligible persons. This amendment is designed to help reduce unemployment and related social and economic issues in rural GOA fishing communities by allowing a few of those communities to participate in the sablefish and halibut fisheries (Hiatt *et al.* 2002).

Past JV and domestic fisheries in the GOA may have had a lingering adverse impact on the sablefish population. Catches were under reported during the late 1980s (Kinoshita *et al.* 1995), and this under reporting may have contributed to the substantial abundance declines in the 1990s.

Change in Reproductive Success

External BSAI and GOA Foreign Groundfish Fisheries (1958-1976)

Fishery Selectivity

Japanese trawlers targeting pollock, rockfishes, Greenland turbot, and Pacific cod also caught large sablefish as bycatch. From 1964-1972, the bycatch averaged nearly 12,000 mt for the Japanese trawl fisheries (Sasaki 1973). In 1968, sablefish bycatch by longline or otter trawl was allowed to be retained up to 10 percent by weight of each landing; this amount was increased to 20 percent in 1972. Bycatch of sablefish in the foreign fisheries was monitored by the foreign Observer Program, and several gear regulations were passed in an attempt to reduce bycatch (NPFMC 2002a).

In 1960, 1961, and 1967, legal gear for the taking of sablefish in directed and bait fishery was defined. Pots were allowed in 1970 and modifications required in 1976, including an untreated cotton escape which would deteriorate and allow for the escapement of bycatch if the pot were lost at sea (NPFMC 2002a).

External State of Alaska Directed Sablefish Fisheries

Spatial/Temporal Concentration of Catch/Bycatch

1999 ADF&G data show that the state sablefish fishery is somewhat concentrated; in the PWS, catch was dominated by a few statistical areas; in the Cook Inlet region, catches came from the outer coast; and in the south Alaska Peninsula fishery, catches came predominately from the areas southwest of Unimak Island. The fishery in the PWS is also concentrated temporally, lasting only a few days, whereas the Cook Inlet and south Alaska Peninsula fisheries last a few months (ADF&G 2000b).

The state fishery is found to have had an adverse effect on the spatial/temporal distribution of the sablefish stock due to the spatial/temporal concentration of the catch. However, there are no observable lingering negative effects on the sablefish population.

External Exxon Valdez Oil Spill

The effects of the EVOS on sablefish recruitment in the GOA are unknown.

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of sablefish. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

The regime shift of 1976/1977 had a beneficial effect of recruitment of sablefish and other groundfish species (Sigler *et al.* 2002, Wooster and Hollowed 1995). Sablefish recruitment was high during 1977-1981, associated with the regime shift of 1976/1977. The effects of these strong year-classes lasted about two decades.

Internal JV and Domestic Fisheries (1979 - present)

Fishery Selectivity

The percent of sablefish catch discarded during 1995-2000 averaged 2.8 percent in the directed Alaska-wide sablefish longline fishery. Discards also took place in the BSAI Greenland turbot fishery (31 percent), the BSAI Pacific cod longline fishery (41.4 percent), Alaska-wide rockfish trawl fishery (17.4 percent) and Alaska-wide flatfish trawl fishery (42.1 percent) (Sigler *et al.* 2001a). BSAI FMP Amendment 13 and 15/GOA Amendment 20 helped reduce sablefish bycatch and discards by establishing the domestic Observer Program and the sablefish IFQ program, respectively.

Longline catches are typically of mature, larger sized fish, whereas trawl fisheries tend to target small to medium sized sablefish. The trawl fisheries occur within juvenile sablefish habitat, along the continental shelf. The trawl fisheries make up only 12 percent of the total catch, but may reduce sablefish recruitment by a larger amount because the fish caught are often younger, smaller fish that have not reached their full size (Sigler *et al.* 2002).

The dominating factor determining the age composition is the magnitude of the recruiting year-classes. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of a fished population with a several-decades catch history. How the current age composition of the population compares with the unfished population is unknown. In the short-term, however, the impact of the current fishing mortality levels is overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions (Sigler *et al.* 2001a).

The IFQ program (BSAI FMP Amendment 15/GOA FMP Amendment 20) has increased fishery catch rates while decreasing the harvest of immature fish (Sigler and Lunsford 2001). Catching efficiency increased 1.8 times with the change from an open-access to an IFQ fishery. Decreased harvest of immature fish improved the chance that individual fish will reproduce at least once. Spawning potential of sablefish, expressed as spawning biomass per recruit, increased nine percent under the IFQ fishery (Sigler *et al.* 2001a).

Spatial/Temporal Concentration of Catch/Bycatch

In 1980, GOA FMP Amendment 8 allowed for changes in sablefish management that were needed because the growing U.S. fishery tended to fish in too localized an area off southeast Alaska. This amendment divided the eastern regulatory area into two smaller areas to spread the fishery out. Biodegradable panels were also required to reduce ghost fishing by lost pots.

Change in Prey Availability

External BSAI and GOA Foreign Groundfish Fisheries (1958-1976)

The past foreign fisheries are unlikely to have had an impact on sablefish prey availability since sablefish are opportunistic feeders as described under the trophic interactions of this section. Larval sablefish feed on a variety of small zooplankton ranging from copepod nauplii to small amphipods. The epipelagic juveniles feed primarily on macrozooplankton and micronekton (i.e. euphausiids). The older demersal juveniles and adults appear to be opportunistic feeders, with food ranging from variety of benthic invertebrates, benthic fishes, as well as squid, mesopelagic fishes, jellyfish, and fishery discards. Fish comprise a large part of the adult sablefish diet. Nearshore residence during their second year provides the opportunity to feed on salmon fry and smolts during the summer months.

External State of Alaska Directed Sablefish Fisheries

As with the foreign fisheries, the State of Alaska directed sablefish fishery is unlikely to have an impact on the prey availability of sablefish due to the opportunistic nature of the species.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

As described under trophic interactions, larval sablefish feed mostly on copepods, young-of-the-year sablefish feed mostly on euphausiids and juvenile and adult sablefish are opportunistic feeders. Larvae and young-of-the-year sablefish are more susceptible than juvenile and adult sablefish to large shifts in ecosystem productivity due to their dependence on a few species. However, time-series data are not available to link fluctuations in copepod and euphausiid abundance with larvae and young-of-the-year sablefish abundance (Sigler *et al.* 2002).

External Exxon Valdez Oil Spill

The effects of the EVOS on the abundance of sablefish prey species and on the sablefish population are unknown.

Internal JV and Domestic Fisheries (1979 - present)

Again, as with the foreign fisheries and State of Alaska directed sablefish fisheries, it is unlikely that the past JV and domestic fisheries have had an impact on the prey availability of sablefish due to the opportunistic nature of the species.

Change in Important Habitat

External BSAI and GOA Foreign Groundfish Fisheries (1958-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Habitat suitability has been adversely affected by the intensity of the past foreign fisheries in the BSAI and GOA. The effects of fishery gear on important sablefish habitat are lingering at the population-level.

External State of Alaska Directed Sablefish Fisheries

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Habitat suitability has been adversely affected by the intensity of the state fisheries. The effects of fishery gear on important sablefish habitat are lingering at the population-level.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

Sablefish recruitment appears to be influenced by water mass movements and temperature (Sigler *et al.* 2001a). Data suggest that sablefish recruitment increases with above average temperature as well as the growth rate of young-of-the-year sablefish (Sigler *et al.* 2002).

External Exxon Valdez Oil Spill

The effects of the EVOS on sablefish habitat suitability are unknown.

Internal JV and Domestic Fisheries (1979-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Habitat suitability has been adversely affected by the intensity of the past JV and domestic fisheries. The effects of fishery gear on important sablefish habitat are lingering at the population-level. BSAI FMP Amendment 13 closed waters seaward of 3 nm out to 12 nm surrounding the Walrus Islands and Cape Pierce from April 1 through September 30 to all groundfish fishing. Amendments 55 and 65 were proposed to identify EFH, minimize practicable adverse effects on habitat, and encourage conservation.

BSAI/GOA Sablefish Comparative Baseline

Longline surveys were conducted annually in the GOA by the Japan-U.S. cooperative longline survey from 1978 to 1994, and added the Aleutian Islands region in 1980 and the EBS in 1982 (Sasaki 1985, Sigler and Fujioka 1988). The AFSC began conducting annual longline surveys in the upper continental slope in 1987 to continue the U.S.-Japan cooperative survey time series (Sigler and Zenger 1989). The AFSC survey began annual sampling in the GOA in 1987, biennial sampling in the Aleutian Islands region in 1996, and biennial sampling in the EBS in 1997 (Rutecki *et al.* 1997).

Killer whale depredation of the survey's sablefish catches has occurred in the Bering Sea since the beginning of the survey and has been adjusted for by excluding portions of the gear affected (Sasaki 1987). However, sperm whale depredation has not been adjusted for because researchers are uncertain when the depredation began. If depredation began recently, the current survey estimates would underestimate the biomass. However, if adjustments were made and depredation occurred consistently over time, then the biomass would be overestimated. Sperm whale depredation will continue to be monitored; however, no plans have been made to adjust survey estimates (Sigler *et al.* 2001a).

Relative abundance of sablefish has cycled through three major declines and two significant increases between 1970 and 1985. The post-1970 decline has been attributed to heavy fishing, and the 1985 peak has been attributed to high recruitment of late 1970s year-classes. Following 1988, sablefish abundance has decreased significantly, declining faster in the EBS, Aleutian Islands region, and western GOA and slower in the central and eastern GOA (Sigler *et al.* 2002). Geographic differences are probably due to the migration of small sablefish westward, while large sablefish migrate eastward (Heifetz and Fujioka 1991).

Recent important year-classes are 1980-1981, 1984, 1990, 1995, and 1997. Abundance has fallen in recent years because recent recruitment is insufficient to replace strong year-classes from the later 1970s, which are dying off (Sigler *et al.* 2001a).

BSAI Sablefish Cumulative Effects Analysis Status

BSAI sablefish will be brought forward for cumulative effects analysis.

3.5.1.4 BSAI Atka Mackerel

Life History and Distribution

Atka mackerel (*Pleurogrammus monopterygius*) are distributed from the east coast of the Kamchatka Peninsula, Russia, throughout the Aleutian Islands and the EBS, and eastward through the GOA to southeast Alaska (Wolotira *et al.* 1993). Their current center of abundance is in the Aleutian Islands, with marginal distributions extending into the southern Bering Sea and into the western GOA (Lowe *et al.* 2001, Lowe and Fritz 2001).

Atka mackerel are one of the most abundant groundfish species in the Aleutian Islands, where they are the target of a directed trawl fishery (Lowe and Fritz 2001). Adults are semipelagic and spend most of the year over the continental shelf in depths generally less than 200 m. Adults migrate annually to shallow coastal waters during spawning, forming dense aggregations near the bottom (Morris 1981, Musienko 1970). In Russian waters, spawning peaks in mid-June (Zolotov 1993) and in Alaskan waters in July through October (McDermott and Lowe 1997). Females deposit adhesive eggs in nests or rocky crevices. The nests are guarded by brightly colored males until hatching occurs (Zolotov 1993). The first *in situ* observations of spawning habitat in Seguam Pass were documented in August 1999 and 2000 (Robert Lauth, NOAA Fisheries AFSC, personal communication). Atka mackerel nests, nest-guarding males, and spawning females were observed and verified with underwater video and SCUBA diving operations. Nichol and Somerton (2002) examined the diurnal vertical migrations of Atka mackerel using archival tags, and related these movements to light intensity and current velocity. Atka mackerel displayed strong diel behavior, with vertical movements away from the bottom occurring almost exclusively during daylight hours and little to no movement at night. A morphological and merisitic study suggests that there may be separate populations of Atka mackerel in the GOA and the Aleutian Islands (Levada 1979). Data from another morphological study conducted in the BSAI and GOA showed some differences between samples, although the differences were not consistent by area for each characteristic analyzed, suggesting a certain degree of reproductive isolation (Lee 1985). More recent genetic analyses show no evidence of discrete stocks in Alaskan waters (Lowe *et al.* 1998). However, the growth rates have been shown to vary extensively among different areas, and the two Aleutian Islands and GOA populations differ significantly in the size, distribution, and recruitment patterns (Kimura and Ronholt 1988, Lowe *et al.* 1998, Lowe and Fritz 2001). Age and size at 50 percent maturity has been estimated at 3.6 years and 33-38 cm, respectively (McDermott and Lowe 1997). Atka mackerel are a relatively short-lived groundfish species. A maximum age of 15 years has been noted; however, most of the population is probably less than 10 years old. Natural mortality estimates vary extensively, as determined by various methods. The current assumed value of natural mortality is 0.30, which is consistent with values of natural mortality derived from methods which do not rely on growth parameters which vary according to area. Table 3.5-8 summarizes biological and reproductive attributes and habitat associations of Atka mackerel in the BSAI and GOA.

Trophic Interactions

The diets of commercially important groundfish species in the Aleutian Islands during the summer of 1991 were analyzed by Yang (1996 and 1999). More than 90 percent of the total stomach content (by weight) of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Euphausiids (mainly *Thysanoessa inermis* and *T.rachii*) were the most important prey items, followed by calanoid copepods. The two species of euphausiids comprised 55 percent of the total stomach contents, and copepods comprised 17 percent. Larvaceans and hyperiid amphipods had high frequencies of occurrence (81 percent and 68 percent, respectively), but comprised less than 8 percent of the total stomach content weight. Squid was another item in the diet of Atka mackerel; it had a frequency of occurrence of 31 percent, but comprised only 8 percent of total stomach content. Atka mackerel are known to eat their own eggs. Yang (1996 and 1999) found that Atka mackerel eggs comprised 3 percent of the total stomach content and occurred in 9 percent of the analyzed Atka mackerel stomachs. Pollock were the second most important prey fish of Atka mackerel, comprising about 2 percent of the total stomach content. Myctophids, bathylagids, zoarcids, cottids, stichaeids, and pleuronectids were minor components of the Atka mackerel diet; each category comprised less than one percent of the total stomach content.

Yang (1996 and 1999) found some differences between the diet composition of male versus female Atka mackerel; females were found to cannibalize on eggs more often and preferred calanoids when cannibalism occurred, whereas males preferred euphasiids. Yang (1999) hypothesizes that this difference is due to the egg-guarding behavior of males which deters the males from feeding on their own eggs. The location of the cannibalism (Kiska Island) suggests that this area may be a spawning ground for Atka mackerel.

Atka mackerel are an important component in the diet of other commercial groundfish, mainly arrowtooth flounder, Pacific halibut, and Pacific cod; seabirds, mainly tufted puffins; and marine mammals, mainly northern fur seals and Steller sea lions (Byrd *et al.* 1992, Livingston *et al.* 1993, Fritz *et al.* 1995; as referenced by Yang 1996 and 1999). Atka mackerel are also components in the diets of the following marine mammals and seabirds: harbor seals, Dall's porpoise, thick-billed murres, and horned puffins (as referenced by Yang 1996 and 1999).

BSAI Atka Mackerel Management

In the 2002 assessment for the 2003 fishery, Atka mackerel fell into Tier 3a of the ABC and OFL definitions. According to the definitions of Amendment 56 and current stock conditions, the OFL fishing mortality rate at $F_{35\%}$ is estimated to be 0.84 for Atka mackerel (see Appendix B), which equates to a yield of 99,700 mt. The maximum allowable fishing mortality rate for ABC at $F_{40\%,}$ is estimated to be 0.66 for Atka mackerel in 2003, which translates to a yield of 82,800 mt. A recommendation of 63,000 mt, lower than the maximum permissible ABC, was performed by NPFMC (Lowe *et al.* 2002) (Table 3.5-2).

The BSAI Atka mackerel stock is above its minimum stock size threshold (MSST) and is not overfished or approaching an overfished condition. Under current management, the status determination of Atka mackerel relative to its MSST is made under the auspices of NOAA Fisheries' National Standards Guideline, rather than the groundfish FMPs.

Atka mackerel are a difficult species to survey because they do not have a swim bladder and are therefore poor targets for hydroacoustic surveys. They prefer rough and rocky bottoms that are difficult to sample with the current survey gear, and their schooling behavior and patchy distribution result in survey estimates with large variances. The stock assessment in the Aleutian Islands is based on the NOAA Fisheries trawl surveys, as well as total catch and catch-at-age data from the commercial fishery.

In 2002, the BSAI Atka mackerel were assessed using a Stock Assessment Toolbox. This new stock assessment model is designed to better evaluate and estimate assessment uncertainty; to explore alternative models for fishery and to survey selectivities, natural mortality and survey catchability; and to report on abundance and recruitment trends (Lowe *et al.* 2002).

Past/Present Effects Analysis

The geographic scope for the BSAI Atka mackerel past/present effects analysis is the same as the BSAI management areas (Figure 1.2-2). The temporal scope for this analysis begins in 1970 when the foreign fishery started and ends in 2002, the most recent year for which stock assessment information exists.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-9 provides a summary of the BSAI Atka mackerel past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on BSAI Atka mackerel:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to fishery selectivity, spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to commercial whaling, introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).

- Change in important habitat due to fishery gear impacts, marine pollution and oil spills, introduction to exotic species, and climate changes and regime shifts (indirect effect).

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on Atka mackerel in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the Atka mackerel past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (1970-1976)
  - Commercial whaling

- Marine pollution and oil spills
- Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1980-1991)
  - Domestic groundfish fisheries (1981-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - IWC regulations
  - MMPA of 1972
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following section explains any amendments specific to the Atka mackerel fishery. Amendments discussed in Section 3.2 which impact on the target fisheries as a whole and Atka mackerel as a component of the fishery, are not repeated here.

Mortality

External Foreign Groundfish Fisheries (1970-1976)

From 1970 to 1979, the Atka mackerel catch was taken exclusively by foreign fleets, including the Soviet Union, Japan, and the Republic of Korea. Catches of Atka mackerel peaked during the 1970s at over 24,000 mt in 1978 (Lowe *et al.* 2001). The Atka mackerel foreign fisheries had been phased out by 1984.

Although large removals of Atka mackerel occurred during the time of the foreign fisheries, there are no observable lingering negative effects on the Atka mackerel population.

Internal Foreign, JV and Domestic Groundfish Fisheries (1976-present)

The U.S. JV fishery began in 1980, and dominated the Atka mackerel catch from 1982-1988. Catches of Atka mackerel declined from their 1970s numbers from 1980-1983, largely due to changes in management and allocations. From 1985-1987, catches again increased, reaching their highest level at 34,000 mt annually. The domestic Atka mackerel fishery began in 1988 and was fully domesticated by 1990. TACs steadily increased from 1992 on in response to evidence of a large exploitable Atka mackerel population in the central and western Aleutian Islands (Lowe *et al.* 2002).

In June of 1997, BSAI FMP Amendment 34 was passed, allocating Atka mackerel catch to jig gear. This amendment was intended to provide an opportunity for local, small-vessel jig gear fleets to fish for Atka mackerel without direct competition from the large, high-capacity trawl fleets. Since that time, little of the jig gear fishery TAC has been harvested.

Although large removals of Atka mackerel have occurred in the past JV and domestic fisheries, there are no observable lingering adverse effects on the population.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1970-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The Atka mackerel fishery is characteristically a highly localized fishery that occurs in the same few locations every year. Foreign catches were made predominantly in the western Aleutian Islands (west of 180°W longitude) during the early 1970s and moved east during the late 1970s and early 1980s. Past foreign fisheries are found to have had an adverse impact on the spatial/temporal distribution of Atka mackerel due to the spatial/temporal concentration of the fishery in the BSAI.

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of Atka mackerel. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries.

Internal Foreign, JV and Domestic Groundfish Fisheries (1976-present)

Spatial/Temporal Concentration of Catch/Bycatch

The Atka mackerel fishery is a spatially and temporally concentrated fishery, and occurs primarily in depths less than 200 m. As stated above, the fisheries moved eastward from 180° W longitude in the early 1980s, near Seguam and Amlia Islands. The 1984 and 1985 catches took place primarily from a single 1/2° latitude by 1° longitude block in Seguam Pass. Atka mackerel are not commonly caught as bycatch in other directed fisheries, although the largest amounts occur in the trawl Pacific cod and rockfish fisheries (Lowe *et al.* 2000). Prior to 1998, the highest recorded discard rates were recorded in the western Aleutian Islands (543) and the lowest have been recorded in the eastern (541) (Lowe *et al.* 2002). The JV and past domestic groundfish fisheries have had an adverse impact on the spatial/temporal distribution of Atka mackerel due to the spatial/temporal concentration of the fishery in the BSAI.

Prior to 1993, no mechanism existed to spatially allocate TACs in the Aleutians to minimize the likelihood of localized depletion of Atka mackerel. In mid-1993, however, Amendment 28 to the BSAI FMP became effective, dividing the Aleutian subarea into three districts at 177° W and 177° E longitudes for the purposes of spatially apportioning TACs. Amendment 28 created the western (543), central (542), and eastern (541) Aleutian Districts. The BSAI Atka mackerel ABCs and TACs have been apportioned among areas based on weighted average distribution of biomass from the Aleutian Islands bottom trawl surveys.

Studies on Steller sea lion food habits indicate that Atka mackerel is the most common food item of adult and juvenile Steller sea lions in the summer (NMFS 1995b) and winter (Sinclair and Zeppelin 2002). A 10 nm year-round trawl exclusion zone was established around all rookeries west of 150°W in 1991-1992; and a 20 nm trawl exclusion zone was established around 6 rookeries in 1992-93, two of which included Seguam and Agligadak Islands. In 1993, a 20 nm aquatic zone was established around all rookeries and major haulouts west of 144°W and around three foraging areas, including one located near Seguam Pass.

Due to concerns that the spatial/temporal concentration of Atka mackerel catch could be high enough to affect prey availability for Steller sea lions, NPFMC passed a fishery regulatory amendment in June of 1998 which further dispersed the fishery spatially and temporally and reduced the level of fishing within Steller sea lion critical habitat in the BSAI. These regulations have been superceded by Amendment 70 to the BSAI and GOA FMPs which enacted the current Sea Lion Protection Measures in 2002 (Section 12.2.2 of Lowe and Fritz 1997).

Change in Prey Availability

External Commercial Whaling

Whaling is identified as having a past beneficial effect on prey availability for the Atka mackerel stocks. Atka mackerel have been documented as a prey of certain whale species; therefore, by removing large predators, Atka mackerel recruitment is favored.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. In general, a shift toward colder waters favors recruitment and survival of Atka mackerel. When the Aleutian Low was strong, water temperatures were higher, and biomass in the catches was dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changed in this same period, with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of Atka mackerel.

Change in Important Habitat

External Foreign Groundfish Fisheries (1970-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Due to the schooling, semi-demersal nature of Atka mackerel, this species is readily caught by bottom trawl gear (Lowe *et al.* 2001). Therefore Atka mackerel habitat is also subject to fishery gear impacts associated with bottom trawling. However, data on how fishery gear has specifically affected Atka mackerel habitat is unavailable; therefore, the effects of the past foreign fisheries on habitat suitability for the BSAI stock are unknown.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability in both stocks. In general, a shift toward colder waters favors recruitment and survival of Atka mackerel. When the Aleutian Low was strong, water temperatures were higher, and biomass in the catches was dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changed in this same period, with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of Atka mackerel.

Internal Foreign, JV and Domestic Groundfish Fisheries (1976-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

As stated in the external foreign fisheries section above, data regarding fishery gear impacts specific to Atka mackerel habitat are unavailable; therefore, the effects of the post-MSA foreign, JV, and domestic fisheries on the important habitat of Atka mackerel are unknown.

BSAI FMP Amendment 28, discussed above, helped to guard against reduced habitat suitability by reducing the concentration of Atka mackerel fishing effort spatially and temporally. The June 1998 regulation discussed above also contributed to guarding against reduced habitat suitability by banning trawl fishing within Steller sea lion critical habitat, which is habitat shared by Atka mackerel. Amendment 70, which supercedes the previous Steller sea lion regulations, closes Atka mackerel fishing in the Seguam foraging areas in all critical habitat areas east of 178°W longitude, and within 10 nm of rookeries west of 178°W longitude except Buldir which is closed within 15 nm. Atka mackerel fishing is also prohibited within 3 nm of all haulouts. Further closures have also been initiated in the Bering Sea, although the closures are more complex dependent on the type of fishery, gear used, location, and timing of the fishery. BSAI FMP Amendments 55 and 65 were both designed to identify and conserve EFH and HAPC (see Appendix C).

BSAI Atka Mackerel Comparative Baseline

Survey biomass estimates for Atka mackerel come from the 1986 U.S.-Japan cooperative trawl survey and from domestic trawl surveys in 1991, 1994, 1997, 2000, and 2002. The biomass estimate from 2002 is 772,798 mt, a 51 percent increase from the 2000 survey estimate. Atka mackerel biomass tends to be highly variable over depth (between 1 and 200 m) and area. Virtually all the biomass in the trawl surveys was found between 1 and 200 m. In the 2002 survey, areas with large catches were located north of Akun Island, Seguam Pass, Tanaga Pass, south of Amchitka Island, Kiska Island, Buldir Island, and Stalemate Bank (Lowe *et al.* 2002).

Factors that may affect Atka mackerel distribution, and thus availability to surveys, include bottom water temperatures and tidal cycles. Low bottom temperatures could impact the distribution of Atka mackerel and/or their food source. In 2000, the lowest bottom temperatures were recorded relative to past surveys and the fish during the 2000 survey were also found to weigh less than in the 1994 and 1997 surveys, suggesting a food-related impact. Atka mackerel are also thought to be responsive to tidal cycles; during high tide Atka mackerel may not be as accessible to surveys.

The 2000 survey age composition of Atka mackerel from the fishery is shown in Figure 3.5-4. The age composition is dominated by a strong 1992 and 1995 year-class and a very strong 1998 year-class (2 year-olds). The estimated mean age of the 2000 survey age composition is 5 years (Lowe *et al.* 2001). The current fishery tends to select fish aged 3 to 12 years old (Lowe and Fritz 2001). The 2001 fishery age composition data were dominated by the 1995 and 1998 year-classes (Lowe *et al.* 2002). It is not known how the age composition of the population would look in an unfished population.

BSAI Atka Mackerel Cumulative Effects Analysis Status

The BSAI Atka mackerel will be brought forward for cumulative effects analysis.

3.5.1.5 BSAI Yellowfin Sole

Life History and Distribution

Yellowfin sole (*Limanda aspera*) are distributed from British Columbia to the Chukchi Sea (Hart 1973). In the Bering Sea, they are presently the most abundant flatfish species and are the target of the largest flatfish groundfish fishery in the U.S. While also found in the Aleutian Islands and GOA, the stock is of much smaller size in those areas and is less likely to be commercially exploited there. Adults are benthic and occupy separate winter and spring/summer spawning and feeding grounds. Adults overwinter near the shelf-slope break at approximately 200 m and move into nearshore spawning areas as the shelf ice recedes (Nichol 1997). Spawning is protracted and variable, beginning as early as May and continuing through August, occurring primarily in shallow water at depths less than 30 m (Wilderbuer *et al.* 1992). Eggs, larvae, and juveniles are pelagic and usually are found in shallow areas. The estimated age at 50 percent maturity is 10.5 years at a length of approximately 29 cm (Nichol 1994). The maximum recorded age of a yellowfin sole is 34 years. Table 3.5-10 summarizes biological and reproductive attributes and habitat associations of yellowfin sole in the BSAI and GOA.

Trophic Interactions

Major prey items include bivalves, polychaete and echiuroid worms, euphausiids, and crangon shrimp (Livingston and deReynier 1996). Hafflinger and McRoy (1983) also showed that yellowfin sole will consume bairdi and opilio Tanner crabs and red king crabs at certain areas and times in the EBS. Livingston (1991b) found that yellowfin sole consume small quantities of juvenile bairdi and opilio Tanner crab, and blue king crab.

Groundfish predators of yellowfin sole include Pacific cod, skates, and Pacific halibut, which consume fish ranging from 7 to 25 cm standard length (Livingston and deReynier 1996).

BSAI Yellowfin Sole Management

In the Bering Sea, yellowfin sole are considered one stock for management purposes. The reference fishing mortality rate and ABC for yellowfin sole are determined by the amount of population information available (see Appendix B). Yellowfin sole are currently managed under Tier 3a of NPFMC's ABC and OFL definitions (Appendix C; Amendment 56). Management under Tier 3a requires reliable estimates of projected biomass, $B_{40\%}$, $F_{40\%}$ (for ABC), and $F_{35\%}$ (for OFL). The projected yellowfin sole female spawning biomass for 2003 is greater than $B_{40\%}$ (452,800 mt >385,000 mt), leading to an ABC value of 114,000 mt for 2003. The OFL was determined from the Tier 3a formula, equating to a value of 135,000 mt. Model projections indicate that the yellowfin sole stock is neither overfished nor approaching an overfished condition, according to the BSAI groundfish FMP Amendment 56 definitions, although the yellowfin sole stock continues to decline, mainly due to poor recruitment in the last decade (Wilderbuer and Nichol 2002) (Table 3.5-2).

Information on yellowfin sole stock conditions in the BSAI comes primarily from the annual EBS trawl survey. Estimates of yellowfin sole biomass derived from these surveys have been more variable than would be expected for a comparatively long-lived and lightly exploited species (Wilderbuer 1997). The reason for this variability is not known. Recent stock assessment analyses indicate a positive linear relationship between annual estimates of trawl survey biomass and bottom water temperature. This may be due to the decline in activity at low temperatures of the influence of water temperature on the timing of spawning migrations. As indicated by the 2000 survey, a significant portion of the yellowfin sole biomass appears to lie outside this survey border (Wilderbuer and Nichol 2002).

The time-series of fishery and survey age compositions allows the use of an age-based stock assessment model (Wilderbuer 1997). The outputs include estimates of abundance, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass. The model also estimates reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels, which, when considered with projected future biomass, are used to calculate ABC. The stock assessment is updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI SAFE report.

BSAI Past/Present Effects Analysis

The geographic scope for the yellowfin sole past/present effects analysis is the same as the BSAI management areas (Figure 1.2-2). The temporal scope for this analysis begins in 1954 when the foreign fishery for flounders started and ends in 2002, the most recent year for which a stock assessment is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-11 provides a summary of the yellowfin sole past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on yellowfin sole:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to fishery selectivity, spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery catch/bycatch of prey species, climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

- Change in important habitat due to fishery gear impacts, marine pollution and oil spills, introduction of exotic species and climate changes and regime shifts (indirect effect).

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on yellowfin sole in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the northwest Pacific to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the yellowfin sole past/present effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (1954-1976)
  - State of Alaska crab fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1980-1991)
  - Domestic groundfish fisheries (1987-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following section explains any amendments specific to the yellowfin sole fishery. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality

External Foreign Groundfish Fisheries (1954-1976)

The first EBS foreign yellowfin sole fishery was conducted by Japan from 1940 to 1941. The catches for these years totaled 9,600 and 12,200 mt, respectively. Japan was not allowed back into Alaska waters until the signing of the peace treaty between the U.S. and Japan in 1952 (NPFMC 2002a).

In 1954, the Japanese again began targeting flounders (primarily yellowfin sole) in the mothership fishery. Fishing occurred mostly off of Bristol Bay. From 1958 to 1963, the Japanese mothership fleet expanded in the Bering Sea. The foreign fisheries overexploited the yellowfin sole stock from 1959 to 1962, with catches averaging 400,000 mt annually, including the Soviet catch. The Soviet flounder fishery did not begin until about 1959, and occurred in areas where the yellowfin sole formed their winter aggregations. The Soviet portion of the flounder catch (made up mostly of yellowfin sole) from 1959 to 1963 ranged between 60,000 and 155,000 mt. Reduced abundance caused a decline in catches to about 100,000 mt annually from 1963 to 1971. By 1973, the Soviet flounder fishery failed to develop and was limited to a two-week period by four trawlers. A small Taiwanese fishery occurred in December of 1974, and was believed to have been targeting pollock and flounders. Yellowfin sole harvests continued to decline to 50,000 mt from 1972 to 1977. However, with an increase in abundance, the foreign and JV harvest increased in the 1980s. Foreign fisheries dominated the yellowfin sole harvest until 1984, and were completely phased-out of the BSAI in 1987 when the domestic and JV fisheries began rapid development (NPFMC 2002a).

Flounders have made up a relatively minor fishery in the Aleutian Islands, and consist of yellowfin sole, Alaska plaice, rock sole and flathead sole. Annual catch remained well under 5,000 mt from 1962 to 1971, increased to about 10,000 mt in 1972, and decreased to previous levels (5,000 mt) by 1976 (NPFMC 2002a).

Although large removals of yellowfin sole occurred during the past foreign fisheries, there are no observable lingering adverse effects on the BSAI yellowfin sole population.

Internal JV and Domestic Groundfish Fisheries (1980-present)

JV fisheries began in 1980 and ended in 1991 when the fishery became fully domesticated. The domestic yellowfin sole fishery began in 1987. Since that time, catches have not exceeded 150,000 mt annually, except for the 1997 harvest at 181,389 mt. In more recent years, the catch has been below 100,000 mt. The fishery is generally limited by Pacific halibut and crab bycatch limits, and market limitations (Wilderbuer and Nichol 2002).

Although large removals of yellowfin sole occurred during the JV and past domestic fisheries, there are no observable lingering adverse effects on the BSAI yellowfin sole population.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1954-1976)

The fishing mortality imposed on the yellowfin sole population by the foreign fisheries operating in the Bering Sea prior to 1976 has had no effect on the reproductive capabilities of the present population. Large removals of yellowfin sole in the early 1960s were followed by sustained above-average recruitment for over a decade in the period from 1966-1976. This level of productivity resulted in high levels of female spawning biomass. Furthermore, the age classes exploited during those years are no longer present in the current population due to natural mortality.

External Climate Changes and Regime Shifts

Patterns of yellowfin sole recruitment do not directly correspond with changes in the climate and the known regime shifts in 1977 and 1989. Following more than a decade of sustained above-average recruitment, the regime shift in 1977 ushered in a period of more variable recruitment success with very large year-classes in 1981 and 1983 interspersed with years of below average recruitment. The 1990s appear to be a less productive decade for recruitment. Because yellowfin sole are late spring/summertime spawners, it is unknown what physical mechanisms influence recruitment success.

Internal JV and Domestic Groundfish Fisheries (1980-present)

The exploitation fraction of the fisheries on yellowfin sole since the MSA has averaged 0.06 and is thus unlikely to have had much effect on the reproductive success of the stock. The fisheries are also characterized as having been spread out over time and space which has caused minimal disruption to spawning concentrations.

Change in Prey Availability

External Foreign Groundfish Fisheries (1954-1976)

The foreign fisheries in the BSAI are unlikely to have directly impacted prey availability for the yellowfin sole stock since these fish eat infaunal and epifaunal invertebrates. The lingering effect in the BSAI yellowfin sole stock is likely due to the natural events related to climate change.

External State of Alaska Crab Fisheries Bycatch of Juvenile Crabs

The bycatch of juvenile crabs (the size consumed by yellowfin sole) is relatively minor in State of Alaska crab fisheries. It is unknown what effect this removal of juvenile crab has on the foraging capabilities of yellowfin sole as juvenile crabs are only one component of yellowfin sole diet. Also the summertime feeding distribution of yellowfin sole is quite extensive over the Bering Sea shelf, whereas these fisheries are quite limited in space.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. Although flatfishes tend to dominate catch during strong Aleutian Lows, on a microclimate scale, community structures changed in some nearshore areas with decreasing populations of shrimps and small forage fish, and increasing populations of the large, fish-eating species, such as Pacific cod, and other flatfishes (see Section 3.10.1.5). Pacific cod, skates, and Pacific halibut are all predators of yellowfin sole.

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes the majority of the diet of yellowfin sole.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of yellowfin sole.

Internal JV and Domestic Groundfish Fisheries (1980-present)

The bycatch of juvenile crabs occurs in small numbers in domestic trawl fisheries. Crabs less than 25 mm in carapace width are estimated to have a selectivity of 0.001 in domestic fisheries from the snow crab assessment model. Combined with the fact that juvenile crab are only one component of the diet of yellowfin sole, these fisheries are not expected to impact the foraging capabilities of yellowfin sole.

Change in Important Habitat

External Foreign Groundfish Fisheries (1954-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of past foreign fisheries on habitat suitability is either beneficial or adverse; the effects are found to have had a lingering influence in yellowfin sole stocks, and the overall effect is beneficial in the BSAI yellowfin sole assemblage, probably due to climatological effects.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability; depending if habitat suitability is evaluated on a macro- or microscale. In general, when the Aleutian Low was strong, water temperatures were higher, and biomass in the catches was dominated by cod, pollock, and flatfishes. Survey biomass estimates of yellowfin sole over the past 15 years show a positive correlation with shelf bottom temperatures (Nichol 1998); estimates have been low during cold years.

(Wilderbuer and Nichol 2001). The lingering beneficial influence in the BSAI yellowfin sole stock is likely due to the natural events related to climate change.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of yellowfin sole.

Internal JV and Domestic Groundfish Fisheries (1980-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Recent research by the Resource Conservation Assessment Engineering (RACE) Division of the AFSC has investigated the consequences of lost habitat on juvenile flatfishes. The researchers found that juvenile flatfishes, including Pacific halibut and rock sole, prefer structured habitat (sand with sponges, bryozoans, bivalve shells, and waves). Furthermore, it was found that these structured habitats provide for reduced mortality rates by reducing their encounter rate with predators. Invertebrate bycatch from trawled and untrawled areas northeast of the Crab and Halibut Protection Zone 1 in the EBS inspired this research; invertebrates were more abundant in the non-fished zone versus the fished zone (Stone 2002).

The effect of past JV fisheries on habitat suitability is either beneficial or adverse; the effects are found to have had a lingering influence in yellowfin sole stocks, and the overall effect is beneficial in the BSAI yellowfin sole assemblage, probably largely due to climatological effects.

BSAI Yellowfin Sole Comparative Baseline

AFSC surveys conducted in waters 20-200 m from the Alaska Peninsula north to St. Matthew and Nunivak Islands show a doubling of biomass between 1975 and 1979, with a continued increase till 1981 at 2.3 million mt for fish age-7+ (exploitable biomass). Biomass estimates varied from 1981 to 1990, but levels between 1990 and 1999 have shown an even trend at high levels. 1999 and 2000 biomass estimates are at lower levels, while there is a slight increase in the 2001 and 2002 survey estimates (Wilderbuer and Nichol 2002).

Variations in survey results can be attributed to the availability of the yellowfin sole population in a survey area. Yellowfin sole are known to migrate from wintering areas off the shelf-slope break to spawn in nearshore waters that are not sampled by the AFSC survey (Nichol 1995, Wakabayashi 1989, Wilderbuer *et al.* 1992). Some variability can also be attributed to shelf bottom temperatures; biomass estimates over the past 15 years have shown a positive correlation with shelf bottom temperature: the colder the year, the lower the estimate. This may further reduce the availability of the yellowfin sole population to the survey area (Wilderbuer and Nichol 2001).

Model results suggest that the age-2+ biomass was at low levels during most of the 1960s and 1970s. A peak of 2.5 million mt occurred in 1985 due to sustained above average recruitment from 1967-1976 combined with low exploitation. Since 1985, the population of age-2+ yellowfin sole and female spawning biomass has been in slow decline. Above average recruitment from the 1991 year-class is expected to maintain the abundance of yellowfin sole above the $B_{40\%}$ level in the near future (Wilderbuer and Nichol 2001).

BSAI Yellowfin Sole Cumulative Effects Analysis Status

BSAI yellowfin sole will be brought forward for cumulative effects analysis.

3.5.1.6 BSAI Rock Sole

Life History and Distribution

Rock sole are distributed from southern California northward through Alaska (Wolotira *et al.* 1993). Two species of rock sole occur in the NPO, the northern rock sole (*Lepidopsetta polyxystran* sp.), and the southern rock sole (*L. bilineata*). These species have an overlapping distribution in the GOA, but the northern species primarily comprise the BSAI populations (Wilderbuer and Walters 1997). Their center of abundance occurs off the Kamchatka Peninsula, Russia (Shubnikov and Lisovenko 1964), off British Columbia (Forrester 1969), in the central GOA, and in the southern EBS (Alton and Sample 1976). Adults are benthic and, in the EBS, occupy separate winter (spawning) and summertime feeding distributions on the continental shelf. Spawning takes place during the late winter and early spring, near the edge of the continental shelf at depths of 125 to 250 m. Eggs are demersal and adhesive (Forrester 1964). The estimated age at 50 percent maturity for female rock sole is 9-10 years at a length of 35 cm (Wilderbuer and Walters 1997). Table 3.5-12 summarizes biological and reproductive attributes of rock sole in the BSAI and GOA.

Trophic Interactions

Major prey items include polychaete and miscellaneous worms, amphipods, and miscellaneous fish. Groundfish predators on rock sole include Pacific cod, skates, pollock, yellowfin sole, and Pacific halibut, which primarily consume fish ranging from 5-15 cm standard length. (Livingston and deReynier 1996).

BSAI Rock Sole Management

Northern and southern rock sole are managed as a single unit in the BSAI, and are currently managed under Tier 3a of NPFMC's ABC and OFL definitions. Management under Tier 3a requires reliable estimates of projected biomass, $B_{40\%}$, $F_{40\%}$ (for ABC) and $F_{35\%}$ (for OFL). Since the projected rock sole spawning biomass for 2003 is greater than $B_{40\%}$ (303,000 > 158,000), $F_{40\%}$ (the upper limit on ABC) is recommended as the F_{ABC} harvest reference point for 2003. This equates to a 2003 ABC of 110,000 mt and an OFL of 132,000 mt. Rock sole are abundant on the EBS shelf and also occur in the Aleutian Islands. This species represents a relatively data-rich case (Wilderbuer and Walters 2002) (Table 3.5-2).

Information on the rock sole stock conditions in the BSAI comes primarily from AFSC surveys. The time-series of fishery and survey age compositions allows the use of an age-based stock assessment model as the primary analytical tool. The outputs include estimates of abundance, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass. The model also estimates reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels, which, when considered with projected future biomass, are used to calculate ABC. The stock assessment is updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI SAFE report (Wilderbuer and Walters 2001).

BSAI Rock Sole Past/Present Effects Analysis

The geographic scope for the BSAI rock sole past/present effects analysis is the same as the BSAI management units (Figure 1.2-2). The temporal scope for this analysis begins in 1954 when the foreign flounder fishery began and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-13 provides a summary of the rock sole past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on rock sole:

- Mortality due to catch/bycatch and marine pollution and oils spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch, the rock sole roe fishery, fishery selectivity and climate changes and regime shifts (indirect effect).
- Change in prey availability due to introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).

- Change in important habitat due to fishery gear impacts, introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following section explains any amendments specific to the rock sole fishery. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here. For the BSAI, there are no amendments that specifically mention rock sole.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species by way of ballast water and climate changes and regime shifts has not been brought forward since the impacts on rock sole in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate changes and regimes shifts.

The past/present events determined to be applicable to the rock sole past/present effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (1954-1976)
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1980-1990)
  - Domestic groundfish fisheries (1987-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1954-1976)

Rock sole were first targeted in the Japanese mothership fishery which began in 1954. The rock sole fisheries are the same as the flounder fisheries described in Section 3.5.1.5 that primarily targeted yellowfin sole and include the Japanese and Soviet fisheries. Rock sole were not always identified in catches prior to about 1970. Rock sole catch appears to have remained steady at about 7,000 mt from 1963-1969 and then increased to about 30,000 mt annually between 1970 and 1975. The end of the Soviet flounder fishery in 1973 (due to political reasons) is thought to have had a beneficial effect on the flatfish of the BSAI (NPFMC 2002a).

Flounders have made up a relatively minor fishery in the Aleutian Islands, and consist of yellowfin sole, Alaska plaice, rock sole and flathead sole. Annual catch remained well under 5,000 mt from 1962-1971, increased to about 10,000 mt in 1972 and decreased back down to about 5,000 mt by 1976 (NPFMC 2002a, Wilderbuer and Walters 2002).

Although removals of rock sole occurred during the foreign fisheries, there are no observable lingering adverse effects on the BSAI rock sole populations.

Internal JV and Domestic Groundfish Fisheries (1980-present)

The JV fishery began in 1980 and was phased out of the BSAI by 1990. The JV fisheries averaged 2,000 to 9,000 mt annually from 1980-1983, increasing to nearly 30,000 mt in 1984. Peak harvest occurred in 1988 at about 40,000 mt. The domestic rock sole fishery began in 1987. The domestic harvest ranges from about 25,000 to 63,000 mt annually, with a peak in 1997 at 67,564. The average annual harvest from 1987-2000 is 54,960 mt. Rock sole are also a target of a high value roe fishery in February and March which takes the majority of the annual catch. The rock sole directed fishery tends to be limited due to bycatch of prohibited species (i.e. Pacific halibut and crab) (Wilderbuer and Walters 2001).

Although large removals of rock sole occurred during the JV and past domestic fisheries, there are no observable lingering adverse effects on the BSAI rock sole population.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1954-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The effects of the foreign fisheries on the spatial/temporal distribution of BSAI rock sole due to the spatial/temporal concentration of the fishery is unknown. However, any effects would not have had lingering population effects in the population.

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of rock sole. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fisheries

Spatial/Temporal Concentration of Catch/Bycatch

The JV and past domestic fisheries effects on the spatial/temporal distribution of the BSAI rock sole due to the spatial/temporal concentration of the fishery is unknown. However, any effects would not have had lingering population effects in the population.

Fishery Selectivity

Large amounts of rock sole are discarded overboard in various Bering Sea trawl target fisheries. Fisheries with the highest discard rates include the rock sole, yellowfin sole, Pacific cod, and the bottom pollock fisheries. Rock sole discard rates have exceeded the amount of rock sole retained since 1987, ranging from 33-45 percent retention from 1990-2000. Recently, percent discards have increased to 66 and 57 percent, respectively, for 2001 and 2002, and the amount discarded was 9,956 mt and 17,291 mt, respectively. Peak discard occurred in 1993 at 45,669 mt, but has generally ranged from 12,000 to 40,000 mt annually based on 1987-2002 (Wildebuer and Walters 2002).

Roe Fishery

The rock sole roe fishery takes a majority of the annual catch of rock sole, although the total catch in recent years has only been 21 percent of the ABC (2000).

Change in Prey Availability

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on and prey availability depending on the frame of reference. In general, when the Aleutian Low was strong, water temperatures were higher, and biomass in the catches was dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changed in this same period, with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes the majority of the diet of rock sole.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of rock sole.

Change in Important Habitat

External Foreign Groundfish Fisheries (1954-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Recent research by the RACE division of the AFSC has investigated the consequences of lost habitat on juvenile flatfishes. The researchers found that juvenile flatfishes, including Pacific halibut and rock sole, prefer structured habitat (sand with sponges, bryozoans, bivalve shells, and waves). Furthermore, it was found that these structured habitats provide for reduced mortality rates by reducing the flatfish encounter rate with predators. Invertebrate bycatch from trawled and untrawled areas northeast of the Crab and Halibut Protection Zone 1 in the EBS inspired the research; invertebrates were more abundant in the non-fished zone than in the fished zone (Stone 2002).

The effect of these fisheries is either beneficial or adverse; they are found to have had a lingering beneficial influence in the BSAI, probably mostly due to climatological effects.

External Climate Changes and Regime Shifts

The effect of climate changes on habitat suitability is either beneficial or adverse depending on the frame of reference; they are found to have had a lingering beneficial influence in the BSAI. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of rock sole.

Internal JV and Domestic Groundfish Fisheries

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of past JV fisheries on habitat suitability is either beneficial or adverse; they are found to have had a lingering beneficial influence in the BSAI, probably mostly due to climatological effects.

BSAI Rock Sole Comparative Baseline

The AFSC stratified area-swept bottom trawl surveys indicate that rock sole biomass remained stable through 1979, with a substantial increase in abundance to 799,300 mt in 1984. A slight decrease occurred in 1985, but estimates rose again to over 1 million in 1986 and continued to increase throughout the 1990s. The survey estimates peaked in 1994 and thereafter show the stock at a high level with a 2002 estimate of 1.9 million mt (Wilderbuer and Walters 2001).

The stock assessment model abundance estimates indicate that rock sole were at low levels during the mid-1970s through 1982. The population increased from 1982 to 1995, during a period of above-average recruitment and low exploitation, peaking in 1995 at over 1.5 million mt. Current population-levels are 38 percent lower than the peak estimate of 1995, attributable to below-average recruitment of the adult portion of the population during the 1990s, and is projected to decline further in 2003. The female spawning biomass is estimated at a high level, but slightly declining in 2002. Model projections indicate that this stock is neither overfished nor approaching an overfished condition (Wilderbuer and Walters 2002).

Currently, rock sole spawning stock has contributions from a wide range of ages and is well above the $B_{40\%}$ level. Projections for the near future indicate a decline in female spawning biomass due to a lack of good recruitment during the 1990s (Wilderbuer and Walters 2001).

BSAI Rock Sole Cumulative Effects Analysis Status

The BSAI rock sole will be brought forward for cumulative effects analysis.

3.5.1.7 BSAI Flathead Sole

Life History and Distribution

Flathead sole (*Hippoglossus elassodon*) are distributed from northern California northward throughout Alaska. In the northern part of its range, the species overlaps with the related and very similar Bering flounder (*Hippoglossoides robustus*) (Wolotira *et al.* 1993, Hart 1973). Adults are benthic and occupy separate winter spawning and summer feeding distributions. From overwintering grounds near the continental shelf margin, adults begin a migration onto the mid- and outer continental shelf in April or May. The spawning period occurs in late winter/early spring, primarily in deeper waters near the margins of the continental shelf (Walters and Wilderbuer 1997). Eggs are large and pelagic. Upon hatching, the larvae are planktonic and usually inhabit shallow areas (Waldron and Vinter 1978). Age and size at maturity are unknown, but recruitment to the fishery begins at age 3 (Figure 3.5-5). The maximum age from fishery age samples is 28 years. Flathead sole are taken in bottom trawls both as a directed fishery and in pursuit of other bottom dwelling species. Table 3.5-14 summarizes biological and reproductive attributes and habitat associations of flathead sole in the BSAI and GOA.

Trophic Interactions

Flathead sole feed primarily on invertebrates such as ophiuroids, tanner crab, bivalves and polychaetes. Their diet has been shown to include commercially important species such as pollock and tanner crabs. In the EBS, other fish species represented 5 to 25 percent of the diet (Livingston *et al.* 1993). Groundfish predators include Pacific cod, Pacific halibut, arrowtooth flounder, and also cannibalism by large flathead sole, mostly on fish less than 20 cm standard length.

BSAI Flathead Sole Management

Since it is difficult to separate flathead sole and Bering flounder at sea, they are currently managed as a single stock (Walters and Wilderbuer 1997) under Tier 3a of NPFMC's ABC and OFL definitions. Management under Tier 3a requires reliable estimates of projected biomass, $B_{40\%}$, $F_{40\%}$ (for ABC), and $F_{35\%}$ (for OFL). Since the projected flathead sole female spawning biomass for 2003 (225,000 mt) is greater than $B_{40\%}$, the maximum F_{ABC} is recommended as the harvest reference point for 2003, equating to an ABC of 66,000 mt (Table 3.5-2). The $F_{35\%}$ value (0.37) gives an OFL value of 81,000 mt.

Annual trawl survey biomass results have been the primary data component used to assess stock level since 1982. The assessment model has a length-based formulation, which is underlaid by an age-based model. The outputs include estimates of abundance, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass. The model also estimates reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels which, when considered with projected future biomass, are used to calculate ABC. The stock assessment is updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI SAFE report (Spencer *et al.* 2001a).

BSAI Flathead Sole Past/Present Effects

The geographic scope for the BSAI flathead sole past/present effects analysis is the same as the BSAI management units (Figure 1.2-2). The temporal scope for this analysis begins in 1954 when the foreign flounder fishery started and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-15 provides a summary of the flathead sole past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on flathead sole:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch, fishery selectivity, and climate changes and regime shifts (indirect effect).

- Change in prey availability due to climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

- Change in important habitat due to fishery gear impacts, marine pollution and oil spills, introduction of exotic species and climate changes and regime shifts (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following section explains any amendments specific to the rock sole fishery. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here. For the BSAI, no amendments specifically mention flathead sole.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on flathead sole in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the flathead sole past/present effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (1954-1976)
  - State of Alaska crab fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1980-1990)
  - Domestic groundfish fisheries (1987-present)

- Past/Present Management Actions
  - Bilateral agreement
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1954-1976)

Flathead sole were first targeted with other flatfish species in the Japanese mothership fishery which began in 1954. The flathead sole fisheries are the same as the flounder fisheries described in Section 3.5.1.5 that primarily targeted yellowfin sole and include the Japanese and Soviet fisheries. Flathead sole were not always identified in catches prior to about 1970, and were combined into the "other species" category. Flathead sole catch declined from approximately 30,000 mt to under 10,000 mt annually from 1963-1965 and then increased steadily to about 25,000 mt in 1969. A significant increase in catch occurred after 1969, peaking in 1971 at about 51,000 mt. Catches again decreased following 1971 to about 20,000 mt annually and remained relatively stable through 1976. The discontinuation of the Soviet flounder fishery (1973) is thought to have had a beneficial effect on the flatfish of the BSAI (NPFMC 2002a, Spencer *et al.* 2002a).

Flounders have made up a relatively minor fishery in the Aleutian Islands, which consists of yellowfin sole, Alaska plaice, rock sole and flathead sole. Annual catch remained well under 5,000 mt from 1962-1971, increased to about 10,000 mt in 1972 and decreased back down to about 5,000 mt by 1976 (NPFMC 2002a).

Although large removals of flathead sole have occurred in the foreign fisheries, there are no observable lingering negative effects in the BSAI flathead sole population.

Internal JV and Domestic Groundfish Fisheries (1980-present)

The JV fishery began in 1980 and was phased out of the BSAI by 1990. From 1977 to 1989, flathead sole harvests were under 10,000 mt annually, with an average annual catch of 5,286 mt. Catches increased in 1990-2000 to an average of 17,946 mt annually. Flathead sole have remained lightly harvested largely due to prohibited species bycatch restrictions, including halibut and crab limits.

Due to the small removals of flathead sole by the JV and past domestic fisheries, there are no observable lingering adverse effects on the BSAI flathead sole populations.

Prior to 1994, flathead sole and Bering flounder were managed as unit stock *Hippoglossoides sp.* under the "other flatfish" assemblage in the BSAI. At that time NPFMC requested the BSAI Groundfish Plan Team to assign a separate ABC for flathead sole in the BSAI, rather than combining it with the other flatfish assemblage. This request was made to protect the less abundant species of the "other flatfish" category at a time of increased targeting on flathead sole since individual species catch are not distinguished when managing as an assemblage, but rather the ABC is prescribed as a composite of all species.

Recent studies have described the growth and distribution differences between the flathead sole and Bering flounder and have illustrated the possible ramifications of combining the two species as a unit stock (Walters and Wilderbuer 1997). This may lead to separate management in the future.

Change in Reproductive Success

External Foreign Groundfish Fisheries

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the foreign fisheries on spatial/temporal distribution of the BSAI flathead sole stocks is unknown. These fisheries are determined not to have had lingering population effects in the BSAI population. Winter time-area closures in the south EBS, designed pre-MSA for the protection of halibut, also benefitted flathead sole because they form winter concentrations in this area as well. Furthermore, the absence of a directed Soviet fishery on flathead sole after 1972 may have additionally benefitted the stocks (NPFMC 2002a).

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of flathead sole. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fisheries (1980-present)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the JV fisheries on the spatial/temporal distribution of the BSAI flathead sole stock is unknown. These effects are determined not to have had lingering population effects in the BSAI population.

Fishery Selectivity

Significant amounts of flathead sole bycatch occur in the Pacific cod, pollock and rock sole fisheries, although the percentage of retention has increased in recent years from 51 percent in 1995 to 82 percent in 2001. Actual amounts of flathead sole discard have declined from 7,189 mt in 1998 to 3,231 mt in 2001; there has been a slight increase in 2002 at 3,646 mt as of September 21, 2002 (Spencer *et al.* 2002a).

Change in Prey Availability

<u>External Foreign Groundfish Fisheries (1954-1976)</u>

It is unlikely that the foreign fisheries had an effect on the prey availability of flathead sole. Flathead sole are characterized as having both a mixed fish and invertebrate diet. They receive this characterization due to the presence of pollock, brittle stars, crangon shrimp, mysids, and bivalves in their diet. Fish are a relatively small portion (less than 20 cm) of the flathead sole diets, but are increasingly important with size (Livingston and deReynier 1996). Records of past foreign fishery juvenile crab bycatch are unavailable; however, the impacts of these fisheries on flathead sole prey availability are also considered to be minimal.

<u>External State of Alaska Crab Fisheries</u>

The bycatch of juvenile crabs (the size consumed by flathead sole) is relatively minor in the State of Alaska crab fisheries. It is unknown what effect this removal of juvenile crab has on the foraging capabilities of flathead sole as crabs are only one component of their diet and these fisheries are quite limited in space.

<u>External Climate Changes and Regime Shifts</u>

Environmental conditions, such as changes in the Aleutian Low pressure system, may affect flathead sole stock recruitment (Hare and Mantua 2000). Future flathead sole research will take environmental variability into account when performing stock-recruitment analyses. Currently, Wilderbuer *et al.* (in press) are investigating a shift in wind patterns that coincided with below average recruitment of flathead sole in the 1990s.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability depending on the frame of reference. In general, when the Aleutian Low was strong, water temperatures were higher, and biomass in the catches was dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changed in this same period, with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes the majority of the diet of flathead sole.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of flathead sole.

Internal JV and Domestic Groundfish Fisheries (1980-present)

It is unlikely that the JV and domestic fisheries have had an effect on the prey availability of flathead sole due to the mixed fish and invertebrate diet of flathead sole. Fish make up a relatively small portion of flathead sole diet, although the importance of fish increases with size. The bycatch of juvenile crabs occurs in small numbers in domestic trawl fisheries. Crabs less than 25 mm in carapace width are estimated to have selectivity of 0.001 in domestic fisheries from the snow crab assessment model. Combined with the fact that juvenile crab are only one component of the diet of flathead sole, these fisheries are not expected to impact their forage capabilities.

Change in Important Habitat

External Foreign Groundfish Fisheries (1954-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6 for a discussion of the potential impacts of fishery gear on habitat.

The effect of the foreign fisheries on habitat suitability is either beneficial or adverse; the effects are found to have had a lingering beneficial influence in the BSAI, probably due to climatological effects.

External IPHC Longline and State of Alaska Crab Fisheries

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6 for a discussion of the potential impacts of fishery gear on habitat.

The effect of the IPHC longline and State of Alaska crab fisheries on BSAI flathead sole habitat suitability is expected to be adverse, however, the magnitude of these effects are unknown. The lingering beneficial influence on habitat suitability in the BSAI in likely due to climatological effects.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability depending on the frame of reference. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changes in the same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of flathead sole.

Internal JV and Domestic Groundfish Fisheries (1980-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6 for a discussion of the potential impacts of fishery gear on habitat.

Recent research by the RACE division of the AFSC has investigated the consequences of lost habitat on juvenile flatfishes. The researchers found that juvenile flatfishes, including Pacific halibut and rock sole, prefer structured habitat (sand with sponges, bryozoans, bivalve shells, and waves). Furthermore, it was found that these structured habitats provide for reduced mortality rates by reducing the encounter rate between flatfish and predators. Invertebrate bycatch from trawled and untrawled areas northeast of the Crab and Halibut Protection Zone 1 in the EBS inspired the research; invertebrates were more abundant in the non-fished zone than in the fished zone (Stone 2002).

The effect of the JV fisheries on habitat suitability is either beneficial or adverse; the effects are found to have had a lingering beneficial influence in the BSAI, probably due to climatological effects.

BSAI Flathead Sole Comparative Baseline

Survey biomass estimates indicate that flathead sole increased from low levels in the early 1980s to a high stable level in the mid-1990s. However, values for 1999-2000 were nearly half of the peak value estimated in 1997, with a slight increase in the 2001 and 2002 surveys (Spencer *et al.* 2002a).

Model estimates indicate an increase in age-3+ total biomass from 1977 to a peak in 1991, followed by a steady decline through 2001. Female spawning biomass increased from 1977 to a peak in 1995, also followed by a steady decline through 2001. Model estimates fit the survey biomass estimate data well, except for 1994, 1997, and 1998 estimates. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

BSAI Flathead Sole Cumulative Effects Analysis Status

The BSAI flathead sole will be brought forward for cumulative effects analysis.

3.5.1.8 BSAI Arrowtooth Flounder

Life History and Distribution

Arrowtooth flounder (*Atheresthes stomias*) occur from central California to the Bering Sea, in waters from about 20-800 m (Zimmerman and Goddard 1996). Spawning is protracted and variable and probably occurs from September through March (Zimmermann 1997). For female arrowtooth flounder collected off the Washington coast, the estimated age at 50 percent maturity was 5 years, with an average length of 37 cm.

Males matured at 4 years and 28 cm (Rickey 1995). The maximum reported ages are 16 years in the Bering Sea, 18 years in the Aleutian Islands, and 23 years in the GOA (Turnock *et al.* 1997a, Wilderbuer and Sample 1997). Arrowtooth flounder is currently the most abundant groundfish species in the GOA; however, they are currently considered of low value and mostly discarded.

In the Bering Sea, the arrowtooth flounder inhabits the continental shelf waters almost exclusively until age-4, but older ages occupy both shelf and slope waters, with greatest concentrations at depths between 100 and 200 m (Martin and Clausen 1995). The very similar Kamchatka flounder (*Atheresthes evermanni*) also occurs in the Bering Sea. Values of 50 percent maturity for the Bering Sea stock are 42.2 cm and 46.9 cm for males and females, respectively (Zimmerman 1997). Table 3.5-16 summarizes biological and reproductive attributes and habitat associations of arrowtooth flounder in the BSAI and GOA.

Trophic Interactions

Arrowtooth flounder play an important role in the Bering Sea and GOA ecosystems because they are large, aggressive, and abundant predators of other groundfish species (Hollowed *et al.* 1995, Livingston 1991b, Yang 1993). The majority of prey by weight of arrowtooth flounders larger than 40 cm is pollock, the remainder consisting of herring, capelin, euphausiids, shrimp, and cephlapods (Yang 1993). These fish also consumed salmonids and Pacific cod in the GOA (Yang and Nelson 2000). The percent of pollock in the diet of arrowtooth flounder increases for sizes greater than 40 cm. Arrowtooth flounder 15-30 cm consume mostly shrimp, capelin, euphausiids and herring, with small amounts of pollock and other miscellaneous fish (DiCosimo 1998). Groundfish predators on arrowtooth include Pacific cod and pollock, which feed mostly on small fish (Livingston and deReynier 1996).

BSAI Arrowtooth Flounder Management

Since the Kamchatka flounder is not usually distinguished from arrowtooth flounder in commercial catches, both species are managed as a group. These species are managed under Tier 3a of the ABC/OFL definitions since equilibrium recruitment can be approximated by the average recruitment from the time-series estimated in the stock assessment, and $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ can be estimated. The spawning biomass is above $B_{40\%}$ (436,000 mt >206,000 mt), which leads to an ABC value of 112,000 mt. The 2003 OFL has been established at 139,000 mt (Table 3.5-2). The BSAI Arrowtooth flounder stock is neither overfished nor approaching an overfished condition (Wilderbuer and Sample 2002).

Information on arrowtooth flounder stock conditions in the BSAI comes primarily from the AFSC annual continental shelf trawl survey, the U.S.-Japan cooperative trawl surveys conducted triennially on the continental slope from 1979-1991 (and 1981), and triennial surveys in the Aleutian Island region. The 2002 BSAI SAFE report introduced a new split-sex model for arrowtooth flounder. This model takes into account the high ratio of females to males and estimates a separate natural mortality rate for males. In turn, separate selectivities are calculated for males and females. The abundance, mortality, and recruitment are also evaluated with this model. The outputs include estimates of sex-specific abundance, year-class strengths, length-at-age relationship, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass. The model also estimates reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels, which, when considered with projected future biomass, are used to calculate ABC. The stock assessment is updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI SAFE report. The reference fishing mortality rate and ABC for arrowtooth flounder are determined by the amount of population information available (see Appendix B) (Wilderbuer and Sample 2002).

BSAI Past/Present Effects Analysis

The geographic scope for the arrowtooth flounder past/present effects analysis is the same as the BSAI management units (Figure 1.2-2). The temporal scope for this analysis begins in 1954 when the foreign fishery for arrowtooth flounder began and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-17 provides a summary of the arrowtooth flounder past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on arrowtooth flounder:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to the spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery bycatch of prey species, introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).

- Change in important habitat due to fishery gear impacts, introduction of exotic species, marine pollution and oil spills, and climate changes and regime shifts (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explains any management actions specific to the arrowtooth flounder. Amendments discussed in Section 3.2 which impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on arrowtooth flounder in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate change or regime shifts.

The past/present events determined to be applicable to the arrowtooth flounder past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1954-1976)
  - State of Alaska groundfish fisheries
  - State of Alaska herring fisheries

- Marine pollution and oil spills
- Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1980-1990)
  - Domestic groundfish fisheries (1986-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1954-1976)

The foreign flatfish fishery began in 1954, mainly targeting yellowfin sole (see Section 3.5.1.5). Catches of Greenland turbot (arrowtooth flounder and Greenland turbot) were relatively high in early years of the EBS fishery ranging over 50,000 mt in 1961 and 1962. Japanese fisheries targeted on arrowtooth flounder from 1961 to 1962 for the production of fishmeal (Takahashi 1976). Catches dropped below 40,000 mt in 1963-1970 as these species were only taken as bycatch in the pollock and other directed fisheries. Annual harvest of arrowtooth flounder reached peak rates between 1974-1976 at levels between 19,000 and 25,000 mt (NPFMC 2002a).

Flounders have formed a relatively small proportion of the total catches in the Aleutian Islands dominated by the Japanese fisheries, although Greenland turbot and arrowtooth flounder have been the main flounder species taken. Reported catches of arrowtooth flounder and Greenland turbot were low until 1970, after which they increased sharply, with Greenland turbot as the primary species taken (NPFMC 2002a).

Although large removals of arrowtooth flounder have occurred during the foreign fisheries, there are no observable lingering adverse effects in the BSAI arrowtooth flounder populations.

Internal JV and Domestic Groundfish Fisheries (1980-present)

The JV arrowtooth flounder fisheries began in 1980 and were phased-out by 1990, when the fishery became fully domesticated. The domestic fisheries began in 1986. With the phasing-out of the foreign fisheries and restrictions placed on Greenland turbot fisheries, harvest rates decreased from the foreign exploitation harvest rates and have remained lightly harvested since that time, averaging 13,500 mt from 1977-2000. Total catch for 2001 (as of September 15, 2001) was 11,230 mt, well below the ABC. Arrowtooth flounder are typically caught in the pursuit of high-value fish and are not a target species in the BSAI (Wilderbuer and Sample 2002).

Prior to 1985, arrowtooth flounder were managed with Greenland turbot as a species complex due to similarities in their life history characteristics, distribution, and exploitation. Greenland turbot were the target species of the fisheries, whereas arrowtooth flounder were caught as bycatch. Because the stock condition of the two species have differed markedly in recent years, management since 1986 has been by individual species.

Discard rates of arrowtooth flounder have been high, ranging from 72 mt in 1985 to 18,841 mt in 1991. Percent retention from 1985-1998 ranged from 4 to 19 percent; however, retention has risen in recent years to 62 percent in 2001. Substantial amounts of discard take place in the BSAI trawl and longline target fisheries, mostly in the Pacific cod, rock sole, "other flatfish," and Greenland turbot fisheries. A developing arrowtooth flounder market is expected to increase retention in coming years (Wilderbuer and Sample 2001).

Although large removals of arrowtooth flounder have occurred in the JV and past domestic fisheries, there are no observable lingering adverse effects in the arrowtooth flounder populations.

Currently, arrowtooth flounder have a low perceived commercial value because the flesh softens soon after capture due to protease enzyme activity (Greene and Babbitt 1990). Enzyme inhibitors such as beef plasma have been found to counteract this flesh-softening activity, but suitable markets have not been established to support increased harvests. Thus, arrowtooth flounder are primarily caught by bottom trawls as bycatch in high value fisheries. Stocks are lightly exploited and appear to be increasing in both the GOA and the BSAI.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1954-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the direct foreign fisheries on the spatial/temporal distribution of the BSAI arrowtooth flounder is unknown. However, these effects are determined to not have had lingering population effects on the stock.

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of arrowtooth flounder. The combination of climate effects and regime shifts on prey availability and habitat suitability influence the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an in-depth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries.

Internal JV and Domestic Groundfish Fisheries (1980-present)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the JV and past domestic fisheries on the spatial/temporal distribution of the BSAI arrowtooth flounder is unknown. However, these effects are determined to not have had lingering population effects in either stock.

Change in Prey Availability

External Foreign Groundfish Fisheries (1954-1976)

The past foreign fisheries in the BSAI have had either an adverse or beneficial lingering impact on prey availability. Arrowtooth flounder from 15-30 cm feed mostly on shrimp, euphausiids, capelin, and herring (DiCosimo 1998). Arrowtooth flounder are important as a large and abundant predator of other groundfish species. Adults (fish over 40 cm) are almost exclusively piscivorus and over half their diet can consist of pollock (Hollowed *et al.* 1995, Livingston 1991b, Yang 1993). In turn, the effects of the fisheries could have been beneficial or adverse since pollock also prey on arrowtooth flounder.

Bycatch of forage species in the past foreign BSAI groundfish fisheries is also likely to have been minimal. Furthermore, since arrowtooth flounder feed on a number of different prey species, it is also unlikely that the groundfish fisheries would have had a significantly adverse impact on prey availability.

External State of Alaska Groundfish Fisheries and Herring Fisheries

Bycatch of forage species and juvenile pollock in the BSAI State of Alaska groundfish fisheries is minimal and is unlikely to reduce the prey availability of arrowtooth flounder. Furthermore, since arrowtooth flounder feed on a number of different prey species, it is also unlikely that State of Alaska herring fisheries would have a significantly adverse impact on prey availability.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of arrowtooth flounder.

Internal JV and Domestic Groundfish Fisheries (1980-present)

The past JV fisheries in the BSAI have had either an adverse or beneficial lingering impact on prey availability. However, there are no indications that harvest conditions resulting from arrowtooth flounder management would alter the genetic structure of the populations, the available prey, or the suitability of nursery and/or spawning habitat in a manner that would impede long-term suitability of the stock.

Bycatch of forage species in the BSAI groundfish fisheries is minimal. Furthermore, since arrowtooth flounder feed on a number of different prey species, it is also unlikely that the groundfish fisheries would have a significantly adverse impact on prey availability. BSAI/GOA Amendment 36/36 was established to protect forage fish species from developing in to a fishery market, and limiting the forage fish bycatch.

Change in Important Habitat

External Foreign Groundfish Fisheries (1954-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Habitat suitability for both stocks has been either adversely or beneficially affected by the intensity of the past foreign fisheries, and these effects are considered to have lingering influence at the population-level.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of arrowtooth flounder.

Internal JV and Domestic Groundfish Fisheries (1980-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Habitat suitability for both stocks has been either adversely or beneficially affected by the intensity of the past JV fisheries, and these effects are considered to have lingering influence at the population-level.

There are no indications that harvest conditions resulting from arrowtooth flounder management would alter the genetic structure of the populations, the available prey, or the suitability of nursery and/or spawning habitat in a manner that would impede long-term suitability of the stock.

BSAI Arrowtooth Flounder Comparative Baseline

Estimated biomass from the AFSC surveys on the continental shelf showed a consistent increasing trend from 1975-1995. These estimates remained at high levels from 1992-1997, but declined from 1997-2000 to levels 60 percent below the peak 1994 biomass estimate. 2001 survey biomass estimates are slightly higher than the 2000 estimate; however, the 2002 biomass estimates are down from 2001 (Wilderbuer and Sample 2002).

Continental slope surveys show an increase in biomass estimates between 1982 and 1985. Estimates for 1988 and 1991 are lower; however, the surveys in these years were not as deep as in previous years (200-800 m versus 200-1000 m in previous years). Survey estimates from 1979-1985 indicate that 27-51 percent of the arrowtooth flounder biomass are found in slope waters. The 2002 EBS continental slope survey found over 90 percent of arrowtooth flounder biomass at less than 800 m. Biomass estimates in the Aleutian Island region have remained stable at relatively high values since 1994 (Wilderbuer and Sample 2002).

Stock assessment model estimates indicate a five-fold increase in total biomass from 1980 to 1996, attributed to five strong year-classes. Biomass has since declined 22 percent from the peak of 817,700 mt to the 2002 biomass estimate of 638,000 mt. The decline in abundance can be attributed to a below average recruitment during the late 1990s. Currently the arrowtooth flounder spawning stock has contributions from a wide range of ages, and the stock is considered at a high level but declining. Model projections indicate that this stock is neither overfished nor approaching an overfished condition (Wilderbuer and Sample 2002).

BSAI Arrowtooth Flounder Cumulative Effects Analysis Status

The BSAI arrowtooth flounder will be brought forward for cumulative effects analysis.

3.5.1.9 BSAI Greenland Turbot

Life History and Distribution

Greenland turbot (*Reinhardtius hippoglossoides*) are distributed from Baja California northward throughout Alaska and the Arctic, although they are rare south of Alaska and primarily distributed in the EBS and Aleutian Islands region (Hubbs and Wilimovsky 1964). Juveniles are believed to spend the first three or four years of life on the continental shelf, then move to the continental slope as adults (Alton *et al.* 1988, Templeman 1973). Greenland turbot are demersal to semipelagic. Unlike most flatfish, the Greenland turbot's migrating eye does not move completely to one side, but stops at the top of the head, which presumably results in a greater field of vision and helps to explain this species' tendency to feed off the sea bottom (de Groot 1970). Spawning occurs in winter and may be protracted, starting as early as September and continuing until March (Bulatov 1983). The eggs are benthypelagic (D'yakov 1982). Juveniles are absent in the Aleutian Islands, suggesting that populations in that area originate from elsewhere (Alton *et al.* 1988). Greenland turbot are a moderately long-lived species, with a maximum recorded age of 21 years (Ianelli and Wilderbuer 1995). Table 3.5-18 summarizes biological and reproductive attributes and habitat associations of Greenland turbot in the BSAI and GOA.

Trophic Interactions

Pelagic fish are the main prey of Greenland turbot, with pollock often a major species in the diet. Other prey items include squid, euphasiids, shrimp, and other fish species inhabiting deepwater, such as Bathylagidae and Myctophidae (Livingston 1991b).

Groundfish predators include Pacific cod, pollock, and yellowfin sole, which feed mostly on fish ranging from 2-5 cm standard length (Livingston and deReynier 1996).

BSAI Greenland Turbot Management

Greenland turbot are currently managed as a single stock in the BSAI under Tier 3a of NPFMC's ABC and OFL definitions (Amendment 44 to the FMP). Management under Tier 3a requires reliable estimates of projected biomass, $B_{40\%}$, $F_{40\%}$ (for ABC), and $F_{35\%}$ (for OFL). The addition of new slope survey estimates indicate a lower female spawning biomass for 2003 than predicted in the previous year (67,800 mt), which leads to a more conservative ABC. The recommended ABC for 2003 is 5,800 mt based on the recent 5-year average fishing mortality. This conservative ABC value is intended to protect the Greenland turbot stock in light of low recruitment and continued decline in stock abundance. The corresponding OFL is 17,800 mt (Table 3.5-2). Additional slope trawl surveys are necessary to reduce uncertainty in this stock (Ianelli *et al.* 2002a).

Abundance of juvenile and adult Greenland turbot on the EBS shelf is estimated by an annual trawl survey and in the Aleutian Islands by a triennial trawl survey. Abundance of adults and older juveniles were surveyed every three years on the slope cooperatively by the U.S. and Japan from 1979-1991. In the 2002, a biennial bottom trawl survey began in the upper continental slope of the EBS by the AFSC. Data collected provides information on abundance trends and trends in the biological condition of the groundfish and invertebrate resources in that region. As mentioned above, a new continental slope survey also began in the BSAI in 2002 (Ianelli *et al.* 2002a).

The time-series of fishery and survey length compositions allows the use of a length-based stock assessment model (Ianelli *et al.* 1997). The outputs include estimates of abundance, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass. The model also estimates reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels, which, when considered with projected future biomass, are used to calculate ABC. The stock assessment is updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI SAFE report. Recent efforts simplify the model used for Greenland turbot through a two-fishery combined-sexes model. However, further model specification issues will need to be addressed before the model is used extensively (Ianelli *et al.* 2001a).

BSAI Greenland Turbot Past/Present Effects Analysis

The geographic scope for the BSAI Greenland turbot past/present effects analysis is the same as the BSAI management areas (Figure 1.2-2). The temporal scope for this analysis begins in 1954 when the foreign flounder fishery began and ends in 2002, the most recent year for which stock assessment information exists.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-19 provides a summary of the BSAI Greenland turbot past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on BSAI Greenland turbot.

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect)
- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).
- Change in prey availability due to fishery catch/bycatch of prey species, climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).
- Change in important habitat due to fishery gear impacts, climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explains any management actions specific to the Greenland turbot. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on Greenland turbot in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the Greenland turbot past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1954-1976)
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1968-1990)

- Domestic groundfish fisheries (1968-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1954-1976)

The flounder foreign fishery began in 1954 and primarily targeted yellowfin sole (see Section 3.5.1.5). Catches of Greenland turbot (combined arrowtooth flounder and Greenland turbot) were high, ranging over 50,000 mt in 1961 and 1962, during which time the Japanese fisheries were targeting arrowtooth flounder for fishmeal (Takahashi 1976). From 1963 to 1970, catches dropped below 40,000 mt as Greenland turbot and arrowtooth flounder were only taken as bycatch in the pollock and other target fisheries. After 1970, Greenland turbot catch increased in both the Japanese and Soviet fisheries, reaching 70,000 mt in 1974 (NPFMC 2002a).

Flounders formed only a minor fishery in the Aleutian Islands region. Combined catches of arrowtooth flounder and Greenland turbot were low until 1970, after which there was a sharp increase in catch dominated by Greenland turbot. Catches from 1972-1975 ranged from 12,000 to 14,000 mt, taken mostly by the Japanese fisheries (NPFMC 2002a).

The large removals of Greenland turbot by the foreign fisheries are determined to have had an adverse effect on the BSAI Greenland turbot population. However, partly due to the longevity of the species, these effects are determined not to have had any observable lingering adverse effects in the population. The current low levels of BSAI Greenland turbot abundance is not attributed to foreign fishery removals.

Internal JV and Domestic Groundfish Fisheries (1968-present)

Following implementation of the MSA in 1976, catches still remained high, ranging from 48,000 to 57,000 mt annually. Catch restrictions placed on the Greenland turbot due to signs of declining abundance caused a decline in annual harvest rates from 1984 to the present. During these years, catches ranged from a high of 23,120 mt in 1984 to a low of 2,689 mt in 1992. Concerns over low recruitment led to a TAC setting at 7,000 mt between 1992-1997 and has resulted in a primarily bycatch-only fishery (Ianelli *et al.* 2001a).

Prior to 1985, Greenland turbot was managed with arrowtooth flounder as a species complex due to similarities in their life history characteristics, distribution, and exploitation. Greenland turbot were the target species of the fisheries, whereas arrowtooth flounder were caught as bycatch. Because the respective stock conditions of the two species have differed markedly in recent years, management since 1986 has been by individual species (Ianelli *et al.* 2002a).

Discard rates of Greenland turbot are significant, ranging from 2,711 mt in 1994 to a low of 729 mt in 1999. Bycatch occurs primarily in the Greenland turbot, sablefish, flathead sole, Pacific cod, and arrowtooth flounder fisheries. The sablefish fishery has the highest discard rate, increasing from 17 percent in 1999 to about 40 percent in 2001 (Ianelli *et al.* 2001a).

The large removals of Greenland turbot by the JV and past domestic fisheries are found to have had an adverse effect on the BSAI Greenland turbot population However, partly due to the longevity and turnover of the species, these effects are determined not to have had lingering population effects in the population. The current low level of BSAI Greenland turbot abundance is not attributed to the JV and past domestic fisheries removals.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1954-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the past foreign fisheries on spatial/temporal distribution of the BSAI Greenland turbot populations is unknown. However, there are no observable lingering adverse effects on the BSAI stock of Greenland turbot.

External Climate Changes and Regime Shifts

The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on the reproductive success of Greenland turbot. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Dramatic declines in the number of immature Greenland turbot on the EBS shelf relative to 1970s abundance information have inspired research into possible causes of this decline. One hypothesis is that increased abundance of predators (e.g., Pacific cod, Pacific halibut) in the mid-1980s (possibly due to climatological effects) reduced the survival of juvenile Greenland turbot (Ianelli *et al.* 2001a).

Internal JV and Domestic Groundfish Fisheries (1968-present)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the past JV fisheries on spatial/temporal distribution of the BSAI Greenland turbot stock is unknown. However, there are no observable lingering adverse effects in the BSAI Greenland turbot population.

Change in Prey Availability

External Foreign Groundfish Fisheries (1954-1976)

The foreign fisheries in Bering Sea could have had lingering adverse or beneficial effects on the availability of prey for Greenland turbot. Pelagic fish are the main prey of Greenland turbot, with pollock often a major species in the diet (Livingston 1991b). Greenland turbot also feed on squid, euphausiids, and shrimp.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. For example when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock, and flatfishes such as Greenland turbot. Community structure in nearshore areas around Kodiak Island changed in this same period, with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod and flatfishes. Greenland turbot and Pacific halibut responded more strongly to longer-term events (such as decadal-scale climate regime patterns). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor in the population.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of Greenland turbot.

Internal JV and Domestic Groundfish Fisheries (1968-present)

The JV fisheries in the Bering Sea could have had lingering adverse or beneficial effects on the availability of prey for Greenland turbot. Pelagic fish are the main prey of Greenland turbot, with pollock often a major species in the diet (Livingston 1991b). Greenland turbot also feed on squid, euphausiids, and shrimp. However, there are no indications that harvest conditions under current management would alter the population genetic structure, the available prey, or the suitability of nursery and/or spawning habitat in a manner that would impede long-term sustainability of the stock in both the BSAI and GOA.

Change in Important Habitat

External Foreign Groundfish Fisheries (1954-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of the past foreign fisheries on habitat suitability is either beneficial or adverse; overall, a lingering influence on the population is found in both stocks probably mostly due to climatological effects.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability. Another hypothesis to explain the decreased abundance of immature Greenland turbot is that the environmental regime shift that occurred in the late 1970s affected the abundance or shifted the location of Greenland turbot at different life stages due to the changing oceanographic conditions. A Greenland turbot tagging study is being currently being conducted by the NOAA Fisheries Auke Bay Laboratory in an effort to better understand Greenland turbot life history and to develop a multi-species ecosystem model (Ianelli *et al.* 2001a).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of Greenland turbot.

Internal JV and Domestic Groundfish Fisheries (1968-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of these fisheries on habitat suitability is either beneficial or adverse; overall, a lingering influence on the population is found in both stocks, probably mostly due to climatological effects. In 1998, no halibut PSC was apportioned to the Greenland turbot trawl fishery; therefore, no directed trawl fishing occurred, which may decrease the intensity of the fishery on Greenland turbot habitat.

There are no indications that harvest conditions under current management would alter the population genetic structure, the available prey, or the suitability of nursery and/or spawning habitat in a manner that would impede long-term sustainability of the stock in both the BSAI and GOA.

BSAI Greenland Turbot Comparative Baseline

Combined shelf and slope surveys indicate a decline in Greenland turbot abundance between 1979 and 1985. Following 1985, slope and Aleutian Island biomass results are not comparable since surveys were conducted at different depths. However, there is an indication that biomass estimates declined between 1985 and 1991.

The average shelf survey biomass estimate during 1993 and 2001 is 29,968 mt with a declining trend during this period. In the Aleutian Island region, U.S.-Japan cooperative longline surveys suggest an increasing trend from 1980 to 1986, possibly due to the migration of older fish from the EBS (Ianelli *et al.* 2002a).

The stock assessment model estimates biomass in the early 1960s are nearly half of those estimated during the 1970s. Subsequent poor recruitment of young juvenile Greenland turbot led to a decrease in abundance of exploitable stock in the 1980s. However, these biomass estimates may be biased towards low values since the Aleutian Island survey biomass estimates are not included. The Aleutian Island survey biomass estimates typically average about one fourth to one third of the total trawl survey population biomass estimate for the BSAI.

BSAI Greenland Turbot Cumulative Effects Analysis Status

BSAI Greenland turbot will be brought forward for cumulative effects analysis.

3.5.1.10 BSAI Alaska Plaice and Other Flatfish

Life History and Distribution

In the Bering Sea, fifteen flatfish species are managed under the "other flatfish" assemblage: Arctic flounder (*Liopsetta glacialis*), butter sole (*Isopsetta isolepis*), curlfin sole (*Pleuronectes decurrens*), deep-sea sole (*Embassichthys bathybus*), Dover sole (*Microstomus pacificus*), English sole (*Parophrys vetulus*), longhead dab (*Limanda proboscidea*), Pacific sanddab (*Citharichthys sordidus*), petrale sole (*Eopsetta jordani*), rex sole (*Glyptocephalus zachirus*), roughscale sole (*Clidodoerma asperrimum*), sand sole (*Psettichthys melanostictus*), slender sole (*Lyopsetta exilis*), starry flounder (*Platichthys stellatus*), and Sakhalin sole (*Pleuronectes sakhalinensis*). Until 2002, Alaska plaice (*Pleuronectes quadriterculatus*) was also a part of the other flatfish assemblage but has since been broken out and managed separately (Spencer *et al.* 2002c).

The species of the "other flatfish" complex are generally found on the EBS continental shelf, with small populations in the Aleutian Islands region. The distribution of many of the flatfish species extends down to Baja California, Mexico (Eschmeyer *et al.* 1983). Arctic flounder has a larger distribution, and can be found in the northeastern Atlantic, Arctic, and North Pacific oceans. In the North Pacific, the Arctic flounder can be found in the Chukchi and Bering seas and northern Okhotsk Sea. Both Arctic flounder and starry flounder are known to enter rivers (Nielsen 1986, Morrow 1980). Flatfish species tend to prefer sandy and/or muddy bottoms. Adults overwinter in deeper water and move into nearshore spawning areas in the late winter and spring. Spawning takes place as early as November for Dover sole (Hagerman 1952) but occurs from February through April for most species (Hart 1973). All flatfish eggs are pelagic and sink to the bottom shortly before hatching (Alderdice and Forrester 1968, Hagerman 1952, Orcutt 1950, Zhang 1987), except for butter sole, which has demersal eggs (Levings 1968). Little is known of the spawning, growth characteristics, or seasonal movements and population age and size structure of the species in the flatfish complex.

Dover sole produce large amounts of slime which may cover other fishes when caught in trawls (Clemens and Wilby 1961). Dover sole can hybridize with starry flounder producing *Inopsetta ischyra*, which can be found in the Bering Sea south to San Francisco, California. Starry flounder also hybridizes with the stone flounder (*Kareius bicoloratus)* (Morrow 1980).

Of the other flatfish species in the Bering Sea, Alaska plaice is the most abundant and commercially important. It is a comparatively long-lived species, and has frequently been aged as high as 25 years. This species is found at depths less than 110 m in the summer, with small juveniles frequenting in the shallower coastal waters and adults in deeper waters.

The other flatfish species complex in the GOA is currently managed as four categories: shallow water flatfish, deepwater flatfish, flathead sole, and rex sole (*Errex zachirus*). In 2002, flathead sole (*Hippoglossoides elassodon*) (see Section 3.5.1.7) was broken out of the flatfish assemblage and managed independently in the GOA. The shallow water flatfish consist of Alaska plaice (*Pleuronectes quadrituberculatus*), starry flounder (*Platichthys stellatus*), yellowfin sole (*Pleuronectes asper*) (see Section 3.5.1.5), English sole (*Pleuronectes vetulus*), butter sole (*Pleuronectes isolepis*), sand sole (*Psettichthys melanostictus*), northern rock sole (*Lepidopsetta perarcuata*) (see Section 3.5.1.6), and southern rock sole (*Pleuronectes bilineatus*) (see Section 3.5.1.6). Deepwater flatfish include Dover sole (*Microstomus pacificus*), Greenland turbot (*Reinhardtius hippoglossoides*) (see Section 3.5.1.9), and deep-sea sole (*Embassichthys bathbius*). Life history and distribution for these benthic species are as described above as in the BSAI or in the individual sections as indicated. Table 3.5-20 summarizes biological and reproductive attributes and habitat associations of selected flatfish in the BSAI and GOA

Trophic Interactions

The information provided below applies for both BSAI and GOA species not previously discussed in other sections.

Alaska plaice appear to feed primarily on polychaetes, marine worms, and other benthic invertebrates (Livingston and deReynier 1996, Livingston *et al.* 1993, Zhang 1988). Although little is known on the feeding habitats of the remaining flatfish species, most seem to prefer benthic invertebrates including small crustaceans, marine worms, mollusks, echinoderms, and small fishes (Hart 1973, Brodeur and Livingston 1988, Pearcy and Hancock 1978, Lamb and Edgell 1986, Nielsen 1986).

A common documented predator of many of the flatfish, including the Dover and English sole and the Pacific sanddab, is the California sea lion (Lowry *et al.* 1990). Other predators of various flatfish species include the Pacific halibut (on Dover sole) (Yang and Nelson 2000), the Pacific staghorn sculpin (on English sole) (Armstrong *et al.* 1995), the Pacific bonito (on Pacific sanddab) (Oliphant 1962), and the blue shark in California waters (on Pacific sanddab) (Harvey 1989). The hydromedusa water jellyfish may also prey upon the larvae and eggs of the English sole and the sand sole as found in a study in British Columbia (Purcell 1989). Predators of Alaska plaice include Pacific halibut, yellowfin sole, beluga whales, and fur seals.

BSAI Alaska Plaice and Other Flatfish Management

Beginning in 2002, Alaska plaice was broken out of the other flatfish assemblage and managed independently (Table 3.5-2). In the past, Alaska plaice dominated the other flatfish assemblage, constituting 87 percent of the 2000-2001 other flatfish catch. Alaska plaice is evaluated under Tier 3a of Amendment 56. Model projections indicate that Alaska plaice stocks are not overfished or approaching an overfished condition. (Spencer *et al.* 2002c).

The time series of fishery and survey age compositions allows the use of an age-based stock assessment model for the Alaska plaice stock. The outputs include estimates of abundance, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass (Spencer *et al.* 2002c).

Although there are fifteen species considered as part of the "other flatfish" complex, only seven species comprise the majority of catch. These species include English sole, Sakhalin sole, Dover sole, butter sole, longhead dab, rex sole and starry flounder. According to 2001 EBS survey results, English sole, Sakhalin sole, and Dover sole constitute less than one percent of the remaining total flatfish biomass (minus Alaska plaice biomass), butter sole constitutes one percent, longhead dab 16 percent, rex sole 28 percent, and starry flounder 55 percent. The other flatfish assemblage is assessed under Tier 5 for 2002, although it has been managed under Tier 4 and 3a in the past. An ABC value for the other flatfish complex is determined at the 0.75 M level, equating to an ABC of 16,000 mt. The 2003 OFL value is 21,400 mt, based on the Tier 5 formula $F = M$ (Table 3.5-2). It is not possible to determine if the other flatfish assemblage is overfished or approaching an overfished condition (Spencer *et al.* 2002b).

Because other flatfish are generally not targeted in the BSAI, commercial catch data are of limited use for stock assessment purposes. The principal source of information for evaluating the condition of other flatfish stocks in the BSAI is the annual EBS shelf trawl survey. Thus, the annual trawl survey biomass estimates are considered the best information available to determine the stock biomass. Model assessments are not conducted for this group due to lack of sufficient information. The stock assessment is updated annually at the conclusion of the summer trawl survey and is incorporated into the BSAI SAFE report (Spencer *et al.* 2001b).

BSAI Alaska Plaice and Other Flatfish Past/Present Effects Analysis

The geographic scope for the Alaska plaice and other flatfish assemblage past/present effects analysis is the same as the BSAI management areas (Figure 1.2-2). The temporal scope for this analysis begins in 1954 when the foreign flounder fishery begins and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-21 provides a summary of the BSAI Alaska plaice and other flatfish assemblage past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on the BSAI Alaska plaice and other flatfish assemblage:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes and regime shift (indirect effect).

- Change in prey availability due to fishery catch/bycatch of prey species, climate changes and regime shifts, introduction of exotic species, and marine pollution and oil spills (indirect effect).

- Change in important habitat due to fishery gear impacts, climate changes and regime shifts, introduction of exotic species, and marine pollution and oil spills (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explains any management actions specific to the other flatfish assemblage. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on the Alaska plaice and the other flatfish assemblage in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the other flatfish assemblage past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1954-1976)
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1988-1991)
  - Domestic groundfish fisheries (1988-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1954-1976)

The flounder foreign fishery began in 1954 and primarily targeted yellowfin sole (see Section 3.5.1.5). Catches of the other flatfish species, including flathead sole increased from 25,000 mt in the 1960s to 52,000 mt in 1971, mostly due to better identification and better reporting of catches during the 1970s (NPFMC 2002a).

Alaska plaice, which has made up the largest portion of catch of the other species assemblage prior to 2002, were probably taken as bycatch in the yellowfin sole fishery (Zhang *et al.* 1998). Following the peak in 1971, annual catch fell below 20,000 mt throughout the rest of the 1970s (Spencer *et al.* 2001b).

Although large removals of Alaska plaice and other flatfish occurred during the foreign fisheries, they are determined not have had any observable lingering adverse effects on the BSAI Alaska plaice and other flatfish populations.

Internal JV and Domestic Groundfish Fisheries (1988-present)

The other flatfish JV fishery began in 1988 and produced the largest catch of Alaska plaice since 1963 at 67,425 mt (Zhang *et al.* 1998). Harvest was drastically reduced in the remaining years of the JV fisheries to below 20,000 mt annually. The JV fisheries were phased-out and the fishery completely domesticated by 1991. The domestic fishery has taken under 20,000 mt in most years, except 1994 and 1997 which were still under 25,000 mt of annual catch. As of November 2, 2002, the Alaska plaice catch has exceeded the OFL of 11,400 mt. In recent years, the other flatfish fishery has been restricted by PSC limits for Pacific halibut and crab (Spencer *et al.* 2002b, Spencer *et al.* 2002c).

Alaska plaice and other flatfish are taken in directed bottom trawl fisheries in the EBS. The discard rates for the other flatfish fishery are significant, ranging from 11,000-19,000 mt from 1993-2000 (discard rates prior to 1995 also include flathead sole). Percent retention is low, with an average retention rate of 27 percent from 1993-2001. Discard occurs primarily in the yellowfin sole, flathead sole, and rock sole fisheries in 2000 (Spencer *et al.* 2002b, 2002c).

Although large removals of Alaska plaice and other flatfish have occurred in the JV and past domestic fisheries, they are determined not to have had any observable lingering adverse effects on the BSAI Alaska plaice and other flatfish populations.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1954-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the foreign fisheries on the spatial/temporal distribution of the BSAI Alaska plaice and other flatfish populations in the BSAI is unknown. However, these fisheries are determined not to have had any observable lingering adverse effects on the BSAI populations.

External Climate Changes and Regime Shifts

The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on the reproductive success of the Alaska plaice and other flatfish assemblage. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fisheries (1988-present)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the JV and past domestic fisheries on the spatial/temporal distribution of the BSAI Alaska plaice and other flatfish populations in the BSAI is unknown. However, these fisheries are determined not to have had any observable lingering adverse effects on the BSAI populations.

Change in Prey Availability

External Foreign Groundfish Fisheries (1954-1976)

The foreign fisheries BSAI are unlikely to have directly impacted prey availability for the other flatfish since these fish eat infaunal invertebrates. The lingering beneficial influence in the BSAI flatfish stock is likely due to the natural events related to climate changes.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes the majority of the diet of Alaska plaice and other flatfish.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of the other flatfish group.

Internal JV and Domestic Groundfish Fisheries (1988-present)

The JV fisheries in the BSAI are unlikely to have directly impacted prey availability for the other flatfish since these fish eat infaunal invertebrates. The lingering beneficial influence in the BSAI flatfish stock is likely due to the natural events related to climate changes.

Change in Important Habitat

External Foreign Groundfish Fisheries (1954-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of the foreign fisheries on habitat suitability is either beneficial or adverse; they are found to have had a lingering influence in the BSAI stock, and the overall lingering effect is beneficial on the BSAI other flatfish assemblage, probably mostly due to climatological effects.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of the other flatfish group.

Internal JV and Domestic Groundfish Fisheries (1988-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of the JV fisheries on habitat suitability is either beneficial or adverse; they are found to have had a lingering influence in the BSAI stock, and the overall lingering effect is beneficial in the BSAI other flatfish assemblage, probably mostly due to climatological effects.

BSAI Alaska Plaice and Other Flatfish Comparative Baseline

Trawl survey biomass estimates indicate that the abundance of Alaska plaice increased on the EBS continental shelf from 1975 through 1984. A slight decline in the Alaska plaice biomass occurred between 1984 and 1985 and remained relatively stable until an increase in abundance in 1994 and 1997. The 2002 estimate of 424,971 mt is a 27 percent decrease relative to the 2001 biomass estimate, and is very close to the 2000 biomass estimate. It should be noted that there is uncertainty associated with the area-swept method of trawl surveying. Furthermore, there have been changes in gear over time during which the survey has been conducted (Spencer *et al.* 2002c).

Miscellaneous other species in the other flatfish category have shown relatively stable biomass estimates from trawl surveys from 1983-1995. Biomass estimates increased from 1996-2001 with a substantial increase in the 2002 biomass estimate at 97,938 mt in the EBS. The Aleutian Island region generally shows smaller populations of other flatfish, showing slight increases during each survey year since 1991. (Spencer *et al.* 2002b)

BSAI Alaska Plaice and Other Flatfish Cumulative Effects Analysis Status

The BSAI Alaska plaice and the other flatfish assemblage will be brought forward for cumulative effects analysis.

3.5.1.11 BSAI Pacific Ocean Perch

Life History and Distribution

Pacific ocean perch (*Sebastes alutus)* is primarily a demersal species that inhabits the outer continental shelf and slope regions of the NPO and the Bering Sea from southern California to Japan (Allen and Smith 1988). As adults, they live on or near the seafloor, generally in areas with smooth bottoms (Krieger 1993) and generally at depths ranging from 180-420 m. Though more is known about the life history of Pacific ocean perch than about other rockfish species (Kendall and Lenarz 1986), much uncertainty still exists about its life history. Pacific ocean perch are viviparous, with internal fertilization and the release of live young (Hart 1973). Insemination occurs in the fall, and release of larvae occurs in April or May. Pacific ocean perch larvae are thought to be pelagic and drift with the current. Juveniles seem to inhabit rockier, higher relief areas than adults (Carlson and Straty 1981, Krieger 1993). The maximum recorded age of Pacific ocean perch is 100 years (Frimodt 1995). Table 3.5-22 summarizes biological and reproductive attributes and habitat associations of Pacific ocean perch in the BSAI and GOA.

The Pacific ocean perch were found to be genetically similar throughout their range based on allozyme variation (Seeb and Gunderson 1988); however, preliminary analysis using microsatellite deoxyribonucleic acid (DNA) techniques suggests that genetically distinct populations of Pacific ocean perch exist (A.J. Gharrett personal communication, University of Alaska Fairbanks).

Trophic Interactions

During the summer of 1990, the diets of commercially important groundfish species in the GOA were analyzed by Yang (1993). About 98 percent of the total stomach content weight of Pacific ocean perch in the study was made up of invertebrates and 2 percent of fish. Euphausiids (mainly *Thysanoessa inermis*) were the most important prey item. Euphausiids comprised 87 percent, by weight, of the total stomach contents. Calanoid copepods, amphipods, arrow worms, and shrimp were frequently eaten by Pacific ocean perch (Brodeur and Percy 1984, Yang 1996).

Documented predators of Pacific ocean perch include Pacific halibut and sablefish, and it is likely that Pacific cod and arrowtooth flounder also prey on Pacific ocean perch. Pelagic juveniles are consumed by salmon, and benthic juveniles are eaten by lingcod and other demersal fish (NMFS 1997).

BSAI Pacific Ocean Perch Management

Pacific ocean perch is the most commercially important rockfish in Alaska's fisheries and is taken mostly with bottom trawls. Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, therefore qualifying the stock for management under Tier 3. The projected spawning biomass for 2003 is 135,000 mt, placing it into sub-tier "b" of Tier 3. The recommended ABC value for 2003 is 15,100 mt, apportioned between four areas: BS = 2,410 mt; Area 541 = 3,495 mt; Area 542 = 3,330 mt; Area 543 = 5,835 mt. The OFL value of 17,900 mt has been established for the BSAI in 2003 (Table 3.5-2). Model projections indicate that the Pacific ocean perch stock is neither overfished nor approaching an overfished condition.

Previous to 2001, Pacific ocean perch were assessed separately using a model for the EBS and the Aleutian Island region. Beginning with the 2001 stock assessment, the Pacific ocean perch were assessed as one stock, and a single model for the BSAI was used, incorporating the Aleutian Islands trawl survey and the BSAI-wide catches. Pacific ocean perch are assessed with an age-structured model incorporating fishery and survey catch data and length and age compositions. Survey data are from the NOAA Fisheries triennial trawl groundfish surveys, and the fishery data comes from the Observer Program. The age-structured population model is used to obtain estimates of recruitment, numbers at age, and catch at age. Natural mortality and individual weight-at-age are estimated independent of the model (Spencer and Ianelli 2001).

BSAI Pacific Ocean Perch Past/Present Effects Analysis

The geographic scope for the Pacific ocean perch past/present effects analysis is the same as the BSAI management areas (Figure 1.2-2). The temporal scope for this analysis begins in 1960 when the foreign Pacific ocean perch fishery begins and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-23 provides a summary of BSAI Pacific ocean perch past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on BSAI Pacific ocean perch:

- Mortality due to catch/bycatch, and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes, and regime shifts (indirect effect).

- Change in prey availability due to commercial whaling, climate changes and regime shifts, marine pollution and oil spills, and introduction of exotic species (indirect effect).

- Change in important habitat due to fishery gear impacts, climate changes and regime shifts, marine pollution and oil spills, and introduction of exotic species (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explain any management actions specific to Pacific ocean perch. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on the Pacific ocean perch in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to Pacific ocean perch past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1960-1976)
  - Commercial whaling
  - IPHC longline fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1990)
  - JV groundfish fisheries (1980-1990)
  - Domestic groundfish fisheries (1982-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1960-1976)

The Japanese Pacific ocean perch fishery began in 1960 when a mothership operation began fishing for Pacific ocean perch along the continental slope between the Pribilof Islands and Cape Navarin. This fishery expanded in 1963 to Bowers Banks off the Aleutian Islands. Japanese fleets involved in the yellowfin sole fishery also extended their operations to include Pacific ocean perch in 1961-1962 due to the reduced abundance of yellowfin sole. This fishery lengthened the fishing season from one to between four and nine months and began winter fishing. The main target fish of the foreign fisheries was Pacific ocean perch in the Aleutian Islands region. Japanese trawls for Pacific ocean perch concentrated along the shelf edge in the central and western part of the chain, and the fishery took place mostly in the summer or early fall (NPFMC 2002a).

The Soviet Pacific ocean perch fishery also began in 1960 with 25-30 trawlers along the edge of the continental shelf in the eastern and central Bering Sea. Effort shifted to the Aleutian Islands and GOA by 1963, and the directed EBS effort was completely eliminated. However, bycatch of Pacific ocean perch did occur in Soviet pollock fisheries in subsequent years. Soviet harvests of Pacific ocean perch peaked in 1974 and 1975 at 61,000 and 71,000 mt, respectively. In the following years, fishing effort become more sporadic due to reduced abundance of rockfish. Catches in 1973 and 1974 had been reduced to 3,000 and 800 mt, respectively (NPFMC 2002a).

Overall, foreign fishery harvest of Pacific ocean perch and other rockfish species peaked in 1965 in the Aleutian Islands region at 109,100 mt. Apparently, stocks were not productive enough to support the large removals that took place, and they declined throughout the 1960s and 1970s, reaching their lowest levels in the early 1980s. Since that time, stocks have stabilized in the EBS and have increased in the Aleutian Islands and GOA (NPFMC 2002a).

Past foreign fisheries are found to have overfished the BSAI Pacific ocean perch populations; these effects are lingering at the population-level.

Internal JV and Domestic Groundfish Fisheries (1980-present)

A small JV fishery began in 1980 with catches generally under 1,000 mt annually (except in 1988). This fishery was replaced by the domestic fishery in 1990. Domestic Pacific ocean perch fisheries began in 1982 in the EBS and in 1984 in the Aleutian Islands. The EBS fisheries developed rapidly with over 1,000 mt of catch taken by 1984. The Aleutian Islands domestic fishery did not take over 1,000 mt until 1989. Overall, the BSAI Pacific ocean perch domestic fishery reached its peak removal in 1990 at 18,182 mt and has since declined with catches in recent years. The majority of catches take place in the Aleutian Islands region (Spencer and Ianelli 2002).

Discard rates in the Pacific ocean perch fisheries are relatively low, averaging 24.5 percent discard rate in the Bering Sea and a 16.7 percent discard rate in the Aleutian Islands from 1990-1999.

Pacific ocean perch were managed as a complex in association with northern rockfish, rougheye rockfish, shortraker rockfish, and sharpchin rockfish in two distinct areas in the BSAI from 1979-1990. In 1991, NPFMC enacted new regulations that divided the Pacific ocean perch complex into three subgroups in the EBS and two sub-groups in the Aleutian Islands region; Pacific ocean perch, shortraker/rougheye rockfishes, and sharpchin/northern rockfishes in the EBS and shortraker/rougheye and sharpchin/northern rockfishes in the Aleutian Islands region. These groups were established to protect Pacific ocean perch, shortraker rockfish, and rougheye rockfish from possible overfishing. Each group was assigned an individual TAC. Beginning in 1996, the Pacific ocean perch TAC was further subdivided in the Aleutian Islands region. A portion of the Pacific ocean perch TAC (7.5 percent) is allocated to the CDQ group, as well.

The large removals of Pacific ocean perch that occurred in the JV and past domestic fisheries have had an adverse effect on the BSAI Pacific ocean perch population; these effects are lingering at the population-level.

Change in Reproductive Success

<u>External Foreign Groundfish Fisheries (1960-1976)</u>

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the foreign fisheries on spatial/temporal distribution of the BSAI Pacific ocean perch populations due to the spatial/temporal concentration of the fishery is unknown. However, any possible effects are not expected to have any lingering adverse effects in the populations. Forty-nine percent of the foreign and JV fisheries Pacific ocean perch harvest from 1977-1988 was between 200 and 299 m. Forty-six percent of the past foreign and JV fisheries Pacific ocean perch catch took place in management area 541 (Figure 1.2-2). In the late 1970s, management area 543 contributed a large share of the catch; however, the proportions of total Pacific ocean perch caught by foreign fisheries that were sampled by the observers were quite low prior to 1984 (Megrey and Wespestad 1990).

<u>External Climate Changes and Regime Shifts</u>

The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on the reproductive success of Pacific ocean perch. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

<u>Internal JV and Domestic Groundfish Fisheries (1980-present)</u>

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the JV and past domestic fisheries on spatial/temporal distribution of the BSAI Pacific ocean perch populations is unknown. However, any possible effects are not expected to have any lingering adverse effects in the populations. Forty-nine percent of the foreign and JV fisheries observed fishing depth was from 200-299 m between 1977 and 1988 and forty-six percent of the past foreign and JV fisheries Pacific ocean perch catch took place in management area 541 (Figure 1.2-2). Sixty-six percent of the observed domestic catch took place between 200-299 between 1990-2000; and forty-two percent of the domestic catch came from management area 541. Area 543 contributed a large share of the catch in the mid-1990s to the present.

Change in Prey Availability

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. Populations of Pacific ocean perch have rebounded from low population-levels. The controlling factor for these increases appears to be environmental, with changes in the species composition in nearshore areas linked to an increase in advection in the Alaska current. Increased flow around the GOA may enhance the supply of nutrients and plankton on the shelf and upper slope areas, resulting in an increase in productivity.

External Commercial Whaling

Whaling is identified as having a past beneficial effect on prey availability for all Pacific ocean perch stocks, since the diet of Pacific ocean perch appears to consist primarily of plankton (Brodeur and Percy 1984); euphausiids are the single most important prey item (Yang 1996). A reduction in baleen whale populations could mean that more euphausiids would be available for use by Pacific ocean perch. Documented predators of Pacific ocean perch include Pacific halibut and sablefish, and it likely that Pacific cod and arrowtooth flounder also prey on Pacific ocean perch. Pelagic juveniles are consumed by salmon, and benthic juveniles are eaten by lingcod and other demersal fish (NMFS 1997).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of Pacific ocean perch.

Change in Important Habitat

External Foreign Groundfish Fisheries (1960-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effects of the past foreign fisheries on habitat suitability are adverse for the BSAI stock and are found to have had a lingering adverse influence in the stocks. The intense trawling of the foreign, JV and past domestic fisheries is the likely cause of this lingering effect.

External IPHC Longline Fisheries

The impacts of IPHC longline gear on Pacific ocean perch habitat have been identified as adverse effects. Longline fishing is likely to have caused Pacific ocean perch habitat degradation and disruption of Pacific ocean perch spawning and/or rearing grounds. This effect is still lingering at the population-level.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of Pacific ocean perch.

Internal JV and Domestic Groundfish Fisheries (1980-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effects of past JV fisheries on habitat suitability are adverse for the BSAI stock; the effects, in combination with climatic changes, are found to have had a lingering adverse influence in the stock. The intense trawling of the foreign, JV and past domestic fisheries is the likely cause of this lingering effect.

BSAI Pacific Ocean Perch Comparative Baseline

The Aleutian Islands survey covers the Aleutian Islands management area, and a portion of the EBS management area; the entire survey biomass is used as an index of Pacific ocean perch abundance in the BSAI. The EBS slope survey is not used in modeling due to its high variability and relatively small population sizes compared to the Aleutian Islands biomass estimates (Spencer and Ianelli 2002).

Survey biomass estimates in the entire survey area show a steady increase from 1980-1997, followed by a decline to the 2000 and 2002 estimates. The portion of the Aleutian Islands survey that occurs in the EBS has produced variable biomass estimates, from 1,501 mt in 1991 to 18,870 mt in 2000. In the Aleutian Islands region, the biomass estimates are less variable (Spencer and Ianelli 2002).

Surveys produce large amounts of biological data, including age determination, length-weight relationships, sex ratio information, and information for estimating the length distribution of the population. Improved age determination methods have determined the maximum age of Pacific ocean perch to be 90 years (Chilton and Beamish 1982).

Modeling results show that estimated survey biomass declined from 1960 to 1978 and increased to 500,933 mt in 2002. Total biomass results show a similar trend as the survey biomass with a 2002 total biomass estimate of 374,809 mt. Recruitment in the EBS and Aleutian Islands tends to be highly variable, although the 1962 year-class appears to be the largest, more than twice as large as any other estimated recruitment (Spencer and Ianelli 2002).

BSAI Pacific Ocean Perch Cumulative Effects Analysis Status

BSAI Pacific ocean perch will be brought forward for cumulative effects analysis.

3.5.1.12 BSAI Rockfish

Life History and Distribution

Northern Rockfish

Northern rockfish (*Sebastes polyspinis*) inhabit the outer continental shelf from the EBS, throughout the Aleutian Islands and the GOA (Kramer and O'Connell 1988). This species is semidemersal and is usually found in comparatively shallower waters off the outer continental slope (from 50-600 m). Little is known about the biology and life history of northern rockfish. However, they appear to be long-lived, with late maturation and slow growth. Like other members of the genus *Sebastes*, they bear live young, and birth occurs in the early spring through summer (McDermott 1994).

Shortrater/Rougheye Rockfish

Shortraker (*Sebastes borealis*) and rougheye rockfish (*S. aleutianus*) inhabit the outer continental shelf of the NPO from the EBS as far south as southern California (Kramer and O'Connell 1988). Adults of both species are semidemersal and are usually found in deeper waters (from 50 m to 800 m) and over rougher bottoms than Pacific ocean perch (Krieger and Ito 1999). Little is known about the biology and life history of these species, but they appear to be long-lived, with late maturation and slow growth. Shortraker rockfish have been estimated to reach ages in excess of 120 years, and rougheye rockfish in excess of 140 years. Like other members of the genus *Sebastes*, they are viviparous (bear live young), and birth occurs in the early spring through summer (McDermott 1994).

Both species are associated with a variety of habitats, from soft to rocky bottoms, although boulders and sloping terrain appear also to be desirable habitat (Krieger and Ito 1999). Length at 50 percent sexual maturity is about 45 cm for shortraker rockfish and about 44 cm for rougheye rockfish (McDermott 1994). Shortraker and rougheye rockfish are managed as part of the slope rockfish assemblage in the GOA and as part of the other red rockfish assemblage in the BSAI.

Two genetically distinct populations of rougheye rockfish with partially overlapping geographic ranges were found by Hawkins *et al.* (1997) and Gharrett and Gray (1998), and confirmed with recent mitochondrial and microsatellite analyses (A.J. Gharrett, University of Alaska Fairbanks, personal communication).

Other Rockfish

The 'other rockfish' management category includes 28 of the *Sebastes* and *Sebastolobus* species. Of these, only eight have ever been confirmed or tentatively identified in fishery catches in the BSAI, and so these eight species only are managed. The two most abundant species are light dusky rockfish (*Sebastes ciliatus* *sp cf*) and shortspine thornyheads (*Sebastolobus alascanus*). Red banded rockfish (*Sebastes babcocki*), dark dusky rockfish (*Sebastes ciliatus*), redstripe rockfish (*Sebastes proriger*), yelloweye rockfish (*Sebastes ruberrimus*), harlequin rockfish (*Sebastes variegatus*), and sharpchin rockfish (*Sebastes zacentrus*) have been identified by U.S. fishery observers and are also included in this group.

Thornyheads in Alaskan waters are comprised of two species, the shortspine thornyhead (*Sebastolobus alascanus*) and the longspine thornyhead (*S. altivelis*). Only the shortspine thornyhead is of commercial importance and it is now one of the most commercially valuable rockfish species. Thornyheads are a demersal species found in deepwater, from 94 m to 1,460 m, from the Bering Sea and GOA to Baja California (Gaichas and Ianelli 2001). Little is known about thornyhead life history. Like other rockfish, they are long-lived and slow-growing. The maximum recorded age is in excess of 50 years, and females do not become sexually mature until an average age of 12 to 13 years and a length of about 21 cm. Thornyheads spawn large masses of buoyant eggs during the late winter and early spring (Pearcy 1962). Juveniles are pelagic for the first year. The shortspine thornyhead is managed as a single stock in its own management group in the GOA; however, this species and the longspine thornyhead are managed as part of the other rockfish assemblage in the BSAI. Table 3.5-26 summarizes biological and reproductive attributes and habitat associations of thornyhead rockfish in the BSAI and GOA.

Light dusky rockfish are only occasionally observed in surveys and are caught as bycatch in other target fisheries. This species is generally caught between 125-200 m, and largely in the Aleutian Islands region. In recent years, bycatch has been highest near Seguam Pass and Petrel Bank; survey catch has been highest at the western tip of Amchitka Island. Light dusky rockfish are rarely found in the EBS, although some bycatch has occurred along the EBS slope, north of Unalaska Island and Akutan Island, the southern part of the EBS and the southern tip of Zhemchung Canyon in the northern EBS. EBS surveys found light dusky rockfish largely near Unalaska Island and Akutan Island (Reuter and Spencer 2003).

Table 3.5-27 summarizes biological and reproductive attributes and habitat associations for selected rockfish species in the BSAI and GOA.

Trophic Interactions

<u>Northern Rockfish</u>

Northern rockfish are generally planktivorous (feed on plankton) with euphausiids being the predominant prey item (Yang 1993). Copepods, hermit crabs, and shrimp have also been noted as prey items in much smaller quantities. Predators of northern rockfish are not well documented, but likely include larger fish such as Pacific halibut that are known to prey on other rockfish species.

<u>Shortraker/Rougheye Rockfish</u>

Food habit studies conducted by Yang (1993) indicate that the diet of rougheye rockfish is dominated by shrimp. The diet of shortraker rockfish is not well known; however, based on a small number of samples, the diet appears to be dominated by squid. Because shortraker rockfish have large mouths and short gill rakers, it is possible that they are potential predators of other fish species (Yang 1993).

Other Rockfish

Yang (1993 and 1996) and Yang and Nelson (2000) showed that shrimp, mainly pandalids, were the most important food of the thornyhead. Tanner crabs comprised less than 7 percent by weight of stomach contents, and fish such as pollock, capelin, and sculpins comprised about 15 percent. Other prey items for thornyheads included polychaetes, mysids, amphipods, and other crabs. California sea lion (Lowry *et al.* 1990) and sablefish (Orlov 1997) have both been documented as predators of shortspine thornyhead.

Trophic interactions of dusky rockfish are not well known. Food habits information is available from just one study, with a relatively small sample size for dusky rockfish (Yang 1993). This study indicated that adult dusky rockfish consume primarily euphausiids, followed by larvaceans, cephalopods, and pandalid shrimp. Predators of dusky rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

The diet of the other rockfish species (BSAI) for which dietary information exists seems to consist primarily of planktonic invertebrates (Yang 1993 and 1996). Predators of other rockfish are also not well documented, but likely include larger fish, such as Pacific halibut, which are known to prey on other rockfish species.

Management of Rockfish

Northern Rockfish

In 2003, northern rockfish were split out from the BSAI other red rockfish group, which originally included northern, rougheye, and shortraker rockfish. Northern rockfish is now managed under Tier 3 of Amendment 56 to the BSAI groundfish management plan. The projected spawning biomass for 2003 is 43,700 mt, which is greater than the $B_{40\%}$ value, placing it into subtier "a". The recommended ABC value for 2004 is 6,800 mt, apportioned between two areas: EBS = 19 mt and the Aleutian Islands = 6,861 mt. The OFL value of 8,140 mt has been established for the BSAI for 2004 (Table 3.5-2). Model projections indicate that the northern rockfish stock is neither overfished nor approaching an overfished condition (Spencer and Ianelli 2003).

Shortraker/Rougheye Rockfish

Shortraker/rougheye rockfish are now managed as their own group and are managed under Tier 5 of Amendment 56 to the BSAI groundfish management plan, relying on survey biomass estimates for information on population size and to determine ABC and OFL values. ABC values for the BSAI were calculated by 0.75 M = F_{ABC}. It is not possible to determine whether these species are overfished or approaching an overfished condition because they are managed under Tier 5.

It has been recommended that shortraker and rougheye be assigned separate TACs in future evaluations to prevent overfishing of one of the species. However, due to poor identification of shortraker and rougheye as separate species, the SSC was unable to establish separate TACs. Although shortraker/rougheye will remain as a single TAC for 2003, changes have been implemented in the Observer Program to improve species identifications and implement separate TACs beginning in 2004 (Spencer and Reuter 2003).

Though shortraker and rougheye rockfish are highly valued, amounts available to the commercial fisheries are limited by relatively small TAC and ABC amounts, which are to support bycatch needs in other groundfish fisheries. As a result, the directed fishery for these species is typically closed at the beginning of the fishing year. The primary methods of harvest for shortraker and rougheye rockfishes are bottom trawls and longline gear. The bulk of the commercial harvest usually occurs at depths between 200 m and 500 m along the upper continental slope.

Other Rockfish

None of the species in the other rockfish assemblage are subject of a directed fishery, but are mainly caught as bycatch in the other BSAI target fisheries. Two species are predominant in both the catch and survey data: light dusky rockfish and shortspine thornyheads. In 2002, sharpchin rockfish were removed from the other red rockfish assemblage to the other rockfish assemblage in the BSAI. Currently, the other species complex is assumed to be two separate stocks in the EBS and Aleutian Islands regions and is assessed as such.

The other rockfish assemblage falls under Tier 5 of Amendment 56 of the BSAI groundfish FMP, relying on biomass estimates to determine ABC and OFL values. ABC is calculated by multiplying 0.75 M by the best estimate of complex-wide biomass. This equates to a 2003 ABC value of 960 mt in the EBS and 634 mt in the Aleutian Islands (Table 3.5-2). The OFL value is determined by setting F_{OFL} = M, equating to a 2003 OFL value of 1,280 mt in EBS and 846 mt in the Aleutian Islands (Reuter and Spencer 2002).

Reuter and Spencer (2002) recommended in the BSAI SAFE that light dusky rockfish be split out of the other rockfish group and assigned a separate ABC due to findings that indicate that light dusky rockfish make up a large amount of the other rockfish catch in the Aleutian Islands and may be disproportionally exploited. Furthermore, Reuter and Spencer (2002) have recommended that EBS and Aleutian Islands biomass estimate for light dusky rockfish be combined for the BSAI. This recommendation comes in light of new catch and survey distribution maps which show continuous spatial distribution of light dusky rockfish along the Aleutian Islands and EBS slope.

Rockfish Past/Present Effects Analysis

This past/present effects analysis discusses northern, shortraker/rougheye and other rockfish groups managed within the BSAI. These species have been discussed together since they have only recently been broken out for management reasons. Refer to Table 3.5-24 for a list of the rockfish occurring in the BSAI and GOA and their associated management groups.

The geographic scope for the BSAI rockfish past/present effects analysis is the same as the BSAI management areas (Figure 1.2-2). The temporal scope for this analysis begins in 1960 when the foreign rockfish fisheries began and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-25 provides a summary of BSAI rockfish past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on BSAI rockfish:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to commercial whaling, climate changes and regime shifts, marine pollution and oil spills and introduction to exotic species (indirect effect).

- Change in important habitat due to climate changes and regime shifts, fishery gear impacts, marine pollution and oil spills and introduction of exotic species (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explains any management actions specific to rockfish. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on other rockfish in the BSAI have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the BSAI as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to rockfish past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1960-1976)
  - IPHC longline fisheries
  - State of Alaska shrimp fisheries
  - Commercial whaling
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1980-1990)
  - Domestic groundfish fisheries (1986-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

External Foreign Groundfish Fisheries (1960-1976)

Foreign fisheries for rockfish began in 1960, with the Soviet and Japanese fisheries. These fisheries are the same as were targeting Pacific ocean perch. See Section 3.5.1.11 for more information.

Large removals of rockfish have occurred in the foreign fisheries, although the proportion of removals per species is unavailable due to poor species identification. These removals are identified as having had an adverse effect on the rockfish populations. Moreover, due to the longevity of these species, these fisheries are determined to have had a lingering influence on the these BSAI populations.

Internal JV and Domestic Groundfish Fisheries (1980-present)

The JV fisheries began targeting rockfish in 1980 and were phased-out of the BSAI by 1990 when the fishery became fully domesticated. The domestic rockfish fisheries began in 1986. Removals of rockfish by the JV and past domestic fisheries are determined to have had an adverse effect on the rockfish population, although data regarding the proportion of removals per species is unavailable due to poor species identification. Moreover, due to the longevity of these species, these fisheries are determined to have had a lingering influence on these BSAI rockfish populations.

Northern, Shortraker and Rougheye Rockfish

Catches of rockfish from the EBS and Aleutian Islands are dominated by northern rockfish and shortraker rockfish. The largest catches in the northern rockfish times series have occurred since 1993. Catches of shortraker and rougheye rockfish appear low in the mid-1980s, when the foreign fishery was reduced; however, catches of shortraker rockfish have been relatively high since 1995 (Spencer and Reuter 2002).

Other red rockfish were managed as part of the Pacific ocean perch complex from 1979-1990. In 1991, Pacific ocean perch were separated into two management subgroups; the Pacific ocean perch and the other red rockfish group in the EBS, and into the Pacific ocean perch, shortraker/rougheye rockfishes and sharpchin/northern rockfishes group in the Aleutian Islands region. In 2000, the EBS other red rockfish group was furthered divided into the rougheye/shortraker and sharpchin/northern rockfish groups, as was done in the Aleutian Islands region. Each group was assigned a separate TAC to protect these species from overfishing. In 2002, sharpchin rockfish were removed from the other red rockfish assemblage to the other rockfish assemblage in the BSAI. Finally, in 2003, northern rockfish and shortraker/rougheye rockfish were separated and are now managed as their own group with separate TACs; the other red rockfish assemblage no longer exists.

There are concerns that assigning a TAC for two or more species may allow one of those species to be overfished while still remaining under the group TAC. Separate TACs for each individual species were recommended in the 2002 BSAI SAFE report; however, efforts to establish these levels were hindered by limited observer identification of shortraker and rougheye species (Spencer and Reuter 2001).

Other Rockfish

Prior to 1979, the other rockfish category included northern, rougheye, and shortraker rockfish. Catches prior to 1990 are assumed to include discards, whereas catches from 1999-2000 explicitly account for discards based on Observer Program information. The peak catch of other rockfish occurred in the EBS in 1978 with a removal of 941 mt, and in the Aleutian Islands region, the peak occurred in 1982 with a harvest of 2,114 mt. The bulk of the catch comprises shortspine thornyheads in the EBS and light dusky rockfish in the Aleutian Islands, according to Observer Program data (Spencer and Reuter 2002).

Change in Reproductive Success

External Foreign Groundfish Fisheries (1960-1976)

Spatial/Temporal Concentration of Catch/Bycatch

Effects of the foreign fisheries on spatial/temporal distribution of the BSAI rockfish populations due to the spatial/temporal concentration are identified as either adverse or unknown. When the past effect of the fishery is unknown, it is also unknown whether the effect could be lingering.

External Climate Changes and Regimes Shifts

The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as a potentially beneficial or adverse on the reproductive success of other rockfish. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Change in Prey Availability

External State of Alaska Shrimp Fisheries

Effects of State of Alaska shrimp fisheries on the prey availability of BSAI rockfish are potentially adverse, however, due to the localized nature of these fisheries, they are unlikely to have a population-level effect.

External Commercial Whaling

The effects of commercial whaling increased the availability of euphausiid prey for northern rockfish and some of the other rockfish species and is therefore noted as a potential beneficial effect.

External Climate Changes and Regimes Shifts

The effects of climate changes and regime shifts are identified as a potentially beneficial or adverse influence on prey availability depending on the frame of reference. Lingering population effects are identified in the these stocks for this category. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important prey species of rockfish.

Change in Important Habitat

External Foreign Groundfish Fisheries (1960-1976)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas, and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The impacts of foreign groundfish fishery gear on rockfish and habitat have been identified as adverse effects. Intense trawling is likely to have caused rockfish habitat degradation and disruption of rockfish spawning and/or rearing grounds. This effect is still lingering at the population-level.

External IPHC Longline Fishery

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas, and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The impacts of IPHC longline gear on rockfish habitat have been identified as adverse effects. Intense trawling is likely to have caused rockfish habitat degradation and disruption of rockfish spawning and/or rearing grounds. This effect is still lingering at the population-level.

External Climate Changes and Regimes Shifts

The effects of climate changes and regime shifts are identified as a potentially beneficial or adverse influence on habitat suitability depending on the frame of reference. Lingering population effects are identified in the stocks for this category. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the BSAI and what effect these have on the important habitat of rockfish.

Internal JV and Domestic Groundfish Fisheries (1980-present)

See Section 3.5.1.1 (BSAI walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas, and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The impacts of JV and domestic groundfish fishery gear on rockfish habitat have been identified as adverse effects. Intense trawling is likely to have caused rockfish habitat degradation and disruption of rockfish spawning and/or rearing grounds. This effect is still lingering at the population-level.

Rockfish Comparative Baseline

Data for determining exploitable biomass estimates come from a number of surveys, including the U.S.-Japan cooperative survey in the EBS on the continental shelf and slope from 1979-1985, and from 1980-1986 in the Aleutian Islands, and domestic trawl surveys in the EBS slope in 1988 and 1991 and in the Aleutian Islands region in 1991, 1994, 1997, 2000, and 2002. In the Aleutian Islands, the exploitable biomass estimate is the average of the most recent surveys; in the 2002 stock assessment those are the 1991, 1994, 1997, 2000, and 2002 Aleutian Islands surveys. The EBS is divided into two areas when determining the biomass of the other red rockfish category. These two areas are: the shelf/slope area and the area that is labeled the Aleutian Islands portion of the EBS, whose 2002 biomass is determined by averaging the three most recent Aleutian Islands surveys.

Surveys from 1991-2002 indicate that the majority of northern rockfish biomass is found in the western Aleutian Islands (72%). Survey biomass estimates show a steady trend in northern rockfish biomass from 1977 at 131,684 mt to 161,984 mt in 1992. The 2003 survey estimate is 137,564 mt. Modeling results estimate total and spawning biomass for 2003 at 143,604 mt and 46,390 mt, respectively (Spencer and Ianelli 2003).

Surveys estimates indicate that rougheye rockfish biomass has declined since the 1980s from approximately 26,277 mt (1980) to 10,379 mt in 2004. Shortraker rockfish biomass estimates have also indicate a decline from the 1980 value of 38,299 mt to 23,379 mt in 2004. Modeling results estimate rougheye rockfish biomass to be 1,503 mt in the EBS and 11,480 mt in the Aleutian Islands for 2004. Shortraker rockfish biomass is estimated at 6,535 mt in the EBS and 27,317 mt in Aleutian Islands for 2004 (Spencer and Reuter 2003).

The recent surveys indicate that shortspine thornyhead, light dusky rockfish, and harlequin rockfish comprise most of the total other rockfish estimated biomass, approximately 90 percent of which is shortspine thornyheads. The discrepancy between the amount of light dusky rockfish catch in the fishery and the light dusky rockfish catch in the survey is attributed to the unequal survey sampling of differing depth zones. For instance, the majority of the light dusky rockfish fishery catch is at depths less than 200 m, whereas the trawl survey targets waters deeper than 200 m. Based on the best available information, the estimated 2003 exploitable biomass for other rockfish is 6,884 mt in the EBS and 12,087 mt in the Aleutian Islands (Reuter and Spencer 2002).

Gulf of Alaska Target Groundfish Species

This section presents descriptions of major target species, summarizing important life history traits, their habitat environment, prey base, past effects, stock management, stock assessment, and current trends of the stocks. Additional information on life history and habitat features for each major groundfish species can be found in the following three documents 1) EA of the EFH (NPFMC 1998a), 2) EFH assessment report for the groundfish resources of the BSAI region (NPFMC 1998b), and 3) EFH assessment report for the groundfish resources of the GOA region (NPFMC 1998c).

Rockfish Cumulative Effects Analysis Status

BSAI northern rockfish, shortraker/rougheye rockfish, and other rockfish will be brought forward separately for cumulative effects analysis.

3.5.1.13 GOA Walleye Pollock

Life History and Distribution

Walleye pollock is the second most abundant groundfish stock, after arrowtooth flounder, in the GOA. In the GOA, the largest spawning concentrations occur in Shelikof Strait and the Shumagin Islands (Kendall *et al.* 1996). Life history of the GOA pollock is similar to those that inhabit the BSAI (refer to Section 3.1.1.1). Olsen *et al.* (2002) found two major spawning areas in the GOA, one occurring in the Shumagin Island area between February 15 and March 1 and the other occurring in the Shelikof Strait between March 15 and April 1.

<u>Trophic Interactions</u>

Larvae, 5 to 20 millimeters (mm) in length, consume larval and juvenile copepods and copepod eggs (Canino 1994, Kendall *et al.* 1987). Early juveniles (25 to 100 mm) of pollock in the GOA primarily eat juvenile and adult copepods, larvaceans, and euphausiids; late juveniles (100 to 150 mm) eat mostly euphausiids, chaetognaths, amphipods, and mysids (Brodeur and Wilson 1996, Grover 1990, Krieger 1985, Livingston 1985, Merati and Brodeur 1997, Walline 1983). Juvenile and adult pollock in southeast Alaska rely heavily on euphausiids, mysids, shrimp, and fish as prey (Clausen 1983). Euphausiids and mysids are important to smaller pollock; and shrimp and fish are more important to larger pollock in that area. Copepods are not a dominant prey item of pollock in the embayments of southeast Alaska but appear mostly in the summer diet. Similarly, the summer diet of pollock in the central and western GOA does not include as many copepods (Yang 1993). Euphausiids are the dominant prey, constituting a relatively constant proportion of the diet by weight across pollock size groups.

In the GOA, fish prey becomes an increasing fraction of the pollock diet with increasing pollock size. Over 20 different fish species have been identified in the stomach contents of pollock from this area, but the dominant fish consumed is capelin (Yang 1993). A high diversity of prey fish were also found in pollock stomachs. Commercially important fish prey included Pacific cod, pollock, arrowtooth flounder, flathead sole, Dover sole, Pacific halibut, and Greenland turbot. Forage fish such as capelin, eulachon, and Pacific sand lance were also found in pollock stomach contents. However, over the period 1993-1996, Yang and Nelson (2000) found that consumption of capelin declined to non-existent as did the consumption of pandalid shrimp. It appears that because of declining pandalid shrimp and capelin populations, pollock in the GOA consumed more euphausiids and copepods in 1996 as compared to 1993.

Dominant groundfish populations in the GOA that prey on pollock include arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut (Albers and Anderson 1985, Best and St-Pierre 1986, Jewett 1978, Yang 1993). Pollock is one of the top five prey items (by weight) for Pacific cod, arrowtooth flounder, and Pacific halibut. Other predators of pollock include great sculpins (Carlson 1995) and shortspined thornyheads (Yang 1993) (Figure 3.5-3). As in the EBS, Pacific halibut and Pacific cod tend to consume larger pollock, while arrowtooth flounder consume pollock that are mostly under age 3 years. Unlike the EBS, however, the main source of predation mortality on pollock at present appears to be from the arrowtooth flounder (Livingston 1994a and 1994b). Stock assessment scientists have attempted to incorporate predation mortality by arrowtooth flounder, Pacific halibut, and sea lions in the stock assessment for pollock in the GOA (Hollowed *et al.* 1997).

Research on the diets of marine mammals and birds in the GOA has recently been greatly accelerated (Brodeur and Wilson 1996, Calkins 1987, DeGange and Sanger 1986, Hatch and Sanger 1992, Lowry *et al.* 1989, Merrick and Calkins 1996, Pitcher 1980a, 1980b, and 1981) (see Sections 3.7 and 3.8). Brodeur and Wilson's review (1996) summarized both bird and mammal predation on juvenile pollock. The main piscivorus birds that consume pollock in the GOA are black-legged kittiwakes, common murres, thick-billed murres, tufted puffins, horned puffins, and probably marbled murrelets. The diets of common murres have been shown to contain around 5 percent to 15 percent age-0 pollock by weight, depending on the season. Both horned puffins and tufted puffins consume age-0 pollock. The tufted puffin diet is more diverse and tends to contain more pollock than that of the horned puffin (Hatch and Sanger 1992).

Pollock is a major prey of Steller sea lions and harbor seals in the GOA (Merrick and Calkins 1996; Pitcher 1980a, 1980b, and 1981). Pollock is a major prey of both juvenile and adult Steller sea lions in the GOA. It appears that the proportion of animals consuming pollock increased from the 1970s to the 1980s, and this increase was most pronounced for juvenile Steller sea lions. Sizes of pollock consumed by Steller sea lions range from 5 to 56 cm, and the size composition of pollock consumed appears to be related to the size composition of the pollock population. However, juvenile Steller sea lions consume smaller pollock on average than adults. Age-1 pollock was dominant in the diet of juvenile Steller sea lions in 1985, possibly a reflection of the abundant 1984 year-class of pollock available to Steller sea lions in that year. Harbor seals tend to have a more diverse diet, and the occurrence of pollock in their diet is lower than in the diet of sea lions.

GOA Pollock Management

Pollock in the GOA are thought to be a single stock (Alton and Megrey 1986) originating from springtime spawning in Shelikof Strait (Brodeur and Wilson 1996). Separation of GOA pollock from the BSAI pollock stocks is supported by analysis of larval drift patterns from spawning locations and microsatellite allele variability (Bailey *et al.* 1997), genetic studies (Grant and Utter 1980), and mitochondrial DNA variability (Mulligan *et al.* 1992, Dorn *et al.* 2001).

Studies conducted by Olsen *et al.* (2002) indicate that there may be two genetically distinct pollock stocks in the GOA: the northern GOA stock that includes PWS and Middleton Island, and the Shelikof Strait stock. Large interannual genetic variations in the PWS stock between 1997 and 1998 were found; however, Olsen *et al.* (2002) suggest that this variation may be caused by variable reproductive success, adult philopatry, source-sink population structure, or utilization of the same spawning areas by genetically distinct stocks with different spawning times (as referenced in Dorn *et al.* 2002).

Under current management, the general impacts of fishing mortality within Amendment 56/56 ABC and OFL definitions discussed in Appendix B, apply to pollock in the GOA (Table 3.5-28). GOA pollock are managed under Tier 3b of the ABC/OFL definitions, which requires reliable estimates of biomass, $B_{40\%}$ and fishing mortality rates $F_{30\%}$ and $F_{40\%}$. Under the definitions and current stock conditions, the overfishing rate is the fishing mortality rate that reduces the spawning stock biomass per recruit to 35 percent of its unfished level (the $F_{35\%}$ rate). In the GOA region west of 140°W, the 2003 ABC value of 49,590 mt is recommended, with an OFL of 69,410 mt. This year's ABC value was 35 percent lower than the 2002 ABC, partly due to a reported decrease in the female spawning biomass. In the western, central, and west Yakutat areas, the ABC value has been reduced by 1,720 mt to accommodate the Prince William Sound state pollock fishery (see the past/present effects analysis section for a description of the state pollock fishery). The west Yakutat area receives a 1,078 mt allocation, leaving 46,812 mt ABC for the western and central areas. In the east Yakutat and SEO areas, the 2003 ABC and OFL values are the same as the 2002 ABC and OFL values of 6,460 and 8,610 mt, respectively, due to the lack of new survey data. In southeast Alaska (Area 650), a ban on trawling prevents directed harvest of pollock (Figure 1.2-3; Table 3.5-28).

GOA pollock are assessed with an age-structured model incorporating fishery and survey data. The data used in this analysis consist of estimates of total catch biomass, bottom trawl biomass estimates, EIT survey estimates of the spawning biomass in Shelikof Strait, egg production estimates of spawning biomass in Shelikof Strait, and fisheries catch-at-age and survey size compositions. The bottom trawl data may not provide an accurate view of pollock distribution, because a significant portion of the pollock biomass may be pelagic and not available to bottom trawls and because much of the GOA shelf is untrawlable due to the rough bottom. Fishery catch statistics (including discards) are estimated by the NOAA Fisheries, Alaska Regional Office. These estimates are based on the best blend of observer reported catch and weekly production reports. Age composition data are obtained from several sources, including catch-at-age aggregated over all seasons, nations, vessel classes, and INPFC statistical areas for the years, and catch-at-age from the spring EIT survey and the bottom trawl surveys. Historical information on pollock size composition was obtained from the Japanese Pacific ocean perch fishery from the period 1964–1975 (Hollowed *et al.* 1991). Recent assessments have explored the impact of predation mortality by arrowtooth flounder, Pacific halibut, and Steller sea lions by incorporating time series of estimated predator biomass, the age composition of pollock consumed by predators, and estimated consumption rates (Hollowed *et al.* 1997).

Past/Present Effects Analysis

The geographic scope for the GOA pollock past/present effects analysis is the same as the GOA FMP management areas (Figure 1.2-3). The temporal scope for this analysis begins in 1964 when the GOA foreign groundfish fishery begins and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4. Table 3.5-29 provides a summary of the GOA pollock past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on GOA pollock:

- Mortality due to catch/bycatch and the EVOS (direct effect).

- Change in reproductive success due to removal of predators, fishery selectivity of juveniles, roe stripping, spatial/temporal concentration of catch/bycatch, and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery catch/bycatch of prey species, introduction of exotic species, the EVOS, and climate changes and regime shifts (indirect effect).

- Change in important habitat due to fishery gear impacts, the EVOS, introduction of exotic species, and climate changes and regime shifts (indirect effect).

Mortality caused by marine pollution was not brought forward for analysis. The NOAA NS&T program has produced a summary of Alaska marine environmental quality through its research and sampling projects, including the Mussel Watch Project and the Benthic Surveillance Project. This report is available on the NOAA website at: http://ccmaserver.nos.noaa.gov/NSandT/BrochurePDFs/Alaska.pdf. Furthermore, international, federal and state laws and enforcement agencies are in place to monitor marine pollution.

Change in prey availability and in important habitat due the introduction of exotic species by way of ballast water and climate changes and regime shifts has not been brought forward since the impacts on pollock in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998) Also, see Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA.

The past/present events determined to be applicable to the pollock past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (1964-1976)
  - State of Alaska shrimp fisheries
  - State of Alaska crab fisheries
  - State of Alaska groundfish fisheries
  - IPHC halibut fishery
  - Commercial whaling

- Seal harvests
- EVOS
- Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1979-1991)
  - Domestic groundfish fisheries (1976-present)

- Past/Present Management Actions
  - Bilateral agreements
  - IWC management
  - MMPA of 1972
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - Steller sea lion protection measures
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1964-1976)

Pollock began being targeted in 1964 by the foreign groundfish fisheries, predominately by Japan, the Soviet Union and the Republic of Korea. Most of these foreign groundfish fisheries had started in the GOA targeting Pacific ocean perch and switched to other target species during the late 1960s and early 1970s when Pacific ocean perch was reduced in abundance (NPFMC 2002b).

The Soviet fishing vessels first began in the GOA in 1962 and principally targeted Pacific ocean perch. Following decline of the Pacific ocean perch stock, the Soviet fisheries shifted to pollock, Atka mackerel, and flounders. All fishing by the Soviet fisheries in the GOA has been done by trawls (NPFMC 2002b).

The Japanese fishery began exploratory fishing in 1960, although their full-scale groundfish fishery in the GOA did not start until 1963, possibly precipitated by the start of the Soviet fishery. Like the Soviets, the Japanese targeted Pacific ocean perch and did not focus on other targets, including pollock, Pacific cod, and flounder, until the decline of Pacific ocean perch (NPFMC 2002b).

The Republic of Korea fishery began fishing in the GOA in 1972 and targeted pollock, Pacific cod, flounder, sablefish and Atka mackerel. By 1978, the Republic of Korea relied almost exclusively on trawl gear with pollock being the primary target species. As a result of the expansion of the domestic groundfish fisheries, the Republic of Korea has not received a directed fishing allocation in the GOA since 1985 (NPFMC 2002b).

Smaller scale foreign groundfish fisheries, including Poland, Taiwan, and Mexico, have also been conducted in the GOA. Poland arrived in 1973 and began targeting pollock in 1977. From 1978 to 1981, harvest averaged 39,900 mt per year. Poland has not received a directed fishing allocation since 1985. Taiwan began fishing in the GOA in 1975, but Taiwanese vessels were apprehended for violating the U.S. contiguous fishing zone soon thereafter. By 1977, Taiwan had discontinued fishing within the GOA. Mexico harvested about 10,400 mt of groundfish from the GOA in 1979, of which pollock made up 84 percent (NPFMC 2002b).

In 1973, a bilateral agreement between the U.S. and Japan and the U.S. and the Soviet Union included annual catch quotas, which reduced the catch of pollock in the GOA. However, each country was still responsible for monitoring its catch quotas, the only internationally acceptable arrangement at the time. With the passing of the MSA and the increase of U.S. and JV fisheries, foreign groundfish catch in the GOA was further reduced (NPFMC 2002b).

Although large removals of pollock occurred during the foreign fisheries, there appears to be no lingering effect on the GOA pollock populations.

External State of Alaska Groundfish Fisheries

The directed state pollock fishery began in 1995 and is located in PWS. This fishery is broken into three management sections by ADF&G. These sections are the Port Bainbridge Section (waters west of 148°W), the Knight Island Section (waters between 148°W and 147°20'W) and the Hinchinbrook Section (waters east of 147°20'W). Forty percent of the Guideline Harvest Level (GHL) for the year is allocated to each management area. The GHL is accounted for by the federal ABC limits and is allocated to these state fisheries starting at 1,420 mt in 2000 and increasing to 1,720 mt in 2001 and 2002. The fishery is managed to allow closures due to bycatch, exceeding the GHL, or due to emergency orders to protect Steller sea lions. Furthermore, the fisheries are subject to federal observer coverage and are required to maintain a federal logbook and bycatch data. The state fisheries are also subject to IR/IU (5 Alaska Administrative Code [AAC] 29.079 & 5 AAC 28.075), requiring that all pollock be retained during an open directed pollock fishery and up to the maximum retainable bycatch limits when the directed pollock fishery is closed (ADF&G 2002b).

The Cook Inlet Area pollock fishery is a bycatch only fishery, although opportunities are available for directed pollock fisheries through permitting. These directed fisheries are constrained by the same requirements as the PWS directed pollock fisheries (ADF&G 2002a).

External State of Alaska Crab and Shrimp Fisheries and the IPHC Halibut Fisheries

The GOA bait fishery arose due to the need for bait in the crab and halibut fisheries. The bait fishery occurred from PWS west to the Aleutians, with two-thirds of the catch occurring in Kodiak. The catch consisted largely of pollock, Pacific cod, and various flounder species. Groundfish for bait was taken primarily as bycatch in the Kodiak shrimp fishery during the early to mid-1970s. The bait fishery was later characterized by trawlers and longline vessels which targeted groundfish species. Prior to 1972, unrecorded catch of bait may have equaled or exceeded the recorded groundfish catch since bait was transferred to crab and halibut vessels on the fishing grounds. From 1972 to 1976, the catch of groundfish for bait increased from 96 mt to 303 mt. Catches continued to increase through the late 1970s and by 1982 accounted for 1,059 mt. (NPFMC 2002b). In 1983, GOA FMP Amendment 11 eliminated the bait and personal consumption component of the domestic groundfish fishery. Although past bycatch of pollock has occurred in the shrimp fishery, it does not appear to have had a lingering effect on the GOA pollock populations .

External Exxon Valdez Oil Spill

The number of pollock that suffered direct mortality as a result of the EVOS is unknown, but such mortality has not resulted in population-level effects on GOA pollock.

Internal JV and Domestic Groundfish Fisheries (1976-present)

The domestic pollock fishery began in the GOA in 1976 when a fleet of three trawlers from Petersburg, Alaska trawled for pollock during the winter months. Approximately 60 mt of pollock were landed to shoreside processors. During winter, the fishing effort is targeted primarily on pre-spawning aggregations in the Shelikof Strait and near the Shumagin Islands. Fishing in the summer is more variable, but typically occurs on the east side of Kodiak Island and near-shore waters along the Alaska Peninsula. Kodiak, Sand Point, and Dutch Harbor are all major ports for the GOA pollock fishery, with 53 percent of the 1995-2000 landings occurring in Kodiak. The pollock fishery in the GOA was fully domestic by 1988 (NPFMC 2002b).

The development of JV groundfish fisheries occurred rapidly since their beginning in 1979. GOA FMP Amendment 6 regulations adjusted the DAH and the foreign fishery allocations to reflect the best information available from the observers and domestic processors and to allow for a fully utilized groundfish fishery in the GOA. Pollock became the principle target species of the JV groundfish fisheries in 1980, comprising 99 percent of the total catch. In 1980, GOA Amendment 8 modified the timing of reserve releases to allow for increased catches by domestic groundfish fisheries. However, further FMP amendments were needed to make changes in allocations of fish to domestic groundfish and JV groundfish fishermen, and flexibility was needed for the NOAA Fisheries Regional Administrator to reapportion reserves and domestic allocations to foreign groundfish fishermen if it were projected that domestic groundfish fishermen could not harvest them. The Regional Administrator also needed flexibility to impose on foreign groundfish fisheries such closures for conservation reasons as were in place for domestic groundfish fisheries (NPFMC 2002b).

In response, GOA FMP Amendment 11 in 1983: 1) increased the pollock OY in the central GOA from 95,200 to 143,000 mt, 2) established a framework procedure to annually determine domestic groundfish and JV groundfish processing components of the DAH for each species OY, 3) eliminated the bait and personal consumption component of the DAH, 4) increased the flexibility of the Regional Administrator to reapportion reserves and surplus DAH to foreign groundfish fishing, 5) authorized the Regional Administrator to impose time/area closures on foreign nations to conserve resources, and 6) imposed radio/telephone catch reporting requirements on domestic groundfish vessels leaving state waters to land fish outside Alaska beginning in 1983, thus ensuring that all catches were reported.

In 1984, GOA FMP Amendment 13 combined the western and central GOA pollock OYs into a single OY and increased it from 200,000 to 400,000 mt. It was intended to provide optimum harvest of the pollock resource, to allow the pollock resource in the western and central GOA to be managed as one stock, and to prevent undue restriction and economic hardship on the domestic groundfish fishery, by allowing both the harvest of the increased surplus and the distribution of fishing effort to be based on pollock availability.

In 1985, GOA FMP Amendment 14 modified the management of a number of target species. Under this amendment, OYs were changed for pollock, Pacific ocean perch, other rockfish, Atka mackerel, and other species. A mechanism was also established for timely reporting of catches by domestic groundfish catcher processors that stayed at sea for long periods, and NOAA Fisheries habitat policy was implemented.

The 1992 inshore/offshore amendment (GOA FMP Amendment 23) required that 100 percent of the pollock catch be processed at shoreside plants, completing the phase-out of foreign groundfish and JV fisheries in the GOA. This amendment also moved the fishery from bottom to pelagic trawls to avoid bycatch of prohibited species (i.e., halibut) and closed the factory trawling fisheries of the GOA.

Although large removals have occurred in the JV and domestic fisheries, these fisheries have not had a lingering effect on the GOA pollock population.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1964-1976)

Bycatch in the foreign groundfish fisheries has not been well documented; however, it is assumed that bycatch of pollock consisted mainly of juveniles. Few observers were allowed on Soviet vessels under the bilateral agreements, and the Soviets were well-known for under-reporting their catches of target species and, presumably, bycatch as well.

Foreign groundfish fisheries in the GOA also tended to target younger pollock, with a maximization selection of 5 to 6 years versus the current domestic groundfish fishery which selects fish age-7 to -8 years (Dorn *et al.* 2001).

The effect of the foreign fisheries GOA pollock recruitment due to the foreign fisheries selectivity and bycatch of juvenile pollock is unknown.

External Climate Changes and Regime Shifts

Recruitment of GOA pollock is more variable than EBS pollock. Evidence suggests that spawner productivity is higher at low spawning biomass compared to high spawning biomass. The density-dependence of the survival of eggs corresponds with decadal trends in spawner productivity and have produced a pattern in the GOA pollock population (Dorn *et al.* 2002). Environmental conditions have likely influenced spawner biomass, thus influencing GOA pollock recruitment.

FOCI is used by the SSC to make predictions on the strength of year-classes. These predictions are based on precipitation, wind mixing energy, advection of ocean water, pollock larvae counts, and pollock abundance estimates. Precipitation, wind-mixing and advection are all important factors in the survival and success of pollock larvae.

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of pollock. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an in depth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries.

Internal JV and Domestic Groundfish Fisheries (1976-present)

Fishery Selectivity

GOA pollock are caught as bycatch in other directed fisheries. However, because they occur primarily in well-defined aggregations, the impact of this bycatch is typically minimal. Most of the discards in the pollock fishery are juvenile pollock, or pollock too large to fit filleting machines. In the pelagic trawl fishery the catch is almost exclusively pollock; however in the past bottom trawl pollock fishery the bycatch of other species was higher.

To improve reporting of catch and bycatch, reporting requirements were established for the domestic groundfish fisheries under GOA FMP Amendment 7 in 1979. This amendment created the first domestic groundfish reporting requirements to facilitate better estimates of DAH and processing capabilities, along with other management actions. It also initiated area closures to the JV groundfish fisheries to encourage the growth of the domestic groundfish fishery. GOA FMP Amendment 18 established the domestic Observer Program, designed to estimate bycatch and discard rates, among other things. Additional GOA FMP amendments addressing data collection needs (Amendments 11, 14, 15, 16, 17, 18, 30, and 47) were subsequently approved.

GOA FMP Amendment 49 initiated the IR/IU program to reduce discards of all groundfish target fisheries. This amendment required vessels fishing for groundfish in the GOA to retain all pollock beginning January 1, 1998.

Selectivity in the GOA pollock fishery has changed as the fishery has evolved from a foreign groundfish fishery occurring along the shelf break to a domestic groundfish fishery on spawning aggregations and in nearshore waters. Since 1992, GOA pollock have been managed with time and area restrictions, and selectivity has been fairly stable. As in the BSAI, fishery selectivity increases to a maximum around age 7-8 and then declines.

Like the BSAI, cumulative impacts of fishing mortality on age composition are influenced by the selectivity of the fishery. The current age composition of the stock reflects a fished population with a long catch history under low exploitation rates. The NOAA Fisheries FOCI and Coastal Ocean Programs' SEBSCC regional study focuses research on improving understanding of mechanisms underlying annual production of pollock stocks in the GOA and EBS.

Roe Stripping

Large spawning aggregations of pollock were discovered in the Shelikof Strait in 1981, which initiated the development of the GOA pollock roe fishery (Megrey 1989). By 1990, the growth of the domestic pollock fishery had created competition for the pollock TAC. GOA FMP Amendment 19 was implemented in 1991 to address the following roe stripping issues:

- Roe stripping is a wasteful use of the pollock resource.

- Roe stripping causes an unintended allocation of pollock TAC among seasons and industry sectors.
- Roe stripping may adversely affect the ecosystem.
- Roe stripping may adversely affect the future productivity of the stock.
- Roe stripping increases the difficulty of accurately monitoring the pollock TAC for inseason management.

In 1993, regulations were further tightened to close loopholes that could have potentially undermined the intent of the roe stripping regulations (58 FR 57752).

Spatial/Temporal Concentration of Catch/Bycatch

GOA pollock tend to concentrate along the shelf break at intermediate depths of about 150-200 m and pollock fisheries generally occur from 100-200 m (Hollowed *et al.* 1997). Fisheries concentrate on large concentrations of pollock in the central and western GOA management areas (147°W-170°W), mainly in Shelikof Strait, the trough or gully regions of the east side of Kodiak Island, and Shumagin area. Studies show that the GOA pollock, unlike the BSAI pollock, do not show strong seasonal differences in distribution. Spatial patterns remained consistent from 1984-1996, and shifts in the spatial distribution of pollock reflect the seasonal migrations to spawning locations. In general, the fishery for pollock in the GOA has remained fairly constant in time and space, if not in the amount of biomass removed. Therefore, it is suggested that recent levels of fishing in the GOA may not have had a strong impact on these distributions (Meuter and Norcross 2002).

Management of the pollock fishery has changed recently as NOAA Fisheries and NPFMC have taken measures to reduce the possibility of competitive interactions with Steller sea lions. In 1999, this led to further closures of critical habitat to pollock fisheries in the Aleutian Islands region, the EBS, and the GOA. A total of 210,350 km^2 (54 percent) of critical habitat was closed to the pollock fishery. Following 1998, catches of pollock and the proportion of seasonal TAC caught in the Steller Sea Lion Conservation Area and Steller Sea Lion critical habitat have been reduced (Ianelli *et al.* 2001b).

<u>External Commercial Whaling and Seal Harvests</u>

Whaling is identified as having a past beneficial effect on GOA pollock recruitment. Pollock has been noted as a prey item for fin whales, minke whales, and humpback whales (see Sections 3.8.12, 3.8.14 and 3.8.15). By removing the large predators, pollock recruitment is favored. Whale and seal harvests are no longer of concern. Subsistence and personal use of marine mammals is at such a small scale that it is unlikely to have a population-level effect on the GOA pollock stock.

Change in Prey Availability

External Foreign Pacific Ocean Perch and Pollock Fisheries (1964-1976) and Internal JV and Domestic Pacific Ocean Perch and Pollock Fisheries (1976-present)

Research by Somerton (1979) and Alton *et al.* (1987) has explored the possibility that the rise of pollock in the GOA in the early 1970s was in response to the large biomass removals of Pacific ocean perch, a potential predator for euphausiid prey (Dorn *et al.* 2001). The foreign fishery for Pacific ocean perch started in the GOA in 1962 and peaked in 1966. By 1985, only sufficient quantities for bycatch purposes were allocated by NPFMC. A series of GOA FMP amendments (10, 32, and 38) closed Pacific ocean perch areas to the fisheries and laid out a rebuilding plan.

External Exxon Valdez Oil Spill

The effects of pollution have been found to have reduced pollock prey availability, although it is unlikely that pollution has had a population-level effect on the GOA pollock stocks.

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the prey availability of pollock. In general, a shift toward warmer waters favors recruitment and survival of pollock. In 1998/1999, the Pacific Decadal Oscillation shifted to negative, with cooler-than-average northeastern Pacific surface temperature, and warmer-than-average central Pacific surface temperatures.

Changes in Important Habitat

External Foreign Groundfish Fisheries (1964-1976)

Information of the number of trawls that occurred during the pre-MSA GOA foreign fisheries is unavailable. The effects of fishery gear on pollock habitat is potentially adverse, although if so, this does not appear to have had a lingering adverse effect on the GOA pollock populations. See Section 3.6.4 for a discussion of the potential effects of fishery gear on habitat.

A bottom trawling ban was initiated in pollock spawning habitats in pre-MSA fishery management regulations. This initiative reduced the bycatch of juvenile pollock while indirectly reducing the intensity of trawling on pollock spawning habitat. Several of the foreign groundfish fisheries also imposed restrictions on themselves to reduce their effects on pollock spawning habitats.

External Exxon Valdez Oil Spill

This event has been identified as resulting in an adverse effect on pollock spawning habitat; however, this effect has not shown population-level impacts on GOA pollock.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as having potentially beneficial or adverse effects on habitat suitability. In general, a shift toward warmer waters favors recruitment and survival of pollock. As described in Section 3.10.1.5, when the Aleutian Low was weak, resulting in colder water, shrimp dominated the catches. When the Aleutian Low was strong, water temperatures were higher, and the catches were dominated by cod, pollock, and flatfishes.

Large fluctuations in pollock abundance without large changes in the direct fishing suggest that the GOA pollock may be strongly influenced by environmental controls and indirect ecosystem effects. This implies a need for conservative management, since adverse population effects by the fisheries may be difficult or impossible to reverse through management measures (Dorn *et al.* 2002).

Internal JV and Domestic Groundfish Fisheries (1976-present)

Very little research regarding the effects of trawling activities in the GOA has been conducted. The greatest bottom trawl effort in the GOA has taken place in the Kodiak Island region, where directed fisheries have targeted Pacific ocean perch, Pacific cod, and flatfish. Over nine years (1990-1998), a total of 57,948 tows were observed in the GOA. If expanded to include unobserved tows, the total number of trawl tows were estimated at 116,288 tows. The total bottom trawl effort measured in 24-hour days was estimated at 11,829 trawl-days. The highest estimated number of bottom trawls in both the GOA and Aleutian Islands occurred on the continental shelf at a depth of 101-200 m. The density value of trawling for the GOA overall was calculated at 0.35/km^2, the highest density in the Kodiak Island region at 1.43/km^2 in an area of 4,657 km^2 at a depth of 301-500 m. The highest bottom trawl duration in the GOA was at a depth of 101-200 m, with the highest number of days trawled per km^2 in the Chirikof Island area at 0.74 days/km^2 at 301-500 m (see Section 3.6 for more information).

For the period 1990-2000, 64,948 bottom trawls were observed in the GOA. The spatial pattern of this effort is much more dispersed than in the Bering Sea region. During 2000 the amount of trawl effort was 3,443 sets. Areas of high fishing effort are dispersed along the shelf edge with high pockets of effort near Chirikof Island, Cape Barnabus, Cape Chiniak and Marmot Flats. Catch in these areas was composed primarily of pollock, Pacific cod, flatfish and rockfish. A larger portion of the trawl fleet in the Kodiak Island area is composed of smaller catcher vessels that require 30 percent observer coverage (see Section 3.6 for more information).

In April 1987, GOA FMP Amendment 15 closed two areas around Kodiak Island to bottom trawling and scallop dredging. These areas were designated as important rearing habitat and migratory corridors for juvenile and molting crabs. The closures are intended to assist rebuilding severely depressed Tanner and red king crab stocks. In addition to crab resources, the closed areas and areas immediately adjacent to them have rich stocks of groundfish including flathead sole, butter sole, Pacific halibut, arrowtooth flounder, Pacific cod, pollock, and several species of rockfish.

GOA FMP Amendment 18 enhanced the protection of target species beginning in 1990. It established the Shelikof Strait area as a management district because the area was found to contain spawning populations of pollock. The amendment also extended the closed areas around Kodiak Island to bottom trawl gear because those closure areas were scheduled to expire at the end of the year.

As mentioned above, GOA FMP Amendment 23 eliminated the domestic bottom trawl fishery for pollock to avoid bycatch of prohibited species and to further reduce the fisheries impacts on benthic habitats. The fishing industry also initiated self-imposed gear modifications to further protect pollock spawning habitat and other benthic habitats.

GOA FMP Amendment 25 established Steller sea lion buffer zones in the GOA. Regulations authorized by this amendment implemented the following measures:

1. Areas are closed year-round to fishing by trawl vessel within 10 nm of key Steller sea lion rookeries.

2. Areas within 20 nm of five sea lion rookeries are closed to directed pollock fisheries during the “A” season.

3. The specified TAC for pollock in the combined western/central area is further divided among three pollock management districts: Area 61, Area 62, and Area 63. The Shelikof Strait District was eliminated. To prevent excessive accumulation of unharvested portions and quarterly allowance of the pollock TAC, a limit of 150 percent of the initial quarterly allowance in each pollock management district was established.

In 1993, NOAA Fisheries extended the no-trawl zone around Ugamak Island out to 20 nm during the pollock roe fishery (58 FR 13561). GOA Amendment 45 further subdivided the areas for pollock fishing; these areas were further modified in June of 1998 (63 FR 31939).

GOA FMP Amendments 55 and 65 were recently passed in order to identify EFH, minimize practicable adverse effects on habitat, and encourage conservation of HAPC.

GOA Pollock Comparative Baseline

AFSC bottom trawl surveys are conducted every three years in the GOA. Starting in 2001, these surveys have been conducted every two years. In 2001, the AFSC survey covered the western and central GOA, which typically accounts for 97 percent of the GOA pollock. The 2001 biomass estimate (216,761 mt) indicates a 65 percent decline in biomass compared to the 1999 biomass survey estimate (Dorn *et al.* 2001).

The Shelikof Strait EIT survey has been conducted annually since 1981 and is used to assess the biomass of pollock in the Shelikof Strait area. Age-2+ abundance estimates were estimated at 229,100 mt, a 38 percent decrease from the 2001 biomass estimates. However, the 2002 age-3 estimated abundance was the third largest on record. EIT surveys were also conducted in the Shumagin Islands spawning areas and the area along the shelf east of the entrance to the Shelikof sea valley in winter of 2002. The 2002 survey results indicate that there may not be a constant ratio of stock spawning in the Shelikof Strait for the total pollock biomass, an assumption used in the modeling of GOA pollock. The GOA pollock stock modeling will be reevaluated in light of these new results (Dorn *et al.* 2002).

The ADF&G crab/groundfish trawl survey is conducted at a fixed number of stations, mostly nearshore from Kodiak Island to Unimak Pass. These surveys have been conducted since 1987. The 2002 biomass estimate (96,237 mt) indicates an increase of 11 percent from the 2001 biomass, in contrast to the steep decline suggested by the Shelikof Strait EIT survey. The ADF&G survey also shows a predominance of older fish (greater than 45 cm) which may be attributed to selectivity of the gear (Dorn *et al.* 2002). The survey biomass estimates from the AFSC, Shelikof Strait EIT and ADF&G trawl surveys for GOA pollock are listed in Dorn *et al.* 2002.

In order to estimate pollock biomass from 1961-1982, a generalized linear model (GLM) was fit to pre-1984 trawl data and post-1984 triennial trawl survey data. This model indicates low biomass estimates between 1961 and 1971, an increase by a factor of 10 in 1974 and 1975, and declining to 900,000 mt in 1978. No consistent trends are noticeable in the GLM following 1978. The coefficients of variation for the GLM-based biomass estimates range between 0.24 and 0.64, larger than the triennial survey biomass estimates (Dorn *et al.* 2001).

Over the last 15 years, NOAA Fisheries' FOCI targeted much of their research on understanding processes influencing recruitment of pollock in the GOA. These investigations led to the development of a conceptual model of factors influencing pollock recruitment (Kendall *et al.* 1996). Bailey *et al.* (1996) reviewed 10 years of data for evidence of density-dependent mortality at early life stages. Their study revealed evidence of density-dependent mortality only at the late larval to early juvenile stages of development. Bailey *et al.* (1996) hypothesize that pollock recruitment levels can be established at any early life stage (egg, larval, or juvenile) depending on sufficient supply from prior stages. They labeled this hypothesis the *supply dependent multiple life stage control model*. In a parallel study, Megrey *et al.* (1996) reviewed data from FOCI studies and identified several events that are important to pollock survival during the early life history. These events are climatic events (Hollowed and Wooster 1995, Stabeno *et al.* 1995); preconditioning of the environment prior to spawning (Hermann *et al.* 1996), the ability of the physical environment to retain the planktonic life stages of pollock on the continental shelf (Bograd *et al.* 1994, Schumacher *et al.* 1993), and the abundance and distribution of prey and predators on the shelf (Bailey and Macklin 1994, Canino 1994, Theilacker *et al.* 1996). Thus, the best available data suggest that pollock year-class strength is controlled by sequences of biotic and abiotic events and that population density is only one of several factors influencing pollock production.

The 2002 FOCI predictions were based on information from: 1) observed 2002 Kodiak monthly precipitation, 2) wind mixing energy at 57°N, 156°W, 3) advection of ocean water in the vicinity of Shelikof Strait, 4) rough counts of pollock larvae from May 2002, and 5) estimates of age-2 pollock abundance. By weighting these elements, FOCI forecasted that the 2001 year-class is strong and 2002 year-class is average (Dorn *et al.* 2002).

GOA Pollock Cumulative Effects Analysis Status

GOA pollock will be brought forward for cumulative effects analysis.

3.5.1.14 GOA Pacific Cod

Life History and Distribution

Pacific cod (*Gadus macrocephalus*) is a demersal species that occurs on the continental shelf and upper slope from Santa Monica Bay, California through the GOA, Aleutian Islands, and EBS to Norton Sound (Bakkala 1984). The Bering Sea represents the center of greatest abundance, although Pacific cod are also abundant in the GOA and Aleutian Islands. GOA, EBS, and Aleutian Island cod stocks are genetically indistinguishable (Grant *et al.* 1987), and tagging studies show that cod migrate seasonally over large areas (Shimada and Kimura 1994).

In the late winter, Pacific cod converge in large spawning masses over relatively small areas. Major aggregations occur between Unalaska and Unimak Islands, southwest of the Pribilof Islands, and near the Shumagin group in the western GOA (Shimada and Kimura 1994). Spawning takes place in the sublittoral–bathyal zone near the bottom, the area of the continental shelf and slope about 40 to 290 m deep. The eggs sink to the bottom and are somewhat adhesive (Hirschberger and Smith 1983). Table 3.5-4 summarizes the biological and reproductive traits and habitat associations of Pacific cod at its different life stages.

Pacific cod reach a maximum recorded age of 19 years. In the BSAI, 50 percent of Pacific cod is estimated to reach maturity by the time they reach 67 cm in length, or an age of about 5 years (Thompson and Dorn 1999). The same length in the GOA stock corresponds to an age of about 7 years (Thompson *et al.* 1999).

Trophic Interactions

Pacific cod is an opportunistic feeder that feeds both in the water column and in benthic areas (Yang and Nelson 2000). In the BSAI and GOA, in terms of percent occurrence in stomach contents, the most important items were polychaetes, amphipods, and crangonid shrimp. In terms of numbers of individual organisms consumed, the most important items were euphausiids, miscellaneous fish, and amphipods. In terms of weight of organisms consumed, the most important items were pollock, fishery offal, and yellowfin sole. Small Pacific cod were found to feed mostly on invertebrates, while large Pacific cod are mainly piscivorus (Livingston 1991b). In studies conducted on GOA Pacific cod, polychaetes and cephalopods were the most frequently found invertebrates in stomach contents. However, pandalid shrimp were more important in terms of percentage of total stomach contents weight. GOA Pacific cod also consumed large amounts of tanner crabs (Yang and Nelson 2000). Predators of Pacific cod include Pacific halibut, salmon shark, northern fur seals, Steller sea lions, harbor porpoises, various whale species, and tufted puffins (Westrheim 1996).

GOA Pacific Cod Management

Pacific cod in the GOA is managed under Tier 3a. The 2002 assessment projected a 2003 female spawning biomass of 88,300 mt, about 8 percent above 2001 assessment's projection for 2002 and corresponding to a maximum permissible 2003 ABC of 59,900 mt. NPFMC adopted a 2003 ABC of 52,800 mt, down about 8 percent from the 2002 ABC and about 12 percent below the maximum permissible value. The 2003 OFL for the GOA stock is 70,100 mt, down about 9 percent from the 2002 OFL. The 2003 ABC is intended to include all harvest mortality, including catches taken in the State of Alaska Pacific cod fisheries (Table 3.5-28). ABC is allocated among regulatory areas according to the average proportion of trawl survey biomass in each area: western, 39 percent; central, 55 percent; and eastern, 6 percent (Thompson *et al.* 2002) .

Beginning with the 1994 GOA SAFE report (Thompson and Zenger 1994), a length-structured synthesis model (Methot 1990) has formed the primary analytical tool used to assess Pacific cod.

Annual trawl surveys in the EBS and triennial (recently, biennial) trawl surveys in the Aleutian Islands and GOA are the primary fishery-independent sources of data for Pacific cod stock assessments (Thompson and

Dorn 2002, Thompson *et al.* 2002). Other available data include catch size compositions and biomass by gear, for the years 1978 through the early part of 2002. Within each year, catches are divided according to three time periods: January-May, June-August, and September-December. This particular division, which was suggested by participants in the EBS fishery, is intended to reflect actual intra-annual differences in fleet operation (e.g., fishing operations during the spawning period may be different than at other times of year). Four fishery size composition components were included in the likelihood functions used to estimate model parameters: the January-May (early) trawl fishery, June-December (late) trawl fishery, the longline fishery, and the pot fishery. In order to account for differences in selectivity between mostly foreign, mostly domestic, and very recent fisheries, the fisheries data were split into pre-1987, 1987-1999, and post-1999 eras in the GOA and pre-1989, 1989-1999, and post-1999 eras in the EBS. In addition to the fishery size composition components, likelihood components for the size composition and biomass trend from the bottom trawl surveys were included in the model. All components were weighted equally.

Quantities estimated in the most recent stock assessments include parameters governing the selectivity schedules for each fishery and survey in each portion of the time series, parameters governing the length-at-age relationship, population numbers at age for the initial year in the time series, and recruitments in each year of the time series. Given these quantities, plus parameters governing natural mortality, survey catchability, the maturity schedule, the weight-at-length relationship, and the amount of spread surrounding the length-at-age relationship, the stock assessments reconstruct the time series of numbers at age and the population biomass trends (measured in terms of both total and spawning biomass).

The model around which the Pacific cod assessments are structured uses an assumed survey catchability of 1.0 and an assumed natural mortality rate of 0.37 (see Appendix B). Several previous assessments included statistical analyses of the uncertainty surrounding the true values of the survey catchability and natural mortality rate. These analyses of uncertainty led to a risk-averse adjustment factor of 0.87 which is multiplied by the maximum permissible F_{ABC} to obtain the recommended F_{ABC}. Other outputs of the assessments include projections of biomass and harvest under a variety of reference fishing mortality rates.

GOA Pacific Cod Past/Present Effects Analysis

The geographic scope for the GOA Pacific cod past/present effects analysis is the same as the GOA FMP management areas (Figure 1.2-3). The temporal scope for this analysis begins in 1867 when the GOA domestic fishery begins and ends in 2002, the most recent year for which a stock assessment is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-30 provides a summary of the GOA Pacific cod past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on GOA Pacific cod:

- Mortality due to catch/bycatch and marine pollutants and oil spills (direct effect).

- Change in reproductive success due to fishery selectivity of juveniles, spatial/temporal concentration of catch, and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery catch/bycatch of prey species, introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).

- Change in important habitat due to impacts of fishery gear, marine pollutants and oil spills, introduction of exotic species and climate changes and regime shifts (indirect effect).

Mortality caused by marine pollution and change in prey availability and important habitat due the introduction of exotic species by way of ballast water and climate changes and regime shifts has not been brought forward since the impacts on Pacific cod in the GOA has not been directly observed or documented. See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the Pacific cod past effects analysis include the following:

- Past/Present External Events
  - Subsistence and personal use
  - Foreign groundfish fisheries (1962-1976)
  - State of Alaska crab fisheries
  - IPHC longline fisheries
  - State of Alaska groundfish fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1987)
  - JV groundfish fisheries (1978-1988)
  - Domestic groundfish fisheries (1867-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Subsistence and Personal Use

The earliest fisheries for groundfish in the GOA were the Native subsistence fisheries. Catches were traded or sold to the Russians and later to the Americans after the purchase of Alaska by the U.S. in 1867. Groundfish and herring are still important sources of food to many groups of Alaska Natives, although these subsistence harvests are now dwarfed by commercial operations (NPFMC 2002b). Since the overall Pacific cod catch by these groups is relatively small and localized, it is unlikely that these users would have an adverse effect on the GOA Pacific cod populations.

External Foreign Groundfish Fisheries (1962-1976)

The foreign trawl fisheries began in the GOA in 1962 with a Soviet fleet targeting Pacific ocean perch. Japan began fishing the following year, focusing on Pacific ocean perch and sablefish. These fisheries expanded rapidly in the late 1960s, and began targeting other groundfish species, although Pacific cod was not targeted until 1972 by Japan and the Soviet Union, and 1978 by the Republic of Korea. Prior to 1976, the majority of Pacific cod catch was bycatch. Pacific cod became the primary target of Japanese longline vessels in 1978 following the phase-out of foreign fisheries in the sablefish fishery and the expansion of domestic utilization (GOA FMP Amendments 2, 3, and 6). The foreign Pacific cod fishery peaked in 1981 at about 35,000 mt. Foreign fisheries dominated groundfish catch until 1985, when they were limited to only pollock and Pacific cod due to the rapid expansion of domestic fisheries capable of harvesting other species. By 1987, foreign fisheries were eliminated from the GOA (NPFMC 2002b). The past foreign fisheries contributed to fishing mortality in the GOA. Due to the short duration and moderate catch of the past Pacific cod foreign fisheries, there are no observable lingering adverse effects on the GOA Pacific cod populations.

External State of Alaska Groundfish Fisheries

The state-managed Pacific cod fishery began in 1997. Pacific cod fisheries are located in PWS, Cook Inlet, Chignik, Kodiak and the south Alaska Peninsula; each unit is regulated by a state FMP. A portion of the federal ABC is allocated to Pacific cod fisheries as a GHL, similar to the pollock fisheries. The GHLs are then allocated according the location of the fishery and gear type (pot and jig gear) within state waters. In 1999, approximately 14,044 mt of Pacific cod were harvested in the state-managed fisheries (ADF&G 2000b).

The State of Alaska contributed to the fishing mortality of Pacific cod in the GOA. These removals do not appear to have a significantly adverse effect on the GOA Pacific cod populations.

External State of Alaska Crab Bait Fisheries and IPHC Longline Bait Fisheries

The GOA bait fishery arose mainly in response to the need for bait in the growing crab fisheries of Alaska. The halibut fishery also required substantial amount of groundfish for bait. The bait fishery occurred from PWS west to the Aleutians, but some two-thirds of the catch was landed in Kodiak. The catch consisted mainly of pollock, Pacific cod, and various flounder species. The ability to measure the catch of groundfish for bait has been limited due to utilization of large amounts of Pacific cod on board halibut vessels. Therefore, unrecorded catch of bait may equal or exceed the recorded catch of bait. Bait has also been transferred to crab and halibut vessels on the fishing grounds. From 1972 to 1976 the catch of groundfish for bait increased from 96 mt to 303 mt. Catches continued to increase through the late 1970s and by 1982 accounted for 1,059 mt (NPFMC 2002b).

The State of Alaska crab fisheries and the IPHC longline fisheries contributed to fishing mortality in the GOA. The effect of these fisheries consisted of both removals of the fish as bycatch and removals of Pacific cod to be used in the fishery as bait. These past removals may have exerted impacts to the Pacific cod resource, resulting in adverse effects to overall mortality. GOA Amendment 11 was passed in order to eliminate the non-processed portion (bait and personal component) of the domestic fishery.

Internal JV and Domestic Groundfish Fisheries (1867 - present)

The first commercial groundfish fishery in the GOA was a setline fishery for Pacific cod by U.S. Nationals in 1867. Canadians were involved in the groundfish fisheries in the GOA since the beginning of the 20th century, although most of their efforts were focused on Pacific halibut and ended in 1981 as a result of extended jurisdiction (NPFMC 2002b).

Pacific cod have been landed domestically since the late 1950s and early 1960s, although the fishery did not really begin to develop until 1978. In 1985, the foreign fisheries were limited to pollock and Pacific cod in an effort to build the domestic fishery, and by 1987 the GOA had become completely domesticated. A small Pacific cod JV fishery existed through 1988, with a small average catch of approximately 1,400 mt per year. GOA FMP Amendment 8 was proposed to phase out the JV and foreign fisheries. The past JV and pre- and post-MSA domestic fisheries have contributed to the fishing mortality of GOA Pacific cod. There are no observable lingering effects in the GOA Pacific cod populations from these fisheries.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1962-1976)

Fishery Selectivity

In 1969 and 1970, the Soviet groundfish fishery targeted on arrowtooth flounder, sablefish, and pollock with bycatches of Pacific cod, rockfish, and other bottomfish. Data regarding the amount of Pacific cod bycatch and the age of the catch are unavailable; however, it is assumed that the bycatch of juvenile Pacific cod took place. Regardless, there are no observable lingering effects on the GOA Pacific cod population due to past foreign fishery selectivity.

External State of Alaska Groundfish Fisheries

Spatial/Temporal Concentration of Catch/Bycatch

State of Alaska Pacific cod fisheries tend to be spatially concentrated in the separate management areas. In the PWS, a majority of catches occur west of Montague Island and the western part of PWS. In Cook Inlet, catches came predominately from Kachemak Bay. The south Alaska Peninsula fisheries focus on the Sanak and Shumagin Islands area. The Kodiak and Chignik areas are more broadly distributed in space than the other fisheries. Overall, all of the state-managed Pacific cod fisheries tend to be broadly distributed in time, although there is some concentration during the late summer and early fall in certain regions (ADF&G 2000b).

Due to its localized nature, the State of Alaska directed Pacific cod fishery has been noted to have an adverse effect on the spatial distribution of the GOA Pacific cod stock. This effect is determined to have had lingering population effects in that stock.

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of Pacific cod. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5 for more details).

Internal JV and Domestic Groundfish Fisheries (1867-present)

Fishery Selectivity

Pacific cod are caught as bycatch and discarded in the Pacific cod fishery and other domestic groundfish trawl fisheries. GOA FMP Amendment 18 established the Observer Program partially in an attempt to reduce target and non-target species bycatch. Since 1998 (GOA FMP Amendment 49), discarding of Pacific cod has been prohibited except for fisheries in which Pacific cod has a bycatch-only status.

Spatial/Temporal Concentration of Catch/Bycatch

The Pacific cod fishery has changed recently due to management measures instituted to reduce possible adverse impacts on the western population of Steller sea lions. Some of these measures attempted to distribute catch more evenly throughout the year. On average during the period 1998-2000, 84 percent of the annual trawl catch, 97 percent of the annual longline catch, and 90 percent of the annual pot catch was taken from January to May. The attempted redistribution of trawl catches appears to have been the most successful, as the proportion taken during January to May was reduced to 63 percent in 2001. Correspondingly, the proportion of trawl catch taken during June to August increased by one percent and the proportion taken during September to December and increased by 20 percent. The longline and pot fisheries saw little change in temporal distribution; although pot gear saw a slight decline in the proportion of the catch taken during January to May with a slight corresponding increase from September to December (Thompson *et al.* 2002).

Change in Prey Availability

External Foreign Groundfish Fisheries (1962-1976)

Past foreign fisheries in the GOA have had an adverse impact on prey availability for large Pacific cod due to large removals of pollock. Large Pacific cod are mainly piscivorus consuming pollock ranging in age from age-0 to greater than age-6 depending on predator size. However, due to the opportunistic nature of Pacific cod, it is unlikely that the fisheries would have had a population-level effect of these populations. No observable lingering effects are apparent in the present GOA Pacific cod populations .

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important prey species of Pacific cod.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse with respect to prey availability. In general, a shift toward warmer waters appears to favor recruitment and survival of Pacific cod. As described in Section 3.10.1.5 of this Programmatic SEIS, when the Aleutian Low was weak, resulting in colder water, shrimp dominated the catches. When the Aleutian Low was strong, water temperatures were higher, and the catches were dominated by Pacific cod, pollock, and flatfishes.

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes the majority of the diet of small Pacific cod.

Internal JV and Domestic Groundfish Fisheries (1867-present)

JV and domestic fisheries in the GOA have had an adverse impact on prey availability for large Pacific cod due to large removals of pollock. Large Pacific cod are mainly piscivorus consuming pollock ranging in age from age-0 to greater than age-6 depending on predator size. However, due to the opportunistic nature of Pacific cod, it is unlikely that the fisheries would have had a population-level effect of these populations. No observable lingering effects are apparent in the present GOA Pacific cod populations .

Change in Important Habitat

External Foreign Groundfish Fisheries (1962-1976)

The statistics on the effects of bottom trawling in the GOA pre-MSA is generally unavailable. It is assumbed that habitat suitability has been negatively affected by the intensity of the past foreign fisheries; however, the effects have not shown a lingering influence at the population-level.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse with respect to habitat suitability. In general, a shift toward warmer waters appears to favor recruitment and survival of Pacific cod. As described in Section 3.10.1.5 of this Programmatic SEIS, when the Aleutian Low was weak, resulting in colder water, shrimp dominated the catches. When the Aleutian Low was strong, water temperatures were higher, and the catches were dominated by Pacific cod, pollock, and flatfishes.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important habitat of Pacific cod.

Internal JV and Domestic Groundfish Fisheries (1867-present)

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Habitat suitability has been adversely affected by the intensity of the past JV and domestic trawl fisheries; however, the effects are not considered to have a lingering influence at the population-level. GOA FMP Amendments 15, 18, 23, 25 and Steller sea lion protection measures have all contributed to reducing the intensity of bottom trawling by the domestic fishery. GOA FMP Amendments 55 and 65 were proposed to identify EFH, minimize practicable adverse effects on habitat from the fishery, and encourage conservation of HAPC.

GOA Pacific Cod Comparative Baseline

The highest biomass estimate recorded was in the 1984 survey at 571,188 mt and the lowest during the 2001 survey. However, the 2001 survey did not cover the eastern portion of the GOA. The highest number of fish was observed in 1996 with a population estimate of over 315 million fish. Pacific cod distributed throughout the GOA, with 47 percent of the biomass in the western GOA, 45 percent of the biomass in the central GOA, and 8 percent of the biomass in the eastern GOA according to the 2001 survey, using the 1999 eastern GOA survey estimate to approximate the 2001 eastern GOA biomass (Thompson *et al.* 2001).

Modeling indicates an increase in the age-3+ biomass during the early 1980s followed by a period of sustained high abundance through the rest of that decade. A steady decline in survey biomass has occurred from the early 1990s through the present. Female spawning and survey biomass trends also show declines throughout the past decade. Recruitment of age-3 Pacific cod appears to be average for the 1995 year-class and below average for 1998 year-class. Model estimates of age-1 recruitments closely parallel the age-3 recruitment, with the addition of a below average 1999 year-class and an average 2000 year-class (Thompson *et al.* 2002).

GOA Pacific Cod Cumulative Effects Analysis Status

GOA Pacific cod will be brought forward for cumulative effects analysis.

3.5.1.15 GOA Sablefish

Sablefish in the BSAI and GOA are managed as a single stock. Thus, the direct/indirect effects summary and cumulative effects analysis status of BSAI and GOA stocks is presented in Section 3.5.1.3.

3.5.1.16 GOA Atka Mackerel

Life History and Distribution

Atka mackerel existed in the GOA throughout the early 1980s and supported a large foreign fishery. By the mid-1980s, the population had nearly disappeared. This suggests that the Atka mackerel population in the GOA may be the edge of its distribution and that the GOA be populated only during periods of strong recruitment from the Aleutian Islands region. No reliable estimate exists of current Atka mackerel biomass in the GOA. Atka mackerel have not been commonly caught in the GOA triennial trawl surveys and, recently, have been detected by the summer trawl surveys only in the Shumagin (western) area of the GOA (Lowe and Fritz 2001).

Trophic Interactions

The diets of commercially important groundfish species in the GOA during the summer of 1990 were analyzed by Yang (1993). Atka mackerel were not sampled as a predator species. However, it is a reasonable assumption that the major prey items of GOA Atka mackerel would likely be euphausiids and copepods, as was found in Aleutian Islands Atka mackerel (Yang 1996).

The abundance of Atka mackerel in the GOA is much lower compared to the Aleutian Islands. Predators of the GOA Atka mackerel are similar to those encountered in the BSAI, although Atka mackerel appeared only as a minor component in the diet of arrowtooth flounder in the GOA (Yang 1993).

GOA Atka Mackerel Management

GOA Atka mackerel fall into Tier 6 of the ABC and OFL definitions, which define the OFL level as average catch from 1978 to 1995 and ABC as not exceeding 75 percent of OFL. The average annual catch from 1978 to 1995 is 6,200 mt; thus ABC cannot exceed 4,700 mt. The current ABC recommendation from the stock assessment is below the maximum prescribed under Tier 6, to provide a very conservative harvest strategy given the uncertainty about GOA Atka mackerel abundance. The 2002 stock assessment for the 2003 fishery recommended an ABC of 600 mt, with the intention of precluding a directed fishery, while providing for bycatch needs in other trawl fisheries (Table 3.5-28). An ABC lower than the maximum prescribed under Tier 6 was recommended since the fishery may have created localized depletions of Atka mackerel. Catch-per-unit-effort (CPUE) data indicate declines in the Atka mackerel population from 1992-1994 and since data indicated that the GOA population is vulnerable to fishing pressure (Lowe 2002).

Atka mackerel have not been commonly caught in the GOA triennial trawl surveys. It has been determined that the general GOA groundfish bottom trawl survey does not assess the GOA portion of the Atka mackerel stock well, and resulting biomass estimates have little value as absolute estimates of abundance or as indices of trend (Lowe and Fritz 2001). Because of this lack of fundamental abundance information, GOA Atka mackerel are not assessed with an age-structured model. The stock assessment, which does not utilize abundance estimates from the trawl survey, consists of descriptions of catch history, length and age distributions from the fishery (1990-1994), and length distributions from the trawl surveys (1996, 1999, and 2001). This information is presented in the GOA Atka mackerel stock assessment, which is incorporated into the GOA SAFE report.

Complicating the difficulty in surveying Atka mackerel is the low probability of encountering schools in the GOA, where the abundance is lower and their distribution is patchier relative to the BSAI. Because of this, it has not been possible to estimate population trends for the species in the GOA.

Past/Present Effects Analysis

The geographic scope for the GOA Atka mackerel past/present effects analysis is the same as the GOA management areas (Figure 1.2-3). The temporal scope for this analysis begins in 1973 when the foreign fishery started and ends in 2002, the most recent year for which stock assessment information exists.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-31 provides a summary of the GOA Atka mackerel past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on GOA Atka mackerel:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to the spatial/temporal concentration of catch/bycatch, fishery selectivity and climate changes and regime shifts (indirect effect).

- Change in prey availability due to commercial whaling, the introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).

- Change in important habitat due to fishery gear impacts, climate changes and regime shifts, introduction of exotic species and marine pollution and oil spills (indirect effect).

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on Atka mackerel in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the Atka mackerel past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (1973-1976)
  - Commercial whaling
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1986)
  - JV groundfish fisheries (1979-1985)
  - Domestic groundfish fisheries (1979-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - IWC management
  - MMPA of 1972
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following section explains any amendments specific to the Atka mackerel fishery. Amendments discussed in Section 3.2, which impact on the target fisheries as a whole and Atka mackerel as a component of the fishery, are not repeated here.

Mortality

External Foreign Groundfish Fishery (1973-1976)

Atka mackerel was an important target species of the foreign fishery in the GOA. The past foreign Atka mackerel fisheries participated in the GOA from about 1973 to 1986. Harvests peaked in 1975 at 27,777 mt, and were taken mainly by the Soviet fishery, largely due to a decrease in Pacific ocean perch abundance (NPFMC 2002b). The large removals of Atka mackerel by the foreign fisheries are found to have had a lingering adverse effect on the GOA Atka mackerel population.

Internal JV and Domestic Groundfish Fisheries

The past JV Atka mackerel fishery participated for a short time in the GOA, from 1979 to 1985, although significant catches were not made until 1983. Since 1985, all Atka mackerel landings have been by domestic fleets. The domestic fishery began in 1979 but, like the JV fishery, did not begin catching significant amounts of Atka mackerel until 1983 (NPFMC 2002b). By 1992, catches increased to 14,000 mt (Lowe and Fritz 2001). The Atka mackerel fishery is currently a bycatch only fishery. The large removals of Atka mackerel by the JV and past domestic fisheries (see catch history in Lowe 2002) are found to have had a lingering adverse effect on the GOA population.

An Atka mackerel population existed in the GOA primarily in the Kodiak, Chirikof, and Shumagin areas and supported a large foreign fishery through the early 1980s. By the end of the mid-1980s, this fishery, and presumably the population, had all but disappeared. Atka mackerel were combined with the "other species" category in 1988 (GOA FMP Amendment 16). This regulatory category resulted in the mandatory discard of species of minor commercial importance such as sculpin, skate, squid, smelt, etc. In 1990, a directed fishery resumed when a closure of the Atka mackerel fishery in the BSAI resulted in the movement of vessels into the western regulatory area to continue targeting this species. The fishery had expanded significantly by 1992, and the expansion resulted in the listing of the "other species" category as bycatch only. This closure caused the discard of minor species such as octopus. In 1993, Atka mackerel were again targeted in the GOA, accounting for almost the entire TAC of other species in the western regulatory area. As a result, the "other species" category was closed to directed fishery in the western regulatory area. Since Atka mackerel no longer met the definition of other species (of slight economic importance or containing economically valuable species but insufficient data to allow separate management), Atka mackerel were established as a target species in its own right in the GOA by Amendment 31, and harvest levels were then based on biological stock assessments. Such an action reduced the potential for overfishing Atka mackerel, while allowing for increased harvest of the other species complex, and reduced user conflicts within the western regulatory area of the GOA. Steller sea lion conservation measures in 1991-1993 further restricted the amount of Atka mackerel that could be taken in certain areas. GOA Amendment 44 provided a more conservative OFL definition for Atka mackerel, based on Tier 6, which set the OFL equal to the average catch from 1978 to 1995. However, since 1997, the Atka mackerel has been managed as a bycatch only fishery, with a sufficient level to provide for bycatch in other target fisheries (600 mt annually).

Change in Reproductive Success

External Foreign Groundfish Fishery (1973-1976)

Spatial/Temporal Concentration of Catch/Bycatch

As in the BSAI, the foreign GOA Atka mackerel fishery was a highly localized fishery, occurring in the same locations every year at depths less than 200 m. The past foreign fisheries are found to have had an adverse impact on the spatial/temporal distribution of the GOA Atka mackerel stock due to the spatial/temporal concentration of the fishery. This effect is determined to have a lingering population effect in the GOA stock.

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of Atka mackerel. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fishery (1979-present)

Fishery Selectivity

The 1991 to 1994 data show that during certain months on the Davidson Bank and near the Shumagin Islands, more females than males are caught. The presumption is that there is a natural segregation of the population during spawning periods. The Umnak Island fishery ground (1991-1994) represents a more even distribution of males to females in the catch (Lowe and Fritz 2001).

Spatial/Temporal Concentration of Catch/Bycatch

In 1990, the localized Atka mackerel fishery took place near the edge of the continental shelf on Davidson Bank south of Unimak and Sanak Islands, and moved off the southern coast of Umnak Island from 1991-1994. In 1993 and 1994, fishing also took place off the south and east coasts of the Shumagin Islands (Lowe and Fritz 2001).

In 1994, small amounts of Atka mackerel bycatch were caught in the pollock, Pacific cod, and rockfish trawl fisheries in GOA management areas 610 and 620. Bycatch calculations are difficult to obtain for the rockfish fisheries since some vessels "top-off"their hauls with Atka mackerel rather than catch them strictly as bycatch. The 1994 discard rate for the GOA Atka mackerel fishery was about 8 percent (Lowe and Fritz 2001). GOA FMP Amendment 18 (1990) established the Observer Program which was designed to help decrease bycatch and discard rates, among other things.

The past JV fisheries are found to have had an adverse impact on the spatial/temporal distribution of the GOA Atka mackerel stock due to the spatial/temporal concentration of the fishery. This effect has resulted in a lingering population effect.

Change in Prey Availability

External Commercial Whaling

Whaling is identified as having a past beneficial effect on prey availability for the Atka mackerel stocks. Atka mackerel have been recorded as a prey species of certain whales; therefore, by removing large predators, Atka mackerel recruitment is favored.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability in both stocks. In general, a shift toward colder waters favors recruitment and survival of Atka mackerel. When the Aleutian Low was strong, water temperatures were higher, and biomass in the catches was dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changed in this same period, with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod and flatfishes (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important prey species of Atka mackerel.

Change in Important Habitat

External Foreign Groundfish Fishery (1973-1976)

Statistics on the number of bottom trawls and the effects of bottom trawling on habitat within the GOA is generally unknown. Due to the schooling, semi-demersal nature of Atka mackerel, this species is readily caught by bottom trawl gear (Lowe and Fritz 2001). The effect of the past foreign fisheries on habitat suitability for the GOA stock is unknown.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability in both stocks. In general, a shift toward colder waters favors recruitment and survival of Atka mackerel. When the Aleutian Low was strong, water temperatures were higher, and biomass in the catches was dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changed in this same period, with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important habitat of Atka mackerel.

Internal JV and Domestic Groundfish Fishery (1979-present)

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas, and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat. Sex ratio data (1991-1994) suggest that the fisheries frequent habitats inhabited by Atka mackerel, including possible spawning and nesting habitats (Lowe and Fritz 2001). The effects of the JV and past domestic fisheries gear on Atka mackerel habitat are unknown.

Steller sea lion no-trawl or limited trawl zones were established in the BSAI and GOA in 1991, 1992 and 1993. This included a 20 nm aquatic zone around the Shelikof Strait foraging area. From 1991 to 1993, 82 to 89 percent of Atka mackerel were caught between 10-20 nm of Steller sea lion rookeries on islands near Umnak and in the Shumagin Islands. Concerns were raised regarding the localized reduction of food availability to Steller sea lions in those areas. GOA FMP Amendments 55 and 65 were designed to identify, conserve, and mitigate impacts on EFH and HAPC. The effect of the JV fishery on habitat suitability for the GOA stock is unknown.

GOA Atka Mackerel Comparative Baseline

Biomass estimates by survey data are considered unreliable due to high variability in the Atka mackerel distribution and anomalously high single catches. CPUE analyses of Atka mackerel fisheries are the only indicator of recent trends in abundance. These analyses suggest that the Atka mackerel population declined 81 percent between 1992 and 1994 near Umnak Island and declined 58 percent near Shumagin Island in the GOA (Lowe and Fritz 2001).

Fishery age composition data suggests that in 1990, 1992 and 1994, most Atka mackerel were between 3 and 4 years old (1988 year-class). The oldest fish from the 1994 sample was 11 years old from Shumagin Bank (Lowe and Fritz 2001).

GOA Atka Mackerel Cumulative Effects Analysis Status

The GOA Atka mackerel will be brought forward for cumulative effects analysis.

3.5.1.17 GOA Shallow Water Flatfish

Life History and Distribution and Trophic Interactions

Eight flatfish species inhabit shallow waters and are managed in the shallow water flatfish assemblage in the GOA. They include: northern and southern rock sole, yellowfin sole, starry flounder, butter sole, English sole, Alaska plaice and sand sole. The life history, distribution and trophic interactions of these species have been described under the BSAI in Section 3.5.1.5 for yellowfin sole, 3.5.1.6 for rock sole and 3.5.1.10 for the remaining flatfish species.

GOA Shallow Water Flatfish Management

Survey results from 2001 indicate that over half of the estimated biomass (54 percent) of this assemblage are northern and southern rock sole. Rock sole, for which maturity information is deemed adequate, are managed in Tier 4 of the ABC and OFL definitions where $F_{ABC} = F_{40\%}$ (0.17) and $F_{OFL} = F_{30\%}$ (0.209). This equates to on ABC value of 28,351 mt (9,571 mt for northern rock sole and 18,780 mt for southern rock sole) and to an OFL value of 34,214 mt for both species of rock sole; 11,550 mt for northern rock sole and 22,664 mt for southern rock sole (Table 3.5-28) (Turnock 2002b). The rest of the shallow water group is managed as a Tier 5 species in the GOA where ABCs are calculated using F_{ABC} = 0.75 M (0.15) and F_{OFL} = M (0.2). The group is managed this way because maturity information for the GOA stock is unavailable (Turnock *et al.* 2001b).

Stock assessment models are not used for any of the shallow water flatfish in the GOA due to the lack of available information (Turnock *et al.* 2001b). Triennial trawl survey biomass estimates from 1984, 1987, 1990, 1993, 1996, 1999, and 2001 are considered the best information available to determine stock biomass for all of the flatfish species in the GOA. The 2001 GOA survey effort did not encompass the eastern GOA and resulted in the eastern GOA biomass being approximated using the average of the 1993-1999 GOA biomass estimates. Beginning with the 1996 trawl survey, rock sole was further divided into northern rock sole (*Lepidopsetta sp. cf. bilineata*) and a southern rock sole (*L. bilineata*) Overlapping distributions may lead to separate management in the future (Turnock *et al.* 2001b).

GOA Shallow Water Flatfish Past/Present Effects Analysis

The geographic scope for the GOA shallow water flatfish assemblage past/present effects analysis is the same as the GOA FMP management areas (Figure 1.2-3). The temporal scope for this analysis begins in the 1960s when the GOA shallow water flatfish assemblage foreign fishery began and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-32 provides a summary of the GOA shallow water flatfish assemblage past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on GOA shallow water flatfish assemblage:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch, fishery selectivity and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery prey bycatch, introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).

- Change in important habitat due to fishery impacts, scallop dredging, introduction of exotic species, marine pollutants and oil spills and climate changes and regime shifts (indirect effect).

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on the shallow water flatfish in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the shallow water flatfish assemblage past/present effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (1960s-1976)
  - State of Alaska scallop fishery
  - State of Alaska crab bait fisheries
  - IPHC longline bait fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1968-1988)
  - Domestic groundfish fisheries (1968-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following section explains any amendments specific to the shallow water flatfish assemblage fishery. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality

External Foreign Groundfish Fisheries (1960s-1976)

The Japanese and Soviet flounder fisheries both started as Pacific ocean perch fisheries in the early 1960s and switched to other target Groundfish following the decline of Pacific ocean perch. Annual harvests were about 15,000 mt taken mostly by Japanese trawlers. By 1981, the Soviet fleets were no longer allowed in the GOA due to political reasons and Japanese catch was minimal. By 1988, only domestic fleets were harvesting flatfish (NPFMC 2002b).

Although removals of shallow water flatfish occurred during the past foreign fisheries, there are no observable adverse lingering effects on the GOA shallow water flatfish population.

External State of Alaska Crab Bait and IPHC Longline Bait Fisheries

The GOA bait fishery targeted pollock, Pacific cod, and various flounder species in order to provide needed bait for the crab and halibut fisheries. Bait fisheries occurred from PWS west to the Aleutians, although the majority of the bait has been landed in the Kodiak area (NPFMC 2002b). Although these fisheries contributed to flatfish mortality, there are no observable lingering effects on the population.

Internal JV and Domestic Groundfish Fishery (1968-present)

The domestic and JV flounder fisheries began in 1968, although catches were minimal until 1986. The JV fisheries were responsible for a large amount of the increase in flatfish catch in 1986-1987, with a four-fold increase in the 1987 catch. JV fisheries were phased-out of the flatfish fishery by 1988; however, the catch continued to increase with the domestic fishery to a high of 43,107 mt in 1996. Flatfish declined in 1998 to 23,237 mt, increased to 37,303 mt in 2000, and declined again in 2001 to 31,734 mt. Shallow water flatfish remained lightly harvested in 2001 at 6,173 mt, a decrease from 6,928 mt in 2000. The flatfish fishery is likely to be limited by the potential for exceeding the Pacific halibut PSC limits in the future (Turnock *et al.* 2002b).

In the GOA, yellowfin sole is managed as part of the flatfish assemblage. In 1990, NPFMC divided the flatfish assemblage into four categories; shallow flatfish, deep flatfish, flathead sole and arrowtooth flounder. Yellowfin sole fell into the shallow flatfish category. This classification was made because of the significant difference in halibut bycatch rates in directed fisheries targeting on shallow water and deepwater flatfish species. Arrowtooth flounder was separated from the other categories due to its high abundance and low commercial value. Flathead sole were separated due to an overlap in depth distribution with the shallow water and deepwater groups.

Rex sole was split out of the deepwater management category in 1993 due the relatively large amounts of Pacific ocean perch bycatch occurring in the rex sole target fishery. Beginning in 1996, rock sole was split into two species, a northern (*Lepidopsetta sp. cf. bilineata*) and a southern rock sole (*Lepidopsetta bilineata*) (personal communication, Jay Orr) due to overlapping distributions.

The large removals of shallow water flatfish by the JV and past domestic fisheries are found to have had a lingering adverse effect on the GOA shallow water flatfish populations.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1960s-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the past foreign fisheries on the spatial/temporal distribution of the GOA shallow water flatfish assemblage stock is unknown. However, any effects on the spatial/temporal distribution are not expected to have had a lingering population effect.

External Climate Changes and Regime Shifts

Climate changes and regime shifts are identified as having potentially beneficial or adverse effects on the reproductive success of GOA shallow water flatfish. The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fishery (1968-present)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the past JV fisheries on the spatial/temporal distribution of the GOA shallow water flatfish assemblage is unknown. However, any effects on the spatial/temporal distribution are not expected to have had lingering population effects.

Change in Prey Availability

External Foreign Groundfish Fisheries (1960s-1976)

The foreign fisheries in the GOA are unlikely to have directly impacted the prey availability for the shallow water flatfish assemblage since these fish eat infaunal and epifaunal invertebrates. The lingering effect in the GOA shallow water flatfish stock is likely due to the natural events related to climate change.

External Climate Changes and Regime Shifts

The lingering adverse effect in the GOA shallow water flatfish stock is likely due to the natural events related to climate change. Although flatfishes tend to dominate catch during strong Aleutian Lows, on a microclimate scale, community structures changed in some nearshore areas with decreasing populations of shrimps and small forage fish, and increasing populations of the large fish-eating species, such as Pacific cod, and other flatfishes. Pacific cod, skates, and Pacific halibut are predators of the species of the shallow water flatfish assemblage.

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes the majority of the diet of the shallow water flatfish.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important prey species of the shallow water flatfish group.

Internal JV and Domestic Groundfish Fishery (1968-present)

The bycatch of juvenile crabs occurs in small numbers in domestic trawl fisheries. Crabs less than 25 mm in carapace width are estimated to have a selectivity of 0.001 in domestic fisheries from the snow crab assessment model. Combined with the fact that juvenile crab are only one component of the diet of yellowfin sole, these fisheries are not expected to impact the foraging capabilities of yellowfin sole.

Change in Important Habitat

External Foreign Groundfish Fisheries (1960s-1976)

The statistics on the number of bottom trawls occurring in the GOA, and their effects on habitat are generally unknown. It is assumed that the effect of the foreign fisheries on habitat suitability is either beneficial or adverse; and the effects are found to have had a lingering influence in shallow water flatfish assemblage stocks.

External State of Alaska Scallop Fishery

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The State of Alaska scallop fishery has a history of being sporadic due to exploitation of limited stocks, market conditions, and availability of more lucrative fisheries. In 1999, only three boats fished for scallops (B. Bechtol, ADF&G, personal communication). While the effects of dredging on benthic habitat are intense, the magnitude of the overall impact of this fishery is likely to be small.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability in both stocks. When the Aleutian Low was strong, water temperatures were higher, and biomass in the catches was dominated by cod, pollock, and flatfishes. Community structure in nearshore areas around Kodiak Island changed in this same period, with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important habitat of the shallow water flatfish group.

Internal JV and Domestic Groundfish Fishery (1968-present)

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of these past fisheries on habitat suitability is either beneficial or adverse; and the effects are found to have had a lingering influence in the shallow water flatfish assemblage. The 1998 bottom trawl prohibition in the eastern area of 140°W may have had a beneficial effect on habitat suitability for flatfish in that area.

GOA Shallow Water Flatfish Assemblage Comparative Baseline

The 2001 biomass survey took place only in the central and western Gulf; therefore, the eastern GOA biomass has been estimated using the average of the 1993 through 1999 eastern GOA biomass estimates for all flatfish species except butter sole and English sole. Since the trends for butter sole in the central GOA are similar to their trends in the eastern GOA, the 2001 biomass estimates were obtained by applying the declining trend in biomass from 1999 to 2001 in the central GOA to the 1999 biomass in the eastern GOA. For English sole, the biomass estimate from 1999 was used without adjustment for the 2001 biomass.

Northern rock sole and butter sole have all decreased in 2001 relative to 1990s biomass estimates. Alaska plaice experienced an increase in biomass from 1993-1999; however, 2001 estimates show a decline in biomass. In contrast, southern rockfish and yellowfin sole both showed declines in years previous to 1999 with an increase in 2001 biomass estimates. Starry flounder has shown a continuous increase in biomass since 1990, while English sole increased from 1993-1999 and stabilized from 1999-2001. Sand sole has been variable over the years but has shown a slight increase between 1999 and 2001. Exploitable biomass estimates are assumed to be the same as the 2001 survey biomass results (Turnock *et al.* 2002b). Some experimental evidence indicates that flatfish biomass may be under estimated by the northeastern trawl (Weinberg 2003). Experiments are being conducted to estimate the herding component of catchability.

GOA Shallow Water Flatfish Assemblage Cumulative Effects Analysis Status

The GOA shallow water flatfish assemblage will be brought forward and examined as a group in the cumulative effects analysis.

3.5.1.18 GOA Flathead Sole

Life History and Distribution

Flathead sole (*Hippoglossus elassodon*) are distributed from northern California northward throughout Alaska. In the northern part of its range, the species overlaps with the related and very similar Bering flounder (*Hippoglossoides robustus*) (Wolotira *et al.* 1993, Hart 1973). Adults are benthic and occupy separate winter spawning and summer feeding distributions. From overwintering grounds near the continental shelf margin, adults begin a migration onto the mid- and outer continental shelf in April or May. The spawning period occurs in late winter/early spring, primarily in deeper waters near the margins of the continental shelf (Walters and Wilderbuer 1997). Eggs are large and pelagic. Upon hatching, the larvae are planktonic and usually inhabit shallow areas (Waldron and Vinter 1978). Age and size at maturity are unknown, but recruitment to the fishery begins at age 3 (Figure 3.5-5). The maximum age from fishery age samples is 28 years. Flathead sole are taken in bottom trawls both as a directed fishery and in pursuit of other bottom dwelling species. Table 3.5-14 summarizes biological and reproductive attributes and habitat associations of flathead sole in the BSAI and GOA.

Trophic Interactions

Flathead sole feed primarily on invertebrates such as ophiuroids, tanner crab, bivalves and polychaetes. Their diet has been shown to include commercially important species such as pollock and tanner crabs. In the EBS, other fish species represented 5 to 25 percent of the diet (Livingston *et al.* 1993). Groundfish predators include Pacific cod, Pacific halibut, arrowtooth flounder, and also cannibalism by large flathead sole, mostly on fish less than 20 cm standard length.

GOA Flathead Sole Management

Beginning in 2002, flathead sole were managed independent of the other flatfish complex in the GOA. The projected spawning biomass for flathead sole is estimated above the $B_{40\%}$ biomass (38,163 mt), and is therefore evaluated under Tier 3a. The 2003 ABC equates to 41,390 mt, and the OFL equates to 51,556 mt (Table 3.5-28). The ABC and OFL are further apportioned to western, central, and west and east Yakutat GOA regions (Turnock *et al.* 2002c).

An age-structured model was developed for flathead sole in the 2002 GOA SAFE Report. This model includes age and biomass estimates from the 1984, 1993 and 1996 trawl surveys and length and biomass estimates from the 1987, 1990, 1999, and 2001 trawl surveys. CPUE data from the commercial fisheries was also used from 1985-2002 (Turnock *et al.* 2002c).

GOA Flathead Sole Past/Present Effects Analysis

The geographic scope for the GOA flathead sole past/present effects analysis is the same as the GOA management units (Figure 1.2-3). The temporal scope for this analysis begins in 1960s when the foreign flounder fishery started and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. The following direct and indirect effects were identified as potentially having population-level effects on GOA flathead sole:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery bycatch of prey species, introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).

- Change in important habitat due to fishery gear impacts, marine pollution and oil spills, introduction of exotic species and climate changes and regime shifts (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following section explains any amendments specific to the flathead sole fishery. Amendments discussed in Section 3.2 which impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on flathead sole in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the flathead sole past/present effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (1960s-1976)
  - IPHC longline fisheries
  - State of Alaska scallop fisheries
  - State of Alaska crab fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1968-1988)
  - Domestic groundfish fisheries (1968-present)

- Past/Present Management Actions
  - Bilateral agreements

- Industry initiated actions
- Foreign groundfish fishery initiated actions
- Preliminary groundfish FMPs (pre-MSA)
- FMP groundfish fisheries management

For a discussion of the past/present effects on the flathead sole, see the GOA shallow water flatfish past/present effects analysis (Section 3.5.1.5).

GOA Flathead Sole Comparative Baseline

Previous to 1981, flatfish were taken primarily by the foreign fisheries at about 15,000 mt annually. After the passage of the MSA in 1977, catches decreased to a low of 2,441 mt in 1986 and then steadily increased to a high of 43,107 mt in 1996. Flatfish declined in 1998 to 23,237 mt, increased to 37,303 mt in 2000, and declined again in 2001 to 31,734 mt. Flathead sole remain lightly harvested in 2002 at 2,029 mt as of October 5, 2002, a slight increase from 2001. The flatfish fishery is likely to be limited by the potential for high catches of Pacific halibut in the future (Turnock *et al.* 2002c).

Many flatfish species exhibited an increasing biomass trend in the 1980s and an decreasing trend in the 1990s. Flathead sole declined from 247,247 mt in 1990 to 170,915 mt in 2001. Exploitable biomass estimates are assumed to be the same as the 2001 survey biomass results (Turnock *et al.* 2002b). Some experimental evidence indicates that flatfish biomass may be underestimated by the northeastern trawl (Weinberg 2003), experiments are being conducted to estimate the herding component of catchability.

GOA Flathead Sole Cumulative Effects Analysis Status

GOA flathead sole will be brought forward for cumulative effects analysis.

3.5.1.19 GOA Arrowtooth Flounder

Life History and Distribution

Arrowtooth flounder (*Atheresthes stomias*) occur from central California to the Bering Sea, in waters from about 20-800 m (Zimmerman and Goddard 1996). Spawning is protracted and variable and probably occurs from September through March (Zimmermann 1997). For female arrowtooth flounder collected off the Washington coast, the estimated age at 50 percent maturity was 5 years, with an average length of 37 cm. Males matured at 4 years and 28 cm (Rickey 1995). The maximum reported ages are 16 years in the Bering Sea, 18 years in the Aleutian Islands, and 23 years in the GOA (Turnock *et al.* 1997a, Wilderbuer and Sample 1997). Arrowtooth flounder is currently the most abundant groundfish species in the GOA; however, they are currently considered of low value and mostly discarded.

In the Bering Sea, the arrowtooth flounder inhabits the continental shelf waters almost exclusively until age-4, but at older ages occupies both shelf and slope waters, with greatest concentrations at depths between 100 and 200 m (Martin and Clausen 1995). The very similar Kamchatka flounder (*Atheresthes evermanni*) also occurs in the Bering Sea. Values of 50 percent maturity for the Bering Sea stock are 42.2 cm and 46.9 cm for males and females, respectively (Zimmerman 1997). Table 3.5-16 summarizes biological and reproductive attributes and habitat associations of arrowtooth flounder in the BSAI and GOA.

Trophic Interactions

Arrowtooth flounder play an important role in the Bering Sea and GOA ecosystems because they are large, aggressive, and abundant predators of other groundfish species (Hollowed *et al.* 1995, Livingston 1991b, Yang 1993). The majority of prey by weight of arrowtooth flounders larger than 40 cm is pollock, the remainder consisting of herring, capelin, euphausiids, shrimp, and cephlapods (Yang 1993). These fish also consumed salmonids and Pacific cod in the GOA (Yang and Nelson 2000). The percent of pollock in the diet of arrowtooth flounder increases for sizes greater than 40 cm. Arrowtooth flounder 15-30 cm consume mostly shrimp, capelin, euphausiids and herring, with small amounts of pollock and other miscellaneous fish (DiCosimo 1998). Groundfish predators on arrowtooth include Pacific cod and pollock, which feed mostly on small fish (Livingston and deReynier 1996).

GOA Arrowtooth Flounder Management

For the GOA, arrowtooth flounder are also defined in Tier 3a of the ABC and OFL definitions. The 2003 stock assessment ABC (155,140 mt) was based on the $F_{40\%}$ fishing mortality rate because reliable estimates of F_{MSY} and B_{MSY} are unavailable. The 2003 ABC is further apportioned between the western, central, and west and east Yakutat/southeast outside GOA management units. The 2003 OFL value is based on the $F_{35\%}$ value and equates to 181,390 mt (Turnock *et al.* 2002a) (Table 3.5-28).

The stock assessment model used in the arrowtooth flounder assessment uses abundance estimates from IPHC trawl surveys, NOAA Fisheries groundfish surveys, and NOAA Fisheries triennial surveys. Fishery catch and size compositions were also used in the model. Current abundance estimates indicate that arrowtooth flounder have the largest biomass of the groundfish species inhabiting the GOA. The time-series of fishery and survey size compositions allows the use of an age-based stock assessment model. The outputs include estimates of sex-specific abundance, spawning biomass, fishery and survey selectivity, exploitation trends, and projections of future biomass. The model also estimates reference fishing mortality rates in terms of the ratio of female spawning biomass to unfished levels, which are used to calculate ABC. The assessment for 2002 adjusted the population sex ratio so that females were 70 percent of the population. Length frequency data were also incorporated to the 2002 assessment. The stock assessment is updated annually and incorporated into the GOA SAFE report (Turnock *et al.* 2001a).

GOA Arrowtooth Flounder Past/Present Effects Analysis

The geographic scope for the GOA arrowtooth flounder past/present effects analysis is the same as the GOA management units (Figure 1.2-3). The temporal scope for this analysis begins in the 1960s when the foreign fishery for flounders began, and ended in 2002, the most recent year for which stock assessment information exists.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-33 provides a summary of the arrowtooth flounder past effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on arrowtooth flounder:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery bycatch of prey species, marine pollution and oil spills, climate changes and regime shifts and introduction of exotic species (indirect effect).

- Change in important habitat due to fishery gear impacts, climate changes and regime shifts, introduction of exotic species and marine pollution and oil spills (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explains any management actions specific to the arrowtooth flounder. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on arrowtooth flounder in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the arrowtooth flounder past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1960s-1976)
  - IPHC longline fisheries
  - State of Alaska crab fisheries
  - State of Alaska groundfish fisheries
  - State of Alaska herring fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1968-1990)
  - Domestic groundfish fisheries (1968-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1960s-1976)

The Japanese and Soviet flounder fisheries both started as Pacific ocean perch fisheries in the early 1960s and switched to other target groundfish following the decline of Pacific ocean perch (NPFMC 2002b). Catch of arrowtooth flounder remained low from 1964 to 1973, when harvest peaked at 10,007 mt. Catch decreased to between 2,500 and 5,000 mt annually between 1974 and 1976 (Turnock *et al.* 2001a).

Although removals of arrowtooth flounder occurred during the foreign fisheries, there are no observable lingering adverse effects in the GOA arrowtooth flounder populations.

External IPHC Halibut Longline Fisheries and State of Alaska Crab Fisheries

The GOA bait fishery targeted pollock, Pacific cod, and various flounder species in order to provide needed bait for the crab and halibut fisheries. These fisheries took place from PWS west to the Aleutians, although most were landed in the Kodiak area (NPFMC 2002b). The amount of arrowtooth flounder caught in these fisheries is unknown.

Although removal of arrowtooth flounder occurred during the IPHC and crab bait fisheries, there are no observable lingering adverse effects in the GOA arrowtooth flounder populations.

Internal JV and Domestic Groundfish Fisheries (1968-present)

The domestic and JV flounder fisheries began in 1968, although catches of arrowtooth flounder were minimal throughout their duration (catches were dominated by foreign fisheries). From 1980-1990, annual harvest rates remained under 10,000 mt. JV fisheries were phased-out of the arrowtooth flounder fishery by 1990; however, the catch increased with the domestic fishery to a high of 24,252 mt in 2000. The average annual catch from 1990-2001 is approximately 18,000 mt. In 2000, the arrowtooth flounder trawl fishery was limited to bycatch only due to PSC limits for Pacific halibut in the central GOA management region (Turnock *et al.* 2001a).

Arrowtooth flounder is of low value and is typically caught as bycatch in the pursuit of more highly valued target species. Thus, arrowtooth flounder discard rates are high and corresponding percentages of retention are low. From 1991-2000, discard rates averaged 17,000 mt annually, with percent retention ranging from 10 to 43.2 percent. Retention has improved in recent years; 1999 and 2000 percent retention were 26.3 and 43.2 percent, respectively. Marketing efforts for arrowtooth flounder are expected to increase retention rates in coming years (Turnock *et al.* 2001a).

Although removals of arrowtooth flounder have occurred in the JV and past domestic fisheries, there are no observable lingering adverse effects on the GOA arrowtooth flounder populations.

Prior to 1990, arrowtooth flounder was reported as an aggregate of flatfish species. In 1990, NPFMC divided the flatfish assemblage into four categories; shallow water flatfish, deepwater flatfish, flathead sole and arrowtooth flounder. This classification was made because of the significant difference in halibut bycatch rates in directed fisheries targeting on shallow water and deepwater flatfish species. Flathead sole was separated due to an overlap in depth distribution with the shallow water and deepwater groups. Arrowtooth flounder was separated from the other categories due to its high abundance and low commercial value.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1960s-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the foreign fisheries on the spatial/temporal distribution of arrowtooth flounder in the GOA is unknown. However, these effects are determined to not have had lingering population effects on the stock.

External Climate Change and Regime Shift

The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on the reproductive success of arrowtooth flounder. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fisheries (1968-present)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the direct JV fisheries on the spatial/temporal distribution of arrowtooth flounder in the GOA is unknown. However, these effects are determined to not have had lingering population effects in the stock.

Change in Prey Availability

External Foreign Groundfish Fisheries (1960s-1976)

Past foreign fisheries in the GOA have had either an adverse or beneficial lingering impact on prey availability. Arrowtooth flounder from 15-30 cm feed mostly on shrimp, euphausiids, capelin, and herring (DiCosimo 1998). Adults (fish over 40 cm) are almost exclusively piscivorus and over half their diet can consist of pollock (Hollowed *et al.* 1995, Livingston 1991b, Yang 1993). Therefore, arrowtooth flounder are important as a large and abundant predator of other groundfish species. In turn, the effects of the fisheries could have been beneficial or adverse since pollock prey on arrowtooth flounder.

Bycatch of forage species in the foreign GOA groundfish fisheries is likely to have been minimal. Furthermore, since arrowtooth flounder feed on a number of different prey species, it is also unlikely that the groundfish fisheries would have had a significantly adverse impact on prey availability.

External State of Alaska Groundfish Fisheries and Herring Fisheries

Bycatch of forage species and juvenile pollock in the GOA State of Alaska groundfish fisheries is minimal and is unlikely to reduce the prey availability of arrowtooth flounder. Furthermore, since arrowtooth flounder feed on a number of different prey species, it is also unlikely that State of Alaska herring fisheries would have a significantly adverse impact on prey availability.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. Arrowtooth flounder and other flatfishes increased with an increase in advection in the Alaska current. The controlling factor for these increases appears to be environmental, with changes seen in the species composition in nearshore areas. Increased flow around the GOA may enhance the supply of nutrients and plankton on the shelf and upper slope areas, resulting in an increase in productivity.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important prey species arrowtooth flounder.

Internal JV and Domestic Groundfish Fisheries (1968-present)

Bycatch of forage species and juvenile pollock in the GOA groundfish fisheries is minimal. Furthermore, since arrowtooth flounder feed on a number of different prey species, it is also unlikely that the groundfish fisheries would have a significantly adverse impact on prey availability. BSAI/GOA Amendment 56/56 was established to protect forage fish species from developing into a fishery market, and to limit the forage fish bycatch.

Change in Important Habitat

External Foreign Groundfish Fisheries (1960s-1976)

The statistics on the number of bottom trawls and their effects on habitat in the GOA pre-MSA are generally unknown. It is assumed that habitat suitability for the GOA stock has been either beneficially or adversely affected by the intensity of the past foreign fisheries, and these effects are considered to have lingering influence at the population-level.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak

Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important habitat of arrowtooth flounder.

Internal JV and Domestic Groundfish Fisheries (1968-present)

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Habitat suitability for the GOA stock has been either adversely or beneficially affected by the intensity of the past JV fisheries, and these effects are considered to have lingering influence at the population-level.

There are no indications that harvest conditions resulting from arrowtooth flounder management would alter the available prey in a manner that would impede long-term suitability of the stock.

GOA Arrowtooth Flounder Comparative Baseline

Small scale, nearshore surveys indicate that arrowtooth flounder may have been at low levels in the 1960s and 1970s. The AFSC gulfwide triennial surveys estimate that biomass increased to about 1,640,000 mt in 1996, declined to 1,262,797 mt in 1999, and is now at a very high and stable level. Since the eastern GOA was not surveyed in 2001, the average biomass in the eastern GOA for 1993-1999 was used to estimate the biomass for 2001 (Turnock *et al.* 2001a).

Age-3+ biomass increased from a low in 1961 to a high of 1,815,500 mt in 2002. The 2001 survey biomass estimate of 1,621,890 mt is slightly higher than the 1999 estimate. There is not enough information available to estimate recruitment of age-3 arrowtooth flounder for 1999-2001; however, model estimates show an increase of age-3 recruits in the 1970s and 1980s with a decrease in the 1990s (Turnock *et al.* 2002a).

GOA Arrowtooth Flounder Cumulative Effects Analysis Status

The GOA arrowtooth flounder will be brought forward for cumulative effects analysis.

3.5.1.20 GOA Deepwater Flatfish

GOA Deepwater Flatfish Assemblage

Greenland turbot, Dover sole, and deep-sea sole are members of the GOA deepwater flatfish assemblage. Section 3.5.1.9 discusses the life history, distribution, and trophic interactions for Greenland turbot in the

BSAI and GOA. Refer to Section 3.5.1.10 for a description of the life history, distribution, and trophic interactions of Dover sole and deep-sea sole, both members of the BSAI other flatfish assemblage.

GOA Deepwater Flatfish Management

The reference fishing mortality rate and ABC for the flatfish management groups are determined by the amount of population information available. ABCs for Dover sole were calculated using F_{ABC} = 0.75 M and F_{OFL} = M (Tier 5), because maturity information was not available. Natural mortality was assumed to be 0.1 for Dover sole. Greenland turbot and deepsea sole are in Tier 6 because no reliable biomass estimates exist, where ABC = 0.75 OFL and the OFL = the average catch from 1978 to 1995 (238 mt) (Table 3.5-28). ABC is further apportioned among western, central, west and east Yakutat/southeast outside GOA management areas (Turnock *et al.* 2002b).

Stock assessment models are not used for the deepwater flatfish in the GOA due to the lack of available information. Triennial trawl survey biomass estimates from 1984, 1987, 1990, 1993, 1996, 1999, and 2001 are considered the best information available to determine stock biomass for all of the flatfish species in the GOA. The 2001 GOA survey effort did not encompass the eastern GOA and resulted in biomass in the eastern GOA being approximated using the average of the 1993-1999 GOA biomass estimates (Turnock *et al.* 2001b).

GOA Deepwater Flatfish Past/Present Effects Analysis

The geographic scope for the GOA the deepwater flatfish assemblage past/present effects analysis is the same as the GOA management areas (Figure 1.2-3). The temporal scope for this analysis begins in the 1960s when the foreign flounder fishery began and ends in 2002, the most recent year for which stock assessment information exists.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-34 provides a summary of the GOA the deepwater flatfish assemblage past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on GOA the deepwater flatfish assemblage:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).
- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate change and regime shifts (indirect effect).
- Changes in prey availability due to fishery catch/bycatch of prey species, climate changes and regime shifts, introduction of exotic species and marine pollution and oil spills (indirect effect).
- Changes in important habitat due to fishery gear impacts, climate changes and regime shifts, introduction of exotic species, and marine pollution and oil spills (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explain any management actions specific to the deepwater flatfish assemblage. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on the deepwater flatfish in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the deepwater flatfish assemblage past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1960s-1976)
  - State of Alaska scallop fisheries
  - State of Alaska crab bait fisheries
  - IPHC longline bait fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1968-1988)
  - Domestic groundfish fisheries (1968-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

<u>External Foreign Groundfish Fisheries (1960s-1976)</u>

The Japanese and Soviet flounder fisheries both started as Pacific ocean perch fisheries in the early 1960s and switched to other target groundfish following the decline of Pacific ocean perch abundance (NPFMC 2002b). Previous to 1981, catches were about 15,000 mt annually for the entire flatfish assemblage, including arrowtooth flounder, (Turnock *et al.* 2001b).

Removals of deepwater flatfish by foreign fisheries are determined not to have had lingering adverse effects on the GOA deepwater flatfish populations.

External State of Alaska Bait Crab and IPHC Longline Bait Fisheries

The GOA bait fishery targeted pollock, Pacific cod, and various flounder species to provide needed bait for the crab and halibut fisheries. These fisheries took place from PWS west to the Aleutians, although most were landed in the Kodiak area (NPFMC 2002b). The amount of GOA deepwater flatfish caught in these fisheries is unknown, however there are no observable lingering adverse effects on the deepwater flatfish population.

Internal JV and Domestic Groundfish Fisheries (1968-present)

By 1986, the JV fisheries dominated the flatfish catch in the GOA; however, by 1988, the flatfish fishery was fully domesticated. Annual harvest started at a low of 2,441 mt and increased to the peak of 43,107 mt in 1996. Greenland turbot catch has been variable over the last decade, from 3,012 mt in 1992 to 13 mt in 1997. The most recent catch data current through November 3, 2001, indicates a decline from previous years at only 8 mt. Catches in the deepwater complex declined from 1999 to 985 mt in 2000 and are currently at 805 mt for 2001 (as of November 3). Most of the catch in the deepwater complex is Dover sole, although the catch of Greenland turbot has been variable over the last decade. In 1998 and 1999, the deepwater flatfish fisheries were closed due to PSC limits for Pacific halibut, and in 1999 the entire GOA was closed to trawl fisheries due to PSC limits for Pacific halibut (Turnock *et al.* 2001b).

In the GOA, Greenland turbot is managed as part of the deepwater flatfish assemblage. In 1990, NPFMC divided the flatfish assemblage into four categories; shallow water flatfish, deepwater flatfish, flathead sole and arrowtooth flounder. Greenland turbot fell into the deepwater flatfish category. This classification was made because of the significant difference in halibut bycatch rates in directed fisheries targeting on shallow water and deepwater flatfish species. Arrowtooth flounder were separated from the other categories due to their high abundance and low commercial value. Flathead sole were separated due to an overlap in depth distribution with the shallow water and deepwater groups.

The removals of deepwater flatfish by JV and past domestic fisheries are determined not to have had lingering adverse effects of the GOA deepwater flatfish populations.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1960s-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The effects of the foreign fisheries on the spatial/temporal distribution of the GOA deepwater flatfish populations are unknown. Furthermore, it is unknown whether these effects are lingering at the population-level.

External Climate Changes and Regime Shifts

The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on the reproductive success of the deepwater flatfish. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

<u>Internal JV and Domestic Groundfish Fisheries (1968-present)</u>

Spatial/Temporal Concentration of Catch/Bycatch

The effects of the JV and domestic fisheries on the spatial/temporal distribution of the GOA deepwater flatfish populations are unknown. Furthermore, it is unknown whether these effects are lingering at the population-level.

Change in Prey Availability

<u>External Foreign Groundfish Fisheries (1960s-1976)</u>

The foreign fisheries in the GOA could have had lingering adverse or beneficial effects on the availability of prey for the deepwater flatfish assemblage. Pelagic fish are the main prey of these species, with pollock often a major species in the diet (Livingston 1991b). Deepwater flatfish also feed on squid, euphausiids, and shrimp; therefore, foreign fisheries are not expected to have significantly effected prey availability.

<u>External Climate Changes and Regime Shifts</u>

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock, and flatfishes such as Greenland turbot. Community structure in nearshore areas around Kodiak Island changed in this same period, with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod and flatfishes. Greenland turbot and Pacific halibut responded more strongly to longer-term events (such as decadal-scale climate regime patterns). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor in the population.

<u>External/Internal Marine Pollution and Oil Spills</u>

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important prey species of the deepwater flatfish group.

Internal JV and Domestic Groundfish Fisheries (1968-present)

The JV fisheries in the GOA could have had lingering adverse or beneficial effects on the availability of prey for the deepwater flatfish assemblage. However, since deepwater flatfish are found to feed on many species of fish (including pollock), squid, euphausiids, shrimp and some forage species, current management is not expected to alter the available prey in a manner that would impede long-term sustainability of the stocks in the GOA.

Change in Important Habitat

External Foreign Groundfish Fisheries (1960s-1976)

The statistics on the number of bottom trawls and their effects on GOA pre-MSA are generally unknown. It is assumed that the effect of the past foreign fisheries on habitat suitability is either beneficial or adverse; overall, a lingering influence on the population is found in the GOA stock, probably mostly due to climatological effects.

External State of Alaska Scallop Fisheries

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The State of Alaska scallop fishery has a history of being sporadic due to exploitation of limited stocks, market conditions, and availability of more lucrative fisheries. In 1999, only three boats fished for scallops (B. Bechtol, ADF&G, personal communication). While the effect on benthic habitat of the dredging is intense, the magnitude of the overall impact of this fishery is likely to be small.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability and prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important habitat of deepwater flatfish group.

Internal JV and Domestic Groundfish Fisheries (1968-present)

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of the JV fisheries on habitat suitability is either beneficial or adverse; overall, a lingering influence on the population is found in the GOA stock, probably mostly due to climatological effects. Trawl closures (1998 and 1999) due to PSC limits for Pacific halibut reduce the intensity of the fishery on the deepwater flatfish assemblage habitat.

Furthermore, there are no indications that harvest conditions under current management would alter the population genetic structure, the available prey, or the suitability of nursery and/or spawning habitat in a manner that would impede long-term sustainability of the stock in both the BSAI and GOA.

GOA Deepwater Flatfish Comparative Baseline

The 2001 resource assessment trawl survey took place only in the central and western GOA; therefore eastern GOA biomass was estimated using the average of the 1993 to 1999 eastern GOA biomass estimates for all flatfish species except Dover sole. Since the trends in the central GOA for Dover sole are similar to their trends in the eastern GOA, the 2001 biomass estimates were obtained by applying the declining trend in biomass from 1999 to 2001 in the central GOA to the 1999 biomass in the eastern GOA.

Dover sole has decreased in 2001 relative to 1990s biomass estimates. Exploitable biomass estimates are assumed to be the same as the 2001 survey biomass results for Dover sole, but not Greenland turbot or deepsea sole (Turnock *et al.* 2002b). Some experimental evidence indicates that flatfish biomass may be underestimated by the northeastern trawl (Weinberg 2003). Experiments are being conducted to estimate the herding component of catchability.

GOA Deepwater Flatfish Cumulative Effects Analysis Status

The GOA deepwater flatfish assemblage will be brought forward for cumulative effects analysis.

3.5.1.21 GOA Rex Sole

Life History and Distribution and Trophic Interactions

The other flatfish species complex in the GOA is currently managed as four categories: shallow water flatfish, deepwater flatfish, flathead sole, and rex sole (*Errex zachirus*). Life history, distribution and trophic interactions for rex sole is described in the BSAI other flatfish, Section 3.5.1.10. Table 3.5-20 summarizes biological and reproductive attributes and habitat associations of selected flatfish in the BSAI and GOA.

GOA Rex Sole Management

The other flatfish species complex in the GOA is currently managed as four categories with separate ABCs: shallow water flatfish, deepwater flatfish, flathead sole, and rex sole. In 2002, flathead sole were separated from the other flatfish assemblage and assigned a separate ABC due to their overlap in depth distribution of the shallow and deepwater groups (see Section 3.5.1.7). In 1993, rex sole was split out of the deepwater management category because of concerns regarding the Pacific ocean perch bycatch in the rex sole target fishery. The flatfish fishery in the GOA mainly targets rock sole (see Section 3.5.1.6), rex sole, and Dover sole. The flatfish catch is limited by halibut bycatch and does not reach the TAC for any species group (Table 3.5-28).

The reference fishing mortality rate and ABC for the rex sole are determined by the amount of population information available. ABCs are calculated using F_{ABC} = 0.75 M and F_{OFL} = M (Tier 5), because maturity information was not available. Natural mortality was assumed to be 0.2.

Stock assessment models were not used for this species due to the lack of information. Triennial trawl survey biomass estimates from 1984, 1987, 1990, 1993, 1996, 1999, and 2001 are considered the best information available to determine the stock biomass for rex sole (Turnock *et al.* 2002b).

GOA Rex Sole Past/Present Effects Analysis

The geographic scope for the GOA rex sole past/present effects analysis is the same as the GOA management areas (Figure 1.2-3). The temporal scope for this analysis begins in the 1960s when the foreign flounder fishery began and ends in 2002, the most recent year for which stock assessment information exists.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-35 provides a summary of the GOA rex sole past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on GOA rex sole:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery catch/bycatch of prey species, climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

- Change in important habitat due to fishery gear impacts, climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explain any management actions specific to the rex sole. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on rex sole in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to the rex sole past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1960s-1976)
  - IPHC longline fisheries
  - State of Alaska scallop fisheries
  - State of Alaska crab fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1968-1990)
  - Domestic groundfish fisheries (1968-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

External Foreign Groundfish Fisheries (1960s-1976)

The Japanese and Soviet flounder fisheries both started as Pacific ocean perch fisheries in the early 1960s and switched to other target groundfish following the decline of Pacific ocean perch (NPFMC 2002b). Previous to 1981, catches were about 15,000 mt annually for the entire flatfish assemblage, including arrowtooth flounder, with catches dominated by the foreign fisheries. By 1986, the JV fisheries were taking a majority of the flatfish catch (Turnock *et al.* 2001b).

Removals of rex sole by the foreign fisheries are determined to have had an adverse effect on the rex sole population; however, these fisheries are determined not to have had lingering adverse effects on the GOA rex sole populations.

External IPHC Halibut Longline Fisheries and the State of Alaska Crab Fisheries

The GOA bait fishery targeted pollock, Pacific cod, and various flounder species in order to provide needed bait for the crab and halibut fisheries. Bait fisheries occurred from PWS west to the Aleutians, although the majority of the bait has been landed in Kodiak area (NPFMC 2002b). The amount of rex sole caught in these fisheries is unknown.

rex sole population, these fisheries are determined not to have had lingering population effects in the GOA rex sole stocks.

Internal JV and Domestic Groundfish Fisheries (1968-present)

After the passage of the MSA in 1976, catches decreased to a low of 2,441 mt in 1986 and then steadily increased to a high of 43,107 mt in 1996. Flatfish declined in 1998 to 23,237 mt, increased to 37,303 mt in 2000, and declined again in 2001 to 31,734 mt. Catch is currently reported by management areas; catch of each species is estimated by multiplying the fraction of each species observed in a particular group by the total catch for that group. The blend estimate is used as the estimated total catch. The rex sole catches have declined from 1999 to 2,939 mt in 2001 (Turnock *et at.* 2002b). The flatfish fishery is likely to be limited by the potential for high catches of Pacific halibut in the future.

The large removals of rex sole by the JV and past domestic fisheries are determined to have had an adverse effect on the GOA rex sole population and these effects are determined to be lingering at the population-level.

In 1990, NPFMC divided the flatfish assemblage into four categories; shallow water flatfish, deepwater flatfish, flathead sole, and arrowtooth flounder. This classification was made because of the significant difference in halibut bycatch rates in directed fisheries targeting on shallow water and deepwater flatfish species. Arrowtooth flounder were separated from the other categories due to their high abundance and low commercial value. Flathead sole were separated due to an overlap in depth distribution with the shallow water and deepwater groups.

Rex sole were split out of the deepwater management category in 1993. Beginning in 1996, rock sole were split into two species, a northern (*Lepidopsetta sp. cf. bilineata*) and a southern rock sole (*Lepidopsetta bilineata*) (personal communication - Jay Orr as referenced in Turnock *et al.* 2001b) due to overlapping distributions.

Change in Reproductive Success

External Foreign Groundfish Fisheries (1960s-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the past foreign fisheries on spatial/temporal distribution of the GOA rex sole population is unknown. However, these fisheries are determined not to have had any observable lingering adverse effects on the GOA rex sole population.

External Climate Changes and Regime Shifts

The combination of climate effects and regime shifts on prey availability and habitat suitability influence the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on the reproductive success of rex sole. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fisheries (1968-present)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the JV and past domestic fisheries on spatial/temporal distribution of the GOA rex sole population is unknown. However, these fisheries are determined not to have had any observable lingering adverse effects on the GOA rex sole population.

Change in Prey Availability

External Foreign Groundfish Fisheries (1960s-1976)

The foreign fisheries in the GOA are unlikely to have directly impacted prey availability for rex sole since these fish eat infaunal invertebrates. The lingering adverse effects in the rex sole GOA stock are likely due to the natural events related to climate changes.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes the majority of the diet of rex sole.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important prey species of the other flatfish group.

Internal JV and Domestic Groundfish Fisheries (1968-present)

The JV fisheries in the GOA are unlikely to have directly impacted prey availability for rex sole since these fish eat infaunal invertebrates. The lingering adverse effects in the rex sole GOA stock are likely due to the natural events related to climate changes.

Change in Important Habitat

External Foreign Groundfish Fisheries (1960s-1976)

Statistics on the number of bottom trawls and their effects on GOA habitat are generally unknown. It is assumed that the effect of the foreign fisheries on habitat suitability is either beneficial or adverse and is found to have had a lingering influence in the GOA stock.

External IPHC Halibut Longline Fisheries and State of Alaska Scallop Fisheries

See Section 3.5.1.15 (change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of the IPHC halibut longline fisheries on habitat suitability is either beneficial or adverse and is found to have had a lingering influence in the GOA stock. The Alaska scallop fishery has a history of being sporadic due to exploitation of limited stocks, market conditions, and the availability of more lucrative fisheries. In 1999, only three boats fished for scallops (B. Bechtohl, ADF&G, personal communication). While the effect on benthic habitat of the dredging is intense, the magnitude of the overall impact of the fishery is likely to be small.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important habitat of the other flatfish group.

Internal JV and Domestic Groundfish Fisheries (1968-present)

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of these fisheries on habitat suitability is either beneficial or adverse and is found to have had a lingering influence in the GOA stock. The 1998 and 1999 trawl closures, due to PSC halibut limits, help to reduce the intensity of the fishery on rex sole habitat.

GOA Rex Sole Comparative Baseline

The 2001 biomass survey took place only in the central and western Gulf; therefore, eastern GOA biomass have been estimated using the average of the 1993 to 1999 eastern GOA biomass estimates for rex sole.

Rex sole has decreased in 2001 relative to 1990s biomass estimates. Exploitable biomass estimates are assumed to be the same as the 2001 survey biomass results (Turnock *et al.* 2002b). Some experimental evidence indicates that flatfish biomass may be underestimated by the northeastern trawl (Weinberg 2003). Experiments are being conducted to estimate the herding component of catchability.

GOA Rex Sole Cumulative Effects Analysis Status

GOA rex sole will be brought forward for cumulative effects analysis.

3.5.1.22 GOA Pacific Ocean Perch

Life History and Distribution

Pacific ocean perch (*Sebastes alutus)* is primarily a demersal species that inhabits the outer continental shelf and slope regions of the NPO and the Bering Sea from southern California to Japan (Allen and Smith 1988). As adults, they live on or near the seafloor, generally in areas with smooth bottoms (Krieger 1993) and generally at depths ranging from 180-420 m. Though more is known about the life history of Pacific ocean perch than about other rockfish species (Kendall and Lenarz 1986), much uncertainty still exists about its life history. Pacific ocean perch are viviparous, with internal fertilization and the release of live young (Hart 1973). Insemination occurs in the fall, and release of larvae occurs in April or May. Pacific ocean perch larvae are thought to be pelagic and drift with the current. Juveniles seem to inhabit rockier, higher relief areas than adults (Carlson and Straty 1981, Krieger 1993). The maximum recorded age of Pacific ocean perch is 100 years (Frimodt 1995). Table 3.5-22 summarizes biological and reproductive attributes and habitat associations of Pacific ocean perch in the BSAI and GOA.

The Pacific ocean perch were found to be genetically similar throughout their range based on allozyme variation (Seeb and Gunderson 1988); however, preliminary analysis using microsatellite DNA techniques suggests that genetically distinct populations of Pacific ocean perch exist (A.J. Gharrett personal communication, University of Alaska Fairbanks).

Trophic Interactions

During the summer of 1990, the diets of commercially important groundfish species in the GOA were analyzed by Yang (1993). About 98 percent of the total stomach content weight of Pacific ocean perch in the study was made up of invertebrates and 2 percent of fish. Euphausiids (mainly *Thysanoessa inermis*) were the most important prey item. Euphausiids comprised 87 percent, by weight, of the total stomach contents. Calanoid copepods, amphipods, arrow worms, and shrimp were frequently eaten by Pacific ocean perch (Brodeur and Percy 1984, Yang 1996).

Documented predators of Pacific ocean perch include Pacific halibut and sablefish, and it is likely that Pacific cod and arrowtooth flounder also prey on Pacific ocean perch. Pelagic juveniles are consumed by salmon, and benthic juveniles are eaten by lingcod and other demersal fish (NMFS 1997).

GOA Pacific Ocean Perch Management

In the GOA, Pacific ocean perch are managed as a sub-assemblage of the slope rockfish assemblage. Tier 3a is used to compute ABC and OFL for the Pacific ocean perch stock. The current female spawning biomass is 112,270 mt, leading to an OFL level of 16,240 mt. The ABC value for 2003 is 13,660 mt. The ABC value is apportioned over three areas: 2,700 mt for the western GOA, 8,510 mt for the central GOA, and 2,450 mt for the eastern GOA (Table 3.5-28). The OFL values are: 3,220 mt for the western GOA, 10,120 mt for the central GOA, and 2,900 mt for the eastern GOA. In order to prevent the eastern GOA TAC from being taken between 140° and 147°W, the area left open to trawling following the Amendment 58 trawl ban in the eastern area, a separate TAC of 810 mt has been assigned to the west Yakutat area within the eastern GOA (Heifetz *et al.* 2002).

GOA Pacific ocean perch are assessed with an age-structured model with allowance of size composition data. This model is derived from a generic rockfish model developed in a modeling workshop held in the Auke Bay Laboratory in February 2001. Data used in the model included total catch biomass (1961-2002), fishery size and age compositions, and survey age compositions and biomass estimates (Heifetz *et al.* 2001).

GOA Pacific Ocean Perch Past/Present Effects Analysis

The geographic scope for the Pacific ocean perch past/present effects analysis is the same as the GOA management areas (Figure 1.2-3). The temporal scope for this analysis begins in 1961 when the foreign Pacific ocean perch fishery begins and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-36 provides a summary of GOA Pacific ocean perch past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on GOA Pacific ocean perch:

- Mortality due to catch/bycatch marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to commercial whaling, climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

- Change in important habitat due to fishery gear impacts, climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explain any management actions specific to GOA Pacific ocean perch. Amendments discussed in Section 3.2 which impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on Pacific ocean perch in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to GOA Pacific ocean perch past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1961-1975)
  - Commercial whaling
  - IPHC longline fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1979-1989)
  - Domestic groundfish fisheries (1970-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1961-1976)

The Soviet Union began targeting Pacific ocean perch in 1961, but had shifted to pollock, Atka mackerel, and flounders by the late 1960s and early 1970s due to decline in Pacific ocean perch stocks. The Soviet Union Pacific ocean perch fishery practiced pulse fishing, following the Pacific ocean perch throughout its range in the GOA from around the Shumagin Islands to the eastern area of southeastern Alaska. Soviet Union Pacific ocean perch catch peaked in 1965 at 300,000 mt, and declined thereafter, reaching an all-time low in 1970 at 9,000 mt. By this time, the Soviets had shifted to other target resources; however, catches rose again in 1975. From 1981 on, the Soviet Union was excluded from the GOA for political reasons (NPFMC 2002b).

The Japanese Pacific ocean perch fishery began in 1963 with their North Pacific trawl fishery. Maximum catch occurred in 1966 at 65,200 mt, followed by a decline to 4,948 mt in 1983. By the late 1960s and early 1970s, Japan had switched to other less heavily exploited species since Pacific ocean perch abundance was in a decline (NPFMC 2002b).

The Republic of Korea entered the GOA in 1972 and occasionally targeted Pacific ocean perch although their main target was pollock (NPFMC 2002b).

Past foreign fisheries are found to have overfished the GOA Pacific ocean perch populations, and these effects are lingering at the population-level.

Internal JV and Domestic Groundfish Fisheries (1970-present)

Commercial catch for slope rockfish was not reported separately until 1988. Previously they were listed as part of the Pacific ocean perch complex. Foreign fisheries continued to dominate harvests from 1977 to 1984, with Japan taking a majority of the catch. Catch reached a minimum in 1985 following a ban on foreign trawling in the GOA (NPFMC 2002b).

The past JV fisheries began in 1979, taking relatively small catches throughout their duration. The JV fisheries harvest peak occurred in 1983 at 1,975 mt. The domestic fishery for slope rockfish began in 1970; however, this fishery did not start taking significant amounts of slope rockfish until 1985. By 1989, the GOA slope rockfish fishery had become completely domesticated. The domestic fishery developed rapidly, from 825 mt in 1985 to 21,114 mt by 1990 (Heifetz *et al.* 2002).

The slope rockfish assemblage was divided into three management subgroups in 1991: Pacific ocean perch, shortraker/rougheye rockfish, and all other species of slope rockfish. In 1993, the northern rockfish subgroup was created. These groups were created in order to prevent overfishing of the most desirable species. The groups are assigned separate TACs instead of a single group slope rockfish group TAC, as was done prior to 1991. The TACs are further subdivided into the three management areas within the GOA to avoid spatial/temporal concentration of the catch. These TAC apportionments are based on distributions of exploitable biomass. The GOA domestic fishery catch of Pacific ocean perch has been variable over the years (1991-2001), from a low of 1,853 mt in 1994 to a high of 10,972 mt in 2001 (Heifetz *et al.* 2001). The Pacific ocean perch catch has been constrained in recent years due to PSC limits of halibut and bycatch of other species.

The large removals of Pacific ocean perch that occurred during the JV and past domestic fisheries are found to have had an adverse effect GOA Pacific ocean perch populations. These effects are determined to be lingering at the population-level.

In 1994, GOA FMP Amendment 32 established a rebuilding plan for GOA Pacific ocean perch to minimize mortality. This plan was necessary to maximize the probability of rebuilding success in a realistic time period. As a result of increased concern about the status of Pacific ocean perch stocks, biomass assessment methodology has been improved and domestic harvest levels were reduced during the early to mid-1990s (NPFMC 2002b). After 1995, the Pacific ocean perch biomass began increasing at a fast pace in response to several strong year-classes. The rebuilding plan was revised under GOA FMP Amendment 38 in 1996 to allow the Pacific ocean perch TAC to be set at or below the rebuilding formula, but NPFMC did not invoke that measure because the stock met the rebuilding goal. Pacific ocean perch were considered rebuilt in 1997 and the species biomass has increased steadily through 2001 (Heifetz *et al.* 2002).

Discard rates for Pacific ocean perch have varied over the years (1991-2001), but are relatively low throughout with the exception of 1993 and 1994. In 1993 and 1994, discard rates were 79.2 and 60.3 percent, respectively, due to the bycatch-only status of the fishery. Typically, the discard rate is between about 8-20 percent and has declined in recent years (8.5 percent in 2001). Bycatch rates of Pacific ocean perch are highest in PSR, other slope rockfish, and shortspine thornyhead fisheries (Heifetz *et al.* 2001).

Change in Reproductive Success

<u>External Foreign Groundfish Fisheries (1961-1976)</u>

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the foreign fisheries on the spatial/temporal distribution of the GOA Pacific ocean perch populations due to the spatial/temporal concentration of the fisheries is unknown. However, any possible effects are not expected to have lingering effects in the populations.

<u>External Climate Changes and Regime Shifts</u>

The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan et al. (1998), Hollowed et al. (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on the reproductive success of Pacific ocean perch. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fisheries (1970-present)

Spatial/Temporal Concentration of Catch/Bycatch

The effect of the JV and past domestic fisheries on the spatial/temporal distribution of the GOA Pacific ocean perch populations due to the spatial/temporal concentration of the fisheries is unknown. However, any possible effects are not expected to have lingering effects in the populations. Important Pacific ocean perch fishery locations include, in the eastern GOA, the gully and slope southwest of Yakutat Bay and off Cape Omaney; in the central GOA, the shelf, slope, and gullies off of Kodiak Island south of Portlock Bank and near Albatross Bank; and in the western GOA, the shelf and slope south of Unimak and Umnak Islands (Heifetz *et al.* 2002).

As mentioned above, the apportionment of the TACs into GOA management areas for each slope rockfish subgroup helps to reduce the spatial/temporal concentration of the fishery. In 1998, GOA FMP Amendment 58 was passed prohibiting the use of trawl gear in the eastern area of the GOA east of 140°W longitude. However, there are concerns that the entire eastern TAC for slope rockfish, particularly Pacific ocean perch, could be taken in a small area in the eastern unit that is still open to trawling. As explained under GOA slope rockfish management, the eastern GOA TAC is further apportioned into east and west Yakutat Districts to prevent the entire eastern area TAC from being taken in the east Yakutat/southeast outside unit (Heifetz *et al.* 2002).

Change in Prey Availability

External Commercial Whaling

Whaling is identified as having a past beneficial effect on prey availability for all Pacific ocean perch stocks, since the diet of Pacific ocean perch appears to consist primarily of plankton (Brodeur and Percy 1984); euphausiids are the single most important prey item (Yang 1996). A reduction in baleen whale populations could mean that more euphausiids would be available for use by Pacific ocean perch. Documented predators of Pacific ocean perch include Pacific halibut and sablefish, and it likely that Pacific cod and arrowtooth flounder also prey on Pacific ocean perch. Pelagic juveniles are consumed by salmon and benthic juveniles are eaten by lingcod and other demersal fish (NMFS 1997).

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. Populations of Pacific ocean perch have rebounded from low population-levels. The controlling factor for these increases appears to be environmental, with changes in the species composition in nearshore areas linked to an increase in advection in the Alaska current. Increased flow around the GOA may enhance the supply of nutrients and plankton on the shelf and upper slope areas, resulting in an increase in productivity.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important prey species of Pacific ocean perch.

Change in Important Habitat

External Foreign Groundfish Fisheries (1961-1976)

Statistics on the number of bottom trawls and their effects on GOA habitat pre-MSA is generally unknown. However, the effect of the foreign fisheries on habitat suitability is negative for the GOA stock and is found to have had a lingering adverse influence in the stocks. The intense trawling of the foreign, JV and past domestic fisheries is the likely cause of this lingering effect. Prior to 1996, more than 90 percent of slope rockfish were taken by large factory-trawlers.

External IPHC Longline Fisheries

The impacts of IPHC longline gear on Pacific ocean perch habitat have been identified as adverse effects. Intense longline fishing is likely to have caused Pacific ocean perch habitat degradation and disruption of Pacific ocean perch spawning and/or rearing grounds. This effect is still lingering at the population-level.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability and prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important habitat of Pacific ocean perch.

Internal JV and Domestic Groundfish Fisheries (1970-present)

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The effect of past JV fisheries on habitat suitability is adverse for the GOA stock and is found to have had a lingering adverse influence in the stocks. The intense trawling of the foreign, JV and past domestic fisheries is the likely cause of this lingering effect. Prior to 1996, more than 90 percent of the slope rockfish were taken by large factory-trawlers. After 1996, smaller shore-based trawling began taking a larger catch. From 1993-2000, longline catches of shortraker/rougheye rockfish have increased to 30 to 48 percent of the annual catch and a larger portion of Pacific ocean perch have been taken by pelagic trawls. The percentage of Pacific ocean perch taken by pelagic trawls has increased from 2 to 8 percent in 1990-1995 to 14 to 20 percent in 1996-1998.

GOA Pacific Ocean Perch Comparative Baseline

Triennial trawl surveys have been conducted in the GOA since 1984 and are now conducted biennially starting in 2001. The 2001 trawl survey did not survey the eastern GOA; therefore, biomass estimates for that area are based on an average of 1993, 1996 and 1999 biomass estimates. The 2001 trawl survey indicates that Pacific ocean perch was the most abundant species with an estimated biomass of 858,982 mt, 61.9 percent of the total slope rockfish biomass. The 2001 biomass estimates for Pacific ocean perch are greatly influenced by large catches in one or two hauls, resulting in higher variance of biomass.

When comparing the trawl surveys from 1984-2001, Pacific ocean perch biomass estimates were relatively low in 1984-1990, increased in 1993 and 1996. and remained high in 1999 and 2001. Variance in biomass estimates is attributed to anomalously large individual hauls (as in 1999 and 2001), and to a change in availability of rockfish to the survey caused by unknown behavioral or environmental factors. Causes of changes in biomass estimates can not be determined until more is known about rockfish behavior.

GOA Pacific Ocean Perch Cumulative Effects Analysis Status

GOA Pacific ocean perch will be brought forward for cumulative effects analysis.

3.5.1.23 GOA Thornyhead Rockfish

Life History and Distribution

Thornyhead rockfish in Alaskan waters are comprised of two species, the shortspine thornyhead (*Sebastolobus alascanus*) and the longspine thornyhead (*S. altivelis*). Only the shortspine thornyhead is of commercial importance and it is now one of the most commercially valuable rockfish species. Thornyheads are a demersal species found in deepwater, from 94 m to 1,460 m, from the Bering Sea and GOA to Baja California (Gaichas and Ianelli 2001). Little is known about thornyhead life history. Like other rockfish, they are long-lived and slow-growing. The maximum recorded age is in excess of 50 years, and females do not become sexually mature until an average age of 12 to 13 years and a length of about 21 cm. Thornyheads spawn large masses of buoyant eggs during the late winter and early spring (Pearcy 1962). Juveniles are pelagic for the first year. The shortspine thornyhead is managed as a single stock in its own management group in the GOA; however, this species and the longspine thornyhead are managed as part of the other rockfish assemblage in the BSAI (see Section 3.5.1.13). Table 3.5-26 summarizes biological and reproductive attributes and habitat associations of thornyhead rockfish in the BSAI and GOA.

Trophic Interactions

Yang (1993 and 1996) and Yang and Nelson (2000) showed that shrimp, mainly pandalids, were the most important food of the thornyhead. Tanner crabs comprised less than 7 percent by weight of stomach contents, and fish such as pollock, capelin, and sculpins comprised about 15 percent. Other prey items for thornyheads included polychaetes, mysids, amphipods, and other crabs. California sea lion (Lowry *et al.* 1990) and sablefish (Orlov 1997) have both been documented as predators of shortspine thornyhead.

GOA Thornyhead Rockfish Management

Up until 2003, thornyhead rockfish were managed under Tier 3 of the GOA groundfish FMP. Due to uncertainty associated with model estimates of natural mortality and other parameters, GOA thornyhead rockfish estimates of ABC and OFL were based on Tier 5. The recommended ABC is 1,940 mt (Table 3.5-28). ABC and OFL have been further apportioned to the western, central, and eastern GOA (Gaichas and Ianelli 2002).

In the GOA, shortspine thornyheads are assessed with an age-structured model incorporating data from two fisheries (longline and trawl) and two types of survey data. Bottom trawl surveys have been conducted every three years in the GOA during June through August and provide a limited time-series of abundance since 1977. Longline surveys occur annually and extend into the deeper waters (300 to 800 m) of shortspine thornyhead habitat. Both surveys provide estimates of the size distributions of their respective catches. These are used in the stock assessment model in place of age compositions, because extensive age determination on this species has not been done.

Biologically, the greatest area of uncertainty for this species is in their longevity and natural mortality rate. Currently, NOAA Fisheries scientists believe they are slow-growing and long-lived fish that are relatively sedentary on the ocean floor. Recent research based on reproductive information of west coast and Alaska populations indicates that shortspine thornyheads are very long-lived (Pearson and Gunderson in review) with lower natural mortality rates than previously predicted and higher maximum ages (250-350 years). Radiometric analysis suggests that the maximum age is between 50-100 years (Kastelle *et al.* 2000, Cailliet *et al.* 2001), although these are high-variance estimates. Alternative models to estimate natural mortality rates were run during the 2001 and 2002 stock assessments using radiometric and conventional analyses (Kline 1996) and the Kastelle *et al.* (2000) analysis; however, none of the models was a substantial improvement from the base model.

GOA Thornyhead Rockfish Past/Present Effects Analysis

The geographic scope for the thornyhead rockfish past/present effects analysis is the same as the GOA management areas (Figure 1.2-3). The temporal scope for this analysis begins in the late 1800s when the U.S. and Canadian trawl fisheries began exploiting deepwater demersal communities, and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-37 provides a summary of GOA thornyhead rockfish past/present effects analysis presented below. The following direct and indirect effects were identified as potentially having population-level effects on GOA thornyhead rockfish:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to fishery bycatch of prey species, climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

- Change in important habitat due to fishery gear impacts, climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explain any management actions specific to GOA thornyhead rockfish. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here. Sections 3.5.1.11 and 3.5.1.12 discuss management measures for Pacific ocean perch and rockfish, respectively.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on thornyhead rockfish in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regimes shifts.

The past/present events determined to be applicable to GOA thornyhead rockfish past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (late 1800s-1976)
  - State of Alaska shrimp fisheries
  - IPHC longline fisheries
  - Marine pollution and oil spills
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1983-1990)
  - Domestic groundfish fisheries (1983-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (late 1800s-1976)

Thornyheads have been fished in the northeastern Pacific ocean since the late 1800s as part of the deepwater demersal fish community. U.S. and Canadian trawls were the first to fish thornyheads commercially. Soviet, Japanese, and Republic of Korea vessels began fishing for thornyheads in the mid-1960s (Chitwood 1969). Thornyheads have been lightly exploited throughout the history of the fishery. From 1967 to 1977, annual harvest never exceeded 2,000 mt. Catches were made by trawl and hook and line gear, although trawl gear has taken the majority of catch. Foreign harvest peaked in 1973 at 1,565 mt. Catch data from 1967-1980 are based on U.S. Foreign Observer Program reports, Pacific Fishery Information Network reported landings, and reports compiled by French *et al.* (1977) and Wall *et al.* (1978-1981) (Gaichas and Ianelli 2001).

Removals of thornyhead rockfish by the foreign fisheries are determined to have had an adverse effect on the GOA thornyhead rockfish populations; furthermore, these effects are lingering at the population-level.

External IPHC Longline Fisheries

Thornyhead rockfish have been and continue to be caught as bycatch in the IPHC longline fishery. The amount of this bycatch is unknown, although it is expected to be minimal. The IPHC longline fishery is not expected to have a significant impact on the GOA thornyhead rockfish population.

Internal JV and Domestic Groundfish Fisheries (1983-present)

Since 1983, the Observer Program has monitored thornyhead rockfish as part of the JV fisheries, and thornyheads have been monitored as a separate group in the domestic fisheries since 1984. Foreign fishery catch continued to exceed JV and domestic catch until 1985. By 1989, the domestic fishery had reached its peak catch of 3,080 mt. Average catch from 1996-2000 is about 1,260 mt annually (Gaichas and Ianelli 2001).

Thornyhead rockfish are caught primarily as bycatch in other target fisheries. However, they are now among the most valuable rockfish species and are harvested by trawl and longline gear. Most of the domestic harvest is exported to Japan. Thornyheads are taken with some frequency in the longline fishery for sablefish and in the rockfish and combined flatfish fisheries.

The removals of thornyhead by the JV and past domestic fisheries are found to have had an adverse effect on the GOA thornyhead population; however, it is uncertain whether the removals by these fisheries have had a lingering adverse effect on the GOA thornyhead populations.

Change in Reproductive Success

External Foreign Groundfish Fisheries (late 1800s-1976)

Spatial/Temporal Concentration of Catch/Bycatch

The effects of the foreign fisheries on the spatial/temporal distribution of the GOA thornyhead rockfish populations due to the spatial/temporal concentration of the fishery are unknown. Although, historical removals of thornyhead rockfish appear to be more concentrated in the central region of the GOA, there do not appear to be any observable lingering adverse effects on the population (Ianelli and Ito 1995).

External IPHC Longline Fisheries

Thornyhead rockfish have been and continue to be caught as bycatch in the IPHC longline fishery. The amount of this bycatch is unknown, although it is expected to be minimal. The IPHC longline fishery is not expected to have a significant impact on the GOA thornyhead rockfish population.

External Climate Changes and Regime Shifts

The combination of climate effects and regime shifts on prey availability and habitat suitability influences the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on the reproductive success of thornyhead rockfish. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fisheries (1983-present)

Spatial/Temporal Concentration of Catch/Bycatch

Based on foreign historical trends, the concentration of thornyhead rockfish catch appears to be in the central GOA region. Researchers have recommended further apportionment of thornyhead TAC into management units to avoid concentration of catch in the future. Furthermore, the trawl closure of part of the eastern area east of 140°W in 1998 (GOA FMP Amendment 58) may led to concentration of catch in the small area of the eastern management area that has not been closed to trawl gear.

Change in Prey Availability

External Foreign Groundfish Fisheries (late 1800s-1976)

Effects of the foreign fisheries on prey availability in the stock are unknown. However, it is unlikely that the foreign groundfish fisheries have had an adverse impact on thornyhead rockfish prey availability since the majority of thornyhead prey is pandalid shrimp.

External State of Alaska Shrimp Fisheries

Effects of State of Alaska shrimp fisheries on the prey availability of thornyhead rockfish are potentially adverse; however, due to the localized nature of these fisheries, they are unlikely to have a population-level effect.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability and prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5). Due to the ambiguity in the effects related to climate change, the overall lingering influence on competition for prey is unknown.

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes the part of the diet of thornyhead rockfish.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important prey species of thornyhead rockfish.

Internal JV and Domestic Groundfish Fisheries (1983-present)

The effects of the JV and domestic groundfish fisheries on thornyhead rockfish prey availability is unknown, however the effects are expected to be minimal since the majority of thornyhead rockfish prey is made up of pandalid shrimp.

Change in Important Habitat

External Foreign Groundfish Fisheries (late 1800s-1976)

Statistics on the number of bottom trawls and their effects on GOA habitat pre-MSA is generally unknown. Effects of the foreign fisheries on habitat suitability in the stock are not identified.

External IPHC Longline Fisheries

The IPHC longline fishery has and continued to overlap with thornyhead rockfish habitat. IPHC longline fishery gear may negatively contribute to GOA thornyhead rockfish degradation, although the magnitude of this effect is unknown.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability and prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5). Due to the ambiguity in the effects related to climate change, the overall lingering influence on habitat suitability is unknown.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important habitat of thornyhead rockfish.

Internal JV and Domestic Groundfish Fisheries (1983-present)

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

Closure of the eastern management area east of 140°W in 1998 to trawl gear may reduce the intensity of the fishery on thornyhead rockfish habitat. However, those areas in the eastern region not closed to trawl gear may become more intensely fished, or there may be a shift to greater use of longline gear in the areas closed to trawl.

GOA Thornyhead Rockfish Comparative Baseline

Survey and fishery catch rates indicate that shortspine thornyheads are relatively evenly distributed within their habitat and, like many other groundfish species, do not tend to form dense aggregations. This distribution pattern is important in interpreting the survey results, because the assumptions implied in area-swept methods for the bottom trawl gear are likely to be satisfied (for further information on surveys see Appendix B). Fishery data include estimates of the total catch and size distribution information by gear type.

Longline surveys have also been used to estimate abundance of thornyheads in the GOA since 1979. However, the use of the longline survey has been questioned since data show there is an interaction between sablefish and thornyhead abundance. Sigler and Zenger (1994) found that as thornyhead abundance decreased, sablefish abundance increased. Research is underway to evaluate the hook competition between thornyheads and sablefish, and a thornyhead tagging study is being conducted to learn about the movement and growth rates of these species (Gaichas and Ianelli 2001).

Modeling results indicate that the abundance of shortspine thornyheads has remained relatively stable since 1970. Recruitment is highly variable, although several strong year-classes are apparent. Since thornyheads are long-lived and slow growing it is difficult to determine the precise strong year-classes.

GOA Thornyhead Rockfish Cumulative Analysis Status

GOA thornyhead rockfish will be brought forward for cumulative effects analysis.

3.5.1.24 GOA Rockfish

Life History and Distribution

Northern rockfish (*Sebastes polyspinis*) inhabit the outer continental shelf from the EBS, throughout the Aleutian Islands and the GOA (Kramer and O'Connell 1988). This species is semidemersal and is usually found in comparatively shallower waters off the outer continental slope (from 50-600 m). Little is known about the biology and life history of northern rockfish. However, they appear to be long-lived, with late maturation and slow growth. Like other members of the genus *Sebastes*, they bear live young, and birth occurs in the early spring through summer (McDermott 1994). Northern rockfish are managed as part of the slope rockfish assemblage in the GOA.

Table 3.5-27 summarizes biological and reproductive attributes and habitat associations for selected rockfish species in the BSAI and GOA.

Shortraker (*Sebastes borealis*) and rougheye rockfish (*S. aleutianus*) inhabit the outer continental shelf of the NPO from the EBS as far south as southern California (Kramer and O'Connell 1988). Adults of both species are semidemersal and are usually found in deeper waters (from 50 m to 800 m) and over rougher bottoms than Pacific ocean perch (Krieger and Ito 1999). Little is known about the biology and life history of these species, but they appear to be long-lived, with late maturation and slow growth. Shortraker rockfish have been estimated to reach ages in excess of 120 years, and rougheye rockfish in excess of 140 years. Like other members of the genus *Sebastes*, they are viviparous (bear live young), and birth occurs in the early spring through summer (McDermott 1994).

Both species are associated with a variety of habitats, from soft to rocky bottoms, although boulders and sloping terrain appear also to be desirable habitat (Krieger and Ito 1999). Length at 50 percent sexual maturity is about 45 cm for shortraker rockfish and about 44 cm for rougheye rockfish (McDermott 1994). Shortraker and rougheye rockfish are managed as part of the slope rockfish assemblage in the GOA.

Numerous other rockfish species of the genus *Sebastes* have been reported in the GOA (as managed as other slope rockfish) and BSAI (managed as other rockfish) (Eschmeyer *et al.* 1984), and several are of commercial importance. Most are demersal or semidemersal, with different species occupying different depth strata (Kramer and O'Connell 1988). Other slope rockfish inhabit waters of the outer continental shelf and continental slope of the GOA as adults at depths greater than 150-200 m. All are viviparous (Hart 1973). Life history attributes of most of these rockfish are poorly or virtually unknown. Because they are long-lived and slow-growing, natural mortality rates are probably low. Other rockfish species are taken both in directed fisheries and as bycatch in trawl and longline fisheries. In the GOA, although the other slope rockfish management group comprises 17 species, 6 species alone make up 95 percent of the catch and estimated abundance. These six species include the sharpchin, redstripe, harlequin, silvergrey, yellowmouth, and redbanded rockfishes. In the BSAI, the other rockfish species assemblage comprises 28 species, several of which are classified in different groups in the GOA. Shortspine thornyheads are managed as part of the other rockfish species in the BSAI; however, it is managed as part of the thornyhead rockfish assemblage in the GOA (see Section 3.5.1.12).

Genetic studies are currently underway assessing the genetic stock structure of some species of slope rockfish. Some studies examining the differences among areas in age composition, growth, fecundity, and prevalence of parasites suggest that separate populations exist in the adult stage of some rockfish (Leaman and Kabata 1987, Moles *et al.* 1998). Two genetically distinct populations of rougheye rockfish with partially overlapping geographic ranges were found by Hawkins *et al.* (1997) and Gharrett and Gray (1998), and confirmed with recent mitochondrial and microsatellite analyses (personal communication, A.J. Gharrett, University of Alaska Fairbanks).

The GOA PSR group includes: dusky rockfish (*Sebastes ciliatus*), yellowtail rockfish (*S. flavidus*), and widow rockfish (*S. entomelys*). Dusky rockfish is by far the most important species in the group, both in terms of abundance and commercial value. PSR inhabit waters of the continental shelf of the GOA and typically exhibit midwater, schooling behavior. The dusky rockfish has the northernmost distribution of all the rockfish species in the Pacific Ocean, ranging from British Columbia north to the Bering Sea and west to Hokkaido Island of Japan, but is most abundant in the GOA. Studies are underway that indicate the occurrence of two distinct species of dusky rockfish in the GOA, a dark-colored and light-colored variety (Seeb 1986 and 2000, Orr and Blackburn 2000). In the GOA, nearly all dusky rockfish considered are of the light-colored variety. These species are managed as the PSR assemblage in the GOA and as part of the other rockfish species assemblage in the BSAI.

GOA DSR include seven species of nearshore, bottom-dwelling rockfish: canary rockfish (*Sebastes pinniger)*, China rockfish (*S. nebulosus)*, copper rockfish (*S. caurinus)*, quillback rockfish (*S. maliger)*, rosethorn rockfish (*S. helvomaculatus)*, tiger rockfish (*S. nigrocinctus)*, and yelloweye rockfish (*S. ruberrimus*). DSR are nearshore, bottom-dwelling species that occur on the continental shelf and are generally associated with rugged, rocky habitat. Yelloweye rockfish occur on the continental shelf from northern Baja California to the EBS, commonly in depths less than 200 m (Kramer and O'Connell 1988). They inhabit areas of rugged, rocky relief, and adults appear to prefer complex bottoms with the presence of "refuge spaces" (O'Connell and Carlile 1993). All of the DSR are slow-growing and very long-lived; the yelloweye rockfish have been estimated to reach an age of 118 years (Adams 1980, Gunderson 1980, Archibald *et al.* 1981). DSR are classified as ovoviviparous (eggs hatch within the females body). Rockfish have internal fertilization and several months separating copulation, fertilization, and parturition (giving birth). Parturition typically occurs from February through September with most species extruding larvae in late winter and spring. Yelloweye rockfish extrude larvae over an extended period, with the peak occurring in April and May (O'Connell 1987). Demersal rockfish have a closed swim bladder, which makes them susceptible to embolism mortality when brought to the surface from depth. Therefore, most species are fatally injured even when caught as discard in other fisheries. The DSR are managed as an assemblage in the GOA; the canary rockfish, copper rockfish, rosethorn rockfish, and tiger rockfish are managed as part of the other rockfish assemblage in the BSAI.

Trophic Interactions

Northern rockfish are generally planktivorous (feed on plankton) with euphausiids being the predominant prey item (Yang 1993). Copepods, hermit crabs, and shrimp have also been noted as prey items in much smaller quantities. Predators of northern rockfish are not well documented, but likely include larger fish such as Pacific halibut that are known to prey on other rockfish species.

Food habit studies conducted by Yang (1993) indicate that the diet of rougheye rockfish is dominated by shrimp. The diet of shortraker rockfish is not well known; however, based on a small number of samples, the diet appears to be dominated by squid. Because shortraker rockfish have large mouths and short gill rakers, it is possible that they are potential predators of other fish species (Yang 1993).

The diet of the other slope rockfish (GOA) and other rockfish species (BSAI) for which dietary information exists seems to consist primarily of planktonic invertebrates (Yang 1993 and 1996). Predators of other slope rockfish are also not well documented, but likely include larger fish, such as Pacific halibut, which are known to prey on other rockfish species.

Trophic interactions of dusky rockfish are not well known. Food habits information is available from just one study, with a relatively small sample size for dusky rockfish (Yang 1993). This study indicated that adult dusky rockfish consume primarily euphausiids, followed by larvaceans, cephalopods, and pandalid shrimp. Predators of dusky rockfish have not been documented, but likely include species that are known to consume rockfish in Alaska, such as Pacific halibut, sablefish, Pacific cod, and arrowtooth founder.

Yelloweye rockfish are large, predatory fishes that usually feed close to the bottom. Food habit studies indicate that the diet of yelloweye rockfish is dominated by fish remains, which comprised 95 percent, by volume, of the stomachs analyzed. Herring, sand lance, and Puget Sound rockfish (*S. empheaus*) were particularly dominant. Shrimp are also an important prey item (Rosenthal *et al.* 1988).

GOA Rockfish Management

In the GOA, northern rockfish are managed as a sub-assemblage of the slope rockfish assemblage. Tier 3a is used to compute the ABC and OFL values for northern rockfish. The current female spawning biomass for 2002 is 40,070 mt, greater than the $B_{40\%}$ value. The ABC value for 2003 equates to 5,530 mt, and the OFL value equates to 6,560 mt. ABC was apportioned in the western and central areas of the GOA. Northern rockfish are combined with other slope rockfish in the eastern GOA (Heifetz *et al.* 2002).

The northern rockfish group is assessed based on an age-structure model. Data used in this model include triennial survey biomass estimates and fishery catch, age, and size compositions. Natural mortality was fixed at an independently estimated value, and a single selectivity was assumed for the fishery and the survey.

In the GOA, shortraker and rougheye rockfish are managed as a sub-assemblage of the slope rockfish assemblage. GOA shortraker rockfish are managed in Tier 5 and rougheye rockfish are managed under Tier 4, but both have their own TAC-setting processes separate from other rockfish species in the other slope rockfish assemblage. The average exploitable biomass for the shortraker/rougheye and other slope rockfish groups is estimated by the unweighted average of the last three trawl survey results, excluding biomass in the 1-100 m depth stratum. The exploitable biomass for 2003 is 66,830 mt for the shortraker/rougheye group and 107,962 mt for other slope rockfish. According to ABC and OFL definitions, other slope rockfish are placed in Tier 5 where ABC is determined by $F = 0.75M$. Sharpchin are assessed under Tier 4 where OFL is calculated by $F = M$. This equates to an ABC value of 5,050 mt and an OFL value of 6,610 mt for the other slope rockfish group (Heifetz *et al.* 2002). Table 3.5-28 shows the ABC and OFL values for the more common species in the slope rockfish group. For management information on Pacific ocean perch as a member of the slope rockfish assemblage, see Section 3.5.1.11.Efforts have been made to assess rougheye rockfish using an age-structured model; however, development of this model is still in preliminary stages.

The PSR group includes dusky rockfish, yellowtail rockfish and widow rockfish. Beginning with the 2001 stock assessment, dusky rockfish were assessed separately from the larger PSR group since dusky rockfish compose nearly all the biomass. In 2003, dusky rockfish were moved up to Tier 3a, with an age-structured model, while yellowtail and widow rockfish are still managed under Tier 5. The dusky rockfish ABC value is computed using an $F = M$ strategy rather than $F_{40\%}$ due to concerns of unreliable biomass estimates. This equates to an ABC value of 5,070 mt. Yellowtail and widow rockfish ABC values were computed using $F = 0.75M$, equating to an ABC value of 415 mt (Table 3.5-28). These ABC values are apportioned over the western, central and eastern GOA. The Plan Team has recommended that the eastern ABC values be further apportioned over the west Yakutat and the east Yakutat/southeast outside regions at 640 mt and 860 mt, respectively (Clausen *et al.* 2002).

The DSR assemblage includes seven species of rockfish: canary rockfish, China rockfish, copper rockfish, quillback rockfish, rosethorn rockfish, tiger rockfish, and yelloweye rockfish. The yelloweye rockfish is the dominant species in this assemblage. These species are managed jointly by the NOAA Fisheries and the State of Alaska as a distinct assemblage only off the SEO east of 140°W, an area that is further divided into four management units along the outer coast: the south SEO, central SEO, north SEO, and east Yakutat. Two internal state water subdistricts (north southeast Inside District and south southeast Inside District) are managed entirely by the state. Yelloweye rockfish comprise 90 percent of the catch and will be the focus of this section. DSR are highly valued, and a directed longline fishery is held for these species. However, yelloweye are the primary bycatch in the halibut fishery, and therefore a large portion of the TAC and ABC is set aside for bycatch.

DSR falls into Tier 4 of the ABC and OFL definitions. Under these definitions, the OFL mortality rate is $F_{35\%} = 0.028$ (540 mt), and the maximum allowable fishing mortality rate for ABC is $F_{40\%} = 0.025$. However, a more conservative approach has been taken for setting ABC and TAC. By applying $F = M = 0.02$ to yelloweye rockfish biomass, and adjusting for the 10 percent of other DSR species, the recommended 2003 ABC is 390 mt. The total exploitable biomass estimate for 2003 is 17,510 mt, a 10 percent increase from the 2002 estimate. Continued conservatism in managing this fishery is warranted given the life history of the species and the uncertainty of the biomass estimates (O'Connell *et al.* 2002).

Traditional abundance estimation methods (e.g., area-swept trawl surveys, mark recapture) are not considered useful for these fishes, given their distribution, life history, and physiology. However, the ADF&G is continuing research to develop and improve a stock assessment approach for them. As part of that research, a manned submersible, Research Vessel (R/V) *Delta*, has been used to conduct line transects (Burnham *et al.* 1980). Density estimates are limited to adult yelloweye, because it is the principal species targeted and caught in the fishery; therefore, ABC and TAC recommendations for the entire assemblage are keyed to adult yelloweye abundance. Total yelloweye rockfish biomass is estimated for each management subdistrict as the product of density, mean weight of adult yelloweye, and areal estimates of DSR habitat (O'Connell and

Carlile 1993). Both transect line lengths and total area of rocky habitat are difficult to estimate, resulting in some uncertainty in the biomass estimates.

GOA Rockfish Past/Present Effects Analysis

The past/present effects analysis for all species of GOA rockfish are presented in this section and in Table 3.5-38. Species-specific information in noted when applicable. The geographic scope for the rockfish past/present effects analysis is the same as the GOA management areas (Figure 1.2-3). The temporal scope for this analysis begins in 1962, when the foreign rockfish fisheries began and ends in 2002, the most recent year for which stock assessment information is available.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. The following direct and indirect effects were identified as potentially having population-level effects on GOA rockfish species:

- Mortality due to catch/bycatch and marine pollution and oil spills (direct effect).

- Change in reproductive success due to spatial/temporal concentration of catch/bycatch and climate changes and regime shifts (indirect effect).

- Change in prey availability due to climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

- Change in important habitat due to climate changes and regime shifts, marine pollution and oil spills and introduction of exotic species (indirect effect).

Section 3.2 contains brief explanations of all the FMP amendments that impact the target species. The following sections explain any management actions specific to GOA rockfish. Amendments discussed in Section 3.2 that impact the target fisheries as a whole are not repeated here.

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on rockfish in the GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the Pacific Northwest to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section 3.10.1.5 for documentation of occurrences of unusual species in the GOA as influenced by climate changes and regime shifts.

The past/present events determined to be applicable to GOA rockfish past/present effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (1962-1976)
  - State of Alaska groundfish fisheries (DSR and some slope rockfish species, i.e. rougheye and yelloweye rockfish)

- IPHC longline fishery
- State of Alaska shrimp fisheries (pelagic and DSR and some slope rockfish species)
- State of Alaska herring fishery (DSR)
- Commercial whaling
- Marine pollution and oil spills
- Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (1976-1985)
  - JV groundfish fisheries (1980-1990)
  - Domestic groundfish fisheries (1981-present)

- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - Foreign groundfish fishery initiated actions
  - Preliminary groundfish FMPs (pre-MSA)
  - FMP groundfish fisheries management

Mortality

External Foreign Groundfish Fisheries (1962-1976)

Foreign fisheries for rockfish (with the exception of the DSR fishery) began in 1962, with the Soviet and Japanese fisheries. These fisheries are the same as were targeting Pacific ocean perch. See Section 3.5.1.11 for more information.

Foreign fishery removals of GOA rockfish are found to have had an adverse effect on the GOA rockfish populations. Furthermore, due to the longevity of these species, the effects are determined to be lingering at the population-level.

External State of Alaska Directed Groundfish Fisheries

Slope Rockfish

Directed State of Alaska rockfish fisheries take place in PWS, Cook Inlet and the south Alaska Peninsula fisheries. In 1999, 31.3 mt of rockfish were taken from the PWS area of which approximately 42 percent were slope rockfish. The Cook Inlet and south Alaska fisheries tend to focus largely on black and blue rockfish that are now under the State of Alaska jurisdiction. Yelloweye rockfish (part of the demersal rockfish group) is also targeted in the PWS fishery. These fisheries operate under a 68 mt annual harvest cap and are bycatch-only when the directed fishery is closed (ADF&G 2000b).

Internal Joint Domestic and State of Alaska Southeast Groundfish Fisheries

Demersal Shelf Rockfish

The directed DSR fishery began in 1979 by a hook and line fishery in southeast Alaska. Fishing occurred within 110 m, near-shore and targeted the entire DSR complex. Today, the directed DSR fishery is conducted by longliners and focuses mostly on yelloweye rockfish within 75-150m.

Catch rates increased from 106 mt in southeast in 1982 to a peak of 803 mt in 1987. In 1993, catch exceeded 900 mt, but has since decreased to 183 mt in 2000. The lava fields off Cape Edgecumbe in the central southeast area and the offshore Fairweather Ground in the east Yakutat area are the most important fishing areas. A small amount of DSR are taken as bycatch in jig and troll fisheries. Trawling is prohibited in the eastern GOA (GOA FMP Amendment 58). Yelloweye rockfish is the dominant bycatch species in the halibut longline fishery. The majority of the longline vessels in the eastern GOA are unobserved so it is difficult to get an accurate accounting of discards at sea (O'Connell *et al.* 2002).

GOA FMP Amendment 14 separated out and protected DSR from the more general other rockfish category by establishing a central SEO with 600 mt OY for the complex. In the early 1980s, all *Sebastes* species other than Pacific ocean perch and four associated slope rockfish species were managed as other rockfish on a gulfwide basis, and yet a domestic fishery harvesting DSR in the southeastern area was expanding very rapidly by 1984. Yelloweye and quillback rockfish were the primary targets of this longline fishery. Other actions under this amendment 1) changed OYs for Pacific ocean perch and other rockfish, 2) established a mechanism for timely reporting of catches by domestic catcher processors that stayed at sea for long periods; and 3) implemented NOAA Fisheries habitat policy. In 1991, GOA FMP Amendment 21 modified the FMP language that allows DSR in southeast Alaska to be managed by the State of Alaska and modified the overfishing definition.

In 1998, an FMP amendment was passed by NPFMC requiring full retention of DSR. This amendment is still under review by NOAA Fisheries. In July of 2000, the State of Alaska enacted a regulation requiring full retention of DSR and requiring that they be reported on fish tickets. DSR in excess of legal sale limits are forfeited to the State of Alaska fishery fund. The new regulation has substantially increased the estimated amount of yelloweye rockfish landed.

Internal JV and Domestic Groundfish Fisheries (1980-present)

The JV fisheries began targeting rockfish in 1980 and were phased-out of the GOA by 1990 when the fishery became fully domesticated. The domestic rockfish fisheries began in 1981. Past effects on these rockfish are not well characterized, but generally consist of the foreign, JV and domestic fisheries. These fisheries are identified as having contributed to rockfish mortality and are found to have had a lingering adverse effect on the rockfish population.

Pelagic Shelf Rockfish

Catch data for PSR are only available from 1988-2001. Prior to 1988, PSR were managed as a larger aggregate rockfish group "other rockfish" in the GOA. Annual harvest rates of rockfish have been subject to variability mostly due to management action. From 1988-1992, catches generally increased; however, beginning in the early1990s, TACs became more restrictive. In recent years, area closures have created a decrease in catch, while preventing the PSR TAC from being exceeded or preventing excessive bycatch of Pacific ocean perch or Pacific halibut (Clausen *et al.* 2002).

In 1998, GOA FMP Amendment 46 removed black and blue rockfishes from the FMP to enhance their management by the State of Alaska by providing more responsive management and preventing localized overfishing of their stocks. Expansion of a fishery for these species in the central regulatory area in the mid-1990s was believed to possibly result in unsustainable black and blue rockfish catches. Two problems with federal management of black and blue rockfish were identified. First, the TAC for all PSR species was based on a triennial trawl survey. Survey catches are dominated (93 to 99 percent) by the under exploited dusky rockfish. This information led to the calculation of ABC levels for the PSR assemblage as a whole, but managers were concerned that the survey bias caused by dusky rockfish could result in an ABC that was inappropriate for less abundant black and blue rockfish stocks. The second problem with federal management was that the trawl survey samples only fish on or near a smooth bottom; most black and blue rockfish occur in rocky nearshore reef habitats that cannot be sampled by this survey.

Slope Rockfish

As in the BSAI, the Pacific ocean perch were highly sought by the Soviet Union and Japanese fisheries beginning in the early 1960s. Catch of Pacific ocean perch peaked in 1965 at 350,000 mt, followed by a continuous decline into the 1970s, reaching low catch of 8,000 mt in 1978. Commercial catch for slope rockfish was not reported separately until 1988; previously they were listed as part of the Pacific ocean perch complex. Foreign fisheries continued to dominate from 1977 to 1984, with Japan taking a majority of the catch. Catch reached a minimum in 1985 following a ban on foreign trawling in the GOA. The domestic fishery entered the slope rockfish fishery in 1985 and expanded until 1991 when restrictions were placed on the fishery that lowered the TAC of Pacific ocean perch stocks, established the management of the four slope rockfish subgroups, and closed fisheries to avoid exceeding TAC through the rockfish trawl fleet. Since 1996, catches of Pacific ocean perch have increased due to increases in TAC levels, although catch of northern rockfish has remained below TAC.

Current data (1992-2000) available from the Observer Program indicate that harlequin, sharpchin, redstripe, silvergrey, and yellowmouth rockfish are the predominant species in the other slope rockfish group caught in the commercial fishery. The data are based only on trips that had observers on board and may be biased towards larger vessels that had more complete observer coverage. A substantial increase in these five species occurred following the removal of northern rockfish from the other slope rockfish group, apparently since removing northern rockfish allowed for an expansion in the fishery for other species. However, from 1994 to 1998, estimated catch for these five species decreased, partly due to lower TACs established for the other slope rockfish group. Since 1998, the catch for these species has remained low. In the shortraker/rougheye rockfish group, shortraker rockfish has always dominated the commercial catch and also has a higher market value than rougheye rockfish (Heifetz *et al.* 2002).

Change in Reproductive Success

External Foreign Groundfish Fisheries (1960s-1976)

Slope Rockfish

Effects of the foreign fisheries on spatial/temporal distribution of slope rockfish due to the spatial/temporal concentration of the fisheries are identified as either adverse or unknown. When the past effect of the fishery is unknown, it is also unknown whether the effect could be lingering.

External Climate Changes and Regime Shifts

The combination of climate effects and regime shifts on prey availability and habitat suitability influence the reproductive success of species. Research on climate shifts as a forcing agent on species and community structure of the NPO can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). See Section 3.10.1.5 for an indepth discussion of the various effects on climate changes and regime shifts on the NPO ecosystem.

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on the reproductive success of PSR. In general, stronger recruitment would be expected under more favorable climatic conditions because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected (although not perfectly) in the strength and weaknesses of the affected age groups within future fisheries (see Section 3.10.1.5).

Internal Joint Domestic and State of Alaska Southeast Groundfish Fisheries

Demersal Shelf Rockfish

Although management of this assemblage has been conservative, and overall the population appears stable, a decline in the density estimates in the Fairweather Grounds may be an indication that localized overfishing is occurring (Heifetz *et al.* 2002). The TAC for the eastern GOA is partitioned by management district based on biomass density and known habitat. The current harvest strategy indicates that 2 percent of the exploitable biomass is taken per year and that this level of exploitation is sustainable. However, fishing effort on the Fairweather Grounds appears to be concentrated in areas of best habitat and high density and it may be that local overfishing occurs. If occurring, such localized overfishing could have a long-term adverse effect on DSR stocks due to their longevity and slow growth rate (Heifetz *et al.* 2002). Rockfish stocks typically require long periods to recover from high fishing pressure.

Change in Prey Availability

External State of Alaska Shrimp Fisheries

Effects of State of Alaska shrimp fisheries on the prey availability of GOA rockfish (i.e. rougheye rockfish, dusky rockfish and other rockfish species) is potential adverse, however due to the localized nature of these fisheries, they are unlikely to have a population-level effect.

External State of Alaska Herring Fisheries

The State of Alaska herring fisheries effects on the prey availability of GOA DSR are identified as potential negative contributions, however due to the localized nature of these fisheries, they are unlikely to have a population-level effect.

External Commercial Whaling

The effects of commercial whaling increased the availability of euphausiid prey for northern rockfish (as part of the other slope rockfish complex) and some of the other rockfish species and is therefore noted as a potential beneficial effect.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability and prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

Research has not been done on the effects of climate on the benthic community (polychaete worms, clams, etc.), which constitutes part of the diet of some GOA rockfish species.

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important prey species of other rockfish.

Change in Important Habitat

External Foreign Groundfish Fisheries (1962-1976)

Statistics on the number of bottom trawls and their effects on GOA habitat pre-MSA is generally unknown. However, the impacts of foreign groundfish fishery gear on GOA rockfish habitat have been identified as negative effects. Intense trawling is likely to have caused rockfish habitat degradation and disruption of rockfish spawning and/or rearing grounds. This effect is still lingering at the population-level.

External State of Alaska Directed Groundfish Fisheries

Slope Rockfish

Statistics on the number of bottom trawls and their effects on GOA habitat pre-MSA is generally unknown. However, the impacts of JV and domestic groundfish fishery gear on DSR habitat have been identified as negative effects. Intense trawling is likely to have caused rockfish habitat degradation and disruption of rockfish spawning and/or rearing grounds. This effect is still lingering at the population-level.

External IPHC Longline Fishery

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The impacts of IPHC longline gear on GOA rockfish habitat have been identified as negative effects. Intense trawling is likely to have caused rockfish habitat degradation and disruption of rockfish spawning and/or rearing grounds. This effect is still lingering at the population-level.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability and prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

External/Internal Marine Pollution and Oil Spills

It is unknown to what extent marine pollution and oil spills from vessels occur in the GOA and what effect these have on the important habitat of other rockfish.

Internal JV and Domestic Groundfish Fisheries (1980-present)

See Section 3.5.1.15 (GOA walleye pollock past/present effects: change in important habitat) for statistics on the number of bottom trawls occurring in these areas and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat.

The impacts of JV and domestic groundfish fishery gear on rockfish habitat have been identified as adverse effects. Intense trawling is likely to have caused rockfish habitat degradation and disruption of rockfish spawning and/or rearing grounds. This effect is still lingering at the population-level.

Pelagic Shelf Rockfish

PSR are caught almost exclusively by bottom trawls. Light dusky rockfish are typically caught in relatively shallow (100-149 m) offshore banks of the continental shelf (Reuter 1999). They are found in large concentrations in the "W" grounds west of Yakutat, Portlock Bank northeast of Kodiak Island, and around Albatross Bank south of Kodiak Island. The trawlers that target Pacific ocean perch and northern rockfish typically target dusky rockfish, as well, fishing for dusky rockfish after they have filled their quota for the other two species. From 1988-1995, large factory trawlers took over 95 percent of the dusky rockfish catch; however, following 1996, smaller shore-based trawlers began taking larger portions of the PSR catch, taking 58 percent in 2001 in the central area (Clausen *et al.* 2002). HAPC biota bycatch analysis from 1997-1999 ranks the dusky rockfish trawl fisheries fourth among all fisheries in the amount of coral taken as bycatch and sixth in the amount of sponges taken. Research is being conducted to investigate the habitat associations of these species and any detrimental effect in trawl fisheries may have on their associated habitat (see Section 3.6).

GOA Rockfish Comparative Baseline

The Japan-U.S. cooperative survey and the NOAA Fisheries domestic longline survey are conducted on the continental slope of the GOA and provide data on the relative abundance of slope rockfish. Rougheye and shortraker rockfish are the primary species caught; however, caution should be taken when viewing data from both surveys since the analyses do not take into account possible effects of competition for hooks with other species caught on the longline (Heifetz *et al.* 2002).

Data from the Japan-U.S. cooperative survey for 1979-1987 indicate that the abundance of rougheye and shortraker rockfish remained stable in the GOA for those years (Sasaki and Teshima 1988, Clausen and Heifetz 1989). Data also suggest that rougheye and shortraker rougheye are most abundant in the eastern GOA. Domestic longline survey data from 1988-2002 show fluctuations in relative population numbers and relative population weight for shortraker and rougheye rockfish. However, the five highest annual gulfwide relative population numbers and relative population weights for shortraker and rougheye rockfish were seen in the most recent five surveys (1997-2001). This survey also shows the highest abundance of shortraker/rougheye rockfish in the eastern GOA with the Yakutat area having the highest relative population number and relative population weight values for shortraker rockfish and the southeastern area with the best rougheye rockfish values. Relative population numbers and relative population weights for rougheye and shortraker rockfish are slightly lower relative to 2001 estimates (Heifetz *et al.* 2002).

Triennial trawl surveys have been conducted in the GOA since 1984, and are now conducted biennially starting in 2001. The 2001 trawl survey did not survey the eastern GOA, therefore biomass estimates for that area are based on an average of 1993, 1996 and 1999 biomass estimates. The 2001 trawl survey indicates that Pacific ocean perch was the most abundant species with an estimated biomass of 858,982 mt, 61.9 percent of the total slope rockfish biomass. Northern rockfish comprised 25.6 percent of the total biomass. Other slope rockfish were poorly represented since the eastern GOA was not sampled, the area where a large percentage of the other slope rockfish species are located. The 2001 biomass estimates for Pacific ocean perch and northern rockfish are greatly influenced by large catches in one or two hauls, resulting in higher variance of biomass for both species (Heifetz *et al.* 2002).

When comparing the trawl surveys from 1984-2001, high variability in biomass estimates can be seen in nearly all species. Of the other slope species, biomass estimates for rougheye rockfish have been most consistent. Northern rockfish biomass estimates were relatively stable from 1987-1996, however underwent a large increase in population in 1999 and 2001. Biomass estimates for silvergrey rockfish steadily increased from 1984-1999. Variance in biomass estimates is attributed to anomalously large individual hauls (as in 1999 and 2001), and change in availability of rockfish to the survey caused by unknown behavioral or environmental factors. Causes of changes in biomass estimates can not be determined until more is known about rockfish behavior (Heifetz *et al.* 2002).

Comparative biomass estimates over the past seven triennial surveys show that dusky rockfish abundance varies. Total biomass increased from 1984 to 1987 and dropped 50 percent by 1990. Abundance again increased in 1993 and 1996, but has since decreased. None of the changes in biomass are statistically significant and may be attributed to changes in the availability of rockfish to survey gear or the imprecision of sampling methods for these species. In 2001, the eastern GOA was not sampled; therefore, 2001 eastern GOA biomass estimates are based on an average of the 1993, 1996, and 1999 estimates for each species in each region. Light dusky rockfish appear to dominate the PSR assemblage from 1996 to 1999; however, a large biomass of yellowtail rockfish was also seen in the southeastern area in 1999. The Kodiak area shows the highest biomass of dusky rockfish in all survey years (except 1984) and the southeastern area has shown the lowest biomass (except 1999) (Clausen *et al.* 2002).

Current exploitable biomass is based on the average of the three most recent surveys (1996, 1999, and 2001). This equates to 62,489 mt for the PSR assemblage, 56,336 mt for dusky rockfish and 6,153 for widow and yellowtail rockfish (Clausen *et al.* 2002).

Survey age compositions are available from the 1984, 1987, 1990, 1993, 1996, and 1999 surveys, and these show that recruitment of dusky rockfish appears to be highly variable. In 1999, aged 12-13 (1986-1987 year-classes) are most prominent. Fish under age-10 make up a much smaller portion of the population.

Biomass of adult yelloweye rockfish is derived as a product of estimated density, estimated rocky habitat within the 200 m contour, and average weight of fish for each management area. Estimation of the line length for the transects used in the submersible survey and the total area of rocky habitat is difficult; therefore, there is uncertainty in the biomass estimates. Only the north SEO section was surveyed during 2001, and only six transects were run due to poor weather. Consequently, the distance sampling model did not fit the data well. The density estimate for these data was 1,420 adult yelloweye/km^2. This is a 40 percent increase over the 1994 survey data and is more similar to the density estimates from the rest of the SEO region (O'Connell *et al.* 2002).

The age and size distributions of yelloweye rockfish are discussed in O'Connell *et al.* (2001) and O'Connell and Funk (1987). Estimated length and age at 50 percent maturity for yelloweye collected in the central SEO in 1988 are 45 cm and 21 years for females and 50 cm and 23 years for males. The most recent age data is from the 2000 commercial catch samples. In the central SEO, the area with the longest catch history, 2001 age data depicts the average age at 36 years. The older ages have declined in frequency over time, and the average age continues to decline over time. In the south SEO, the 2001 age data shows is bimodal, strongly at 23 and weaker at 44-45 years. In east Yakutat District, the 2001 age distribution is somewhat bimodal, with the largest mode is at 32-34 years, and a smaller mode at 44-45, with a mean age of 42 years. The maximum age recorded for 2001 was 110 years in the east Yakutat and central SEO (O'Connell *et al.* 2002).

An August 1998 sidescan sonar survey was conducted in Fairweather Ground to determine the gross bottom type. In the 1997 survey, the estimate total area of rocky habitat of the Fairweather Ground was reduced from 1,132 km^2 to 448 km^2. Although the 1998 survey did not cover the entire Fairweather area, by comparing techniques, the rock habitat of the east Yakutat area was reestimated at 617 km^2. Estimates of rock habitat in the SEO were also revised, down 46 percent overall to 3,095 km^2. Estimates are likely to continue to change as further information is gathered. Total exploitable biomass for 2003 equates to 17,510 mt, a slight increase from the 2002 estimate due to the addition of average weight data and revised estimates of the area of yelloweye habitat (O'Connel *et al.* 2002).

GOA Rockfish Cumulative Effects Analysis Status

The GOA northern rockfish, shortraker/rougheye rockfish, other slope rockfish, PSR DSR will be brought forward separately for the cumulative effects analysis.

3.5.2 Prohibited Species

Retention of prohibited species is forbidden in the BSAI and GOA groundfish fisheries. These species were typically utilized in domestic fisheries prior to the passage of the MSA in 1976. Retention was prohibited in the foreign, joint venture, and domestic groundfish fisheries to eliminate any incentive that groundfish fishermen might otherwise have to target these species. The prohibited species include:

- Pacific halibut (*Hippoglossus stenolepis*).
- Pacific salmon and Steelhead trout (*Oncorhynchus mykiss*).
- Pacific herring (*Clupea pallasi*).
- Red king crab (*Paralithodes camtschaticus*), blue king crab (*P. Platypus*), golden or brown king crab (*Lithodes aequispinus*), bairdi Tanner crabs (*Chionoecetes bairdi*), and opilio Tanner crabs (*C. opilio)*.

3.5.2.1 Pacific Halibut

The geographic scope for the Pacific halibut past/present effects analysis is the same as the IPHC regulatory areas. The temporal scope for this analysis begins in 1910 when the commercial Pacific halibut fishery started in southeast Alaska and ends in 2001.

Life History and Distribution

Pacific halibut range from Santa Barbara, California to Nome, Alaska, along the North American Pacific coastline. Pacific halibut are considered to be a single stock from the Pacific west coast to the Bering Sea. During the summer Pacific halibut are found along the northeast continental shelf, with a patchy distribution at the northern and southern ends of the range (IPHC 1998). Males can grow to exceed 36 kg and can live up to 27 years, and females can grow to over 225 kg and can live up to 42 years.

Adults make seasonal migrations from the summer feeding grounds on the continental shelf to deeper spawning grounds. Spawning takes place from December through February. Most spawning takes place off the continental shelf edge at depths of 400 to 600 m. Male halibut become sexually mature at 7 or 8 years of age, females mature at 8 to 12 years. The number of eggs a female produces is related to its size. Females over 113 kg may produce up to 4 million eggs annually (IPHC 1998). Fertilized eggs float free for about 15 days before hatching; the larvae and postlarvae drift westward on the prevailing currents for up to another six months. The currents eventually carry the young halibut to shallower waters that serve as nursery grounds (IPHC 1998).

Juvenile halibut spend five to seven years in shallow water nursery grounds before beginning a migration to "home areas." The migration of halibut from their western nursery grounds to home areas appears to be a unidirectional clockwise movement (IPHC 1998). Juvenile halibut marked in the northern GOA have been recovered after migration in the northern GOA and to the south, but rarely from the western GOA or BSAI. Similarly, juvenile halibut marked in British Columbia waters are typically recovered in the British Columbia area or farther south, and very rarely in Alaskan waters (IPHC 1998). It is not known if returning juveniles are the descendants of spawners of a given home area (IPHC 1998).

Trophic Interactions

Halibut are strong swimming apex predators. The diet of Pacific halibut varies with size. Halibut feed on plankton in their larval stage (IPHC 1998). Halibut less than 30 cm are known to feed on hermit crabs (pagurids), small shrimp-like organisms, and small fish (Yang and Nelson 2000, IPHC 1998). Fish become a larger component of the diet as halibut increase in size. Species frequently observed in the stomachs of halibut >50 cm include capelin, Pacific sand lance, eulachon, cod, Pacific salmon, sole species, sablefish, pollock, rockfish, flatfish species (including juvenile Pacific halibut), poachers (agonids), pricklebacks (stichaeids), eelpouts (zoarcids), and sculpins (cottids); and in addition octopi, crabs, clams, and other crustaceans (Yang and Nelson 2000, IPHC 1998).

Due to their size, active nature, and bottom dwelling habit, there are few predators of Pacific halibut aside from humans (IPHC 1998). Occasionally, conflicts have arisen between human predators and marine mammals, which have been observed foraging on halibut hooked on longlines (Bell 1981).

Pacific Halibut Management

Pacific halibut fisheries are managed by the IPHC, a treaty between the U.S. and Canada. The IPHC management process and stock assessments take all removals into account (bycatch in the federal and state groundfish fisheries and catch in the IPHC regulated commercial, subsistence, and sport fisheries) when issuing halibut allocations to the directed halibut fisheries. In addition, migration rates of juvenile halibut are used in concert with bycatch information for the groundfish fisheries to estimate appropriate yield reductions for the directed halibut fishery in each IPHC management area (Clark and Hare 1998).

Bycatch Management in the Federal Groundfish Fisheries

In addition to designating salmon, crab, herring, and halibut as prohibited species, NOAA Fisheries annually sets PSC limits under 50 CFR 679.21 through the annual TAC-setting process. PSC limits are further allocated to fishery categories, gear groups, or seasons to create more refined PSC limits.

Groundfish fishery PSC rates are calculated by dividing the sum of the weights or counts of PSC in a set of observer data by the sum of the weight of groundfish in the dataset. For rates from observed vessels that will be applied to unobserved vessels, a minimum of three different weekly observer reports is required before an average rate is used. For some rates, this threshold is set at a higher number of reports. This process is discussed in detail in Appendix B.

NOAA Fisheries monitor PSC limits for the general and CDQ groundfish fisheries using PSC rate estimates. Reaching a PSC limit can result in closure of an area or a fishery season, even if the groundfish quota (e.g., TAC) remains unharvested. When it is determined that a PSC limit will be reached, NOAA Fisheries publishes a notice in the *Federal Register* closing the associated area or fishery. Bycatch of Pacific halibut constrains the groundfish fisheries in both the BSAI and GOA, preventing the TAC of many groundfish target species from being harvested.

Past/Present Effects Analysis

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-40 provides a summary of the Pacific halibut past effects analysis presented below.

Nutritional stress due to the catch/bycatch of prey species was not brought forward for analysis because halibut have flexible feeding habits. Pacific halibut are apex feeders that can respond to short-term localized shortages of one prey species by substituting another.

The following direct and indirect effects were identified as potentially having population-level effects on Pacific halibut:

- Mortality due to catch/bycatch (direct effect).
- Spawning disruption due to fishing in spawning habitat (indirect effect).
- Reduced recruitment due to spatial/temporal concentration of catch/bycatch (indirect effect).

The past/present events determined to be applicable to the Pacific halibut past effects analysis include the following:

- Past/Present External Events
  - IPHC regulated Pacific halibut fishery
  - Foreign fisheries (pre-MSA)
  - Decadal oscillations
- Past/Present Internal Events
  - Foreign fisheries (post-MSA)
  - JV fisheries
  - Domestic fisheries
- Past/Present Management Actions
  - IPHC fisheries management
  - Industry initiated actions
  - FMP groundfish fisheries management

Past/Present Events and Management Actions

External Mortality- Catch in the IPHC Regulated Pacific Halibut Fishery

Pre-World War I fisheries targeting halibut in the North Pacific were relatively small. Market demand for halibut began to grow once technology was developed to ice and preserve the catch. Fishermen began to explore for Pacific halibut resources, and a small GOA halibut fishery began in 1910. The fishery rapidly expanded both north and south and into offshore waters. Early in the fishery, the stock of Pacific halibut was recognized as being rapidly reduced in areas that had been consistently fished (IPHC 1948).

The U.S. and Canada began discussing international management of halibut in 1913. Conservation of the stocks was not a major consideration until annual landings declined in 1915 despite increase in exploitation of new fishing grounds (IPHC 1948). By 1923, a halibut conservation treaty ratified and established an International Fisheries Commission with limited regulatory powers. The Commission engaged a staff to begin practical scientific investigations of Pacific halibut biology, stock status, and the fishery. The initial results of these investigations indicated that landings were only being maintained by constant increases in fishing intensity (IPHC 1948). The treaty was renegotiated during subsequent years granting the Commission increased regulatory power over the fishery. The regulations governing the Pacific halibut fishery, guided by scientific programs and investigations, stopped the decline of the fishery and allowed for the rebuilding of Pacific halibut stocks.

The halibut fleet remained relatively stable until the 1970s when the Pacific halibut fleet dramatically increased in size due to the rise in halibut price, declining crab stocks, and limited entry salmon fisheries (Coughenower and Blood 1997). By the late 1980s the fishing season had decreased from a five-month season in 1970 to just two 24- to 48-hour openings (Coughenower and Blood 1997).

External Mortality: Bycatch in the pre-MSA Foreign Fisheries

Pacific halibut bycatch mortality in the groundfish fisheries was relatively low until the 1960s when it increased due the development of the foreign fisheries (Williams 2001; see Appendix B for details on the development of the foreign fisheries.) Total bycatch mortality for IPHC regulatory areas:

- Peaked in 1965 at approximately 21 million pounds.
- Decreased in the late 1960s to approximately 15 million pounds.
- Increased to approximately 20 million pounds by the early 1970s.
- Decreased through the late 1970s with an increase to approximately 18 million pounds in 1980.

A detailed discussion of U.S. fisheries management prior to the MSA is presented in Appendix B and summarized in Table 3.5-40. The U.S. had virtually no authority to impose regulations beyond its territorial sea (3 miles prior to 1966, then expanded to 12 miles by public law) and relied primarily on multilateral and bilateral international agreements. Japan instituted some conservation and management measures independently, including a LLP and area restrictions to ease U.S. and Canadian concerns about the Japanese trawl fisheries impact on Pacific halibut (Appendix B).

Internal Mortality: Bycatch in the Post-MSA Groundfish Fisheries

By 1985, the JV operations and growing U.S. domestic fleet had entered the scene and continued the harvest of groundfish species. Federal groundfish fisheries have been prosecuted by an all-domestic fleet since 1987 in the GOA and 1991 in the BSAI. Bycatch of Pacific halibut is associated with all historical groundfish fisheries to varying degrees. The majority of the Pacific halibut bycatch was taken in the Bering Sea foreign and JV groundfish fisheries in the 1980s (Clark and Hare 1998). By 1985, Pacific halibut bycatch mortality had declined to 7.2 million pounds, the lowest level since the IPHC began its monitoring, and peaked again at 20.3 million pounds in 1992 (Williams 2001). The estimate of Pacific halibut bycatch mortality in 2002 of 12.7 million pounds is the lowest seen since 1987 but is consistent with estimates for the past several years (Williams 2002, Williams 2003). Bycatch mortality of legal-sized halibut (80+cm) was 6.73 million pounds in 2001, which remains consistent with the bycatch mortality of legal-sized halibut reported annually since 1995 (Clark and Hare 2002).

The bycatch of Pacific halibut in the groundfish fisheries decreases the amount that can be taken by fishermen in the directed IPHC fishery. Figure 3.5-6 shows Pacific halibut bycatch by area and gear from 1998-2001 (Hiatt *et al.* 2002). Bycatch has been controlled by FMP management measures, but not without cost to groundfish fisheries. In particular, Pacific halibut bycatch management measures have constrained groundfish harvests. Typically, all Pacific halibut bycatch mortality (4,665 mt) allocated to trawl and longline fisheries is taken, along with lesser amounts from pot fisheries and fisheries within Alaska state waters (Williams 1997). Longline fisheries have also been constrained by Pacific halibut bycatch, and careful release requirements have been implemented to improve survival of halibut discards (Smith 1995). Implementation of an IFQ system for Pacific halibut and sablefish longline fisheries in 1995 allowed for more selective longline fisheries with lower bycatch (Adams 1995). An indirect effect of changes in fishery scheduling and fishing ground closures to protect Steller sea lion has been a further reduction of halibut bycatch (Williams 2001).

Reducing halibut bycatch has also been the objective of numerous industry-initiated proposals in recent years. Several trawlers voluntarily use bycatch reduction devices in their nets to release incidentally caught halibut with minimal harm, and testing of these devices is ongoing.

External Spawning Disruption

The early directed Pacific halibut fisheries took place year-round. Pacific halibut caught during spawning season were of poor quality (IPHC 1948). A winter season fishery closure was proposed as a result of the 1913 U.S. and Canada discussions on international halibut management. This closure was proposed in order to eliminate a period of dangerous fishing when poor quality fish were caught and to provide a time frame for sales of accumulated frozen fish inventories (IPHC 1948). The Commission established the proposed three-month winter closed season in 1923.

Internal Spawning Disruption: Post-MSA Groundfish Fisheries

Pacific halibut spawn in very deep waters (400 to 600 m) off the continental shelf edge, and most bottom trawl groundfish fisheries take place in shallower areas of the continental shelf. Most bottom trawl groundfish fisheries occur between March and November, while Pacific halibut spawning takes place from December through February . The largest major spawning ground identified by IPHC is off Yakutat and is currently closed to all groundfish trawling. Typically, the IPHC halibut fishery closes annually from November 16 to March 15 to protect spawning halibut.

External/Internal Reduced Recruitment: Spatial/Temporal Concentration of Bycatch

Alaska groundfish fisheries take the majority (more than 90 percent) of Pacific halibut bycatch (Clark and Hare 1998). Bycatch contains both adult (> 81 cm) and juvenile fish (< 81 cm). Juveniles may or may not have completed their migrations from the nursery ground to home areas. Their capture has the potential effect of reducing recruitment to adult stock in the home area to which they would have migrated (Clark and Hare 1998). Adult fish caught as bycatch have completed their migration back to home areas. Therefore, bycatch of adult fish can be expected to affect only the stock in the area where the bycatch is taken (Clark and Hare 1998). Approximately 50 to 60 percent of Pacific halibut bycatch is below the directed fishery size limit of 81 cm, with differences in bycatch by gear type. The projected halibut bycatch in each major gear type is assumed to follow the general pattern observed from 1997 to 1999 (Figure 3.5-7). While there are more data from the BSAI than the GOA, bottom trawls generally appear to catch a higher proportion of smaller halibut than longlines in both areas.

External Reduced Recruitment: Decadal Oscillations

Climate variability can have both beneficial and adverse effects on Pacific halibut stocks. Positive Pacific Decadal Oscillations are currently thought to enhance the recruitment of Pacific halibut which spawn and rear mainly in Alaska waters (Clark and Hare 2001, see Section 3.3.4 of this Programmatic SEIS for a discussion of decadal oscillations). An analysis conducted by Clark and Hare (2001) indicated that Pacific halibut recruitment is strongly influenced by climatic regime and weather in the year of spawning. The importance of environmental conditions in the year of spawning suggests that regulation of year-class strength occurs in that year. The dependence could be either on available transport of eggs and larvae to nursery grounds by ocean currents, or on planktonic production that varies strongly with climate and weather (Clark and Hare 2001).

Pacific Halibut Comparative Baseline

The assessment of the Pacific halibut stock status was revised in 1996 due to the observed changes in individual growth rates that affected fishing selectivity by gear. The new analyses showed that the exploitable portion of the Pacific halibut stocks apparently peaked at 326,520 mt in 1988 (Sullivan and Parma 1998). The population has since declined slightly and has maintained a biomass in the range of 270,000 to 277,000 mt. The long-term average reproductive biomass for the Pacific halibut resource was estimated at 118,000 mt (Parma 1998). Long-term average yield was estimated at 26,980 mt, round weight (Parma 1998).

Average catches from 1995 to 1999 were 29,325 mt for the U.S. and 6,935 mt for Canada, for a combined total of 36,260 mt for the entire Pacific halibut resource. This catch was 34 percent higher than long-term potential yield, which reflects the good condition of the Pacific halibut resource. The 1999 coastwide catch totaled 58,026 mt (round weight). The breakdown by fishery was: commercial fisheries, 43,270 mt, or 75 percent; recreational fisheries, 5,502 mt (9 percent); personal use, 440 mt (1 percent); bycatch in other fisheries, 7,779 mt (13 percent); and wasted mortality due to fishing by lost gear and discards, 1,035 mt (2 percent). The 2002 commercial catch totaled 33,748 mt (net weight). Removals of Pacific halibut for 2002 totaled 44,453 mt (net weight), similar to annual removals for the past six years. The breakdown by fishery is as follows: commercial catch, 33,748 mt (76 percent); sport catch, 3,946 mt (9 percent); incidental bycatch mortality, 5,806 mt (13 percent); personal use, 363 mt (1 percent); and wastage, 726 mt (2 percent) (Gilroy 2003). At its 2003 annual meeting, the IPHC recommended commercial catch limits totaling 33,975 mt for the 2003 U.S. and Canadian commercial catch which is identical to the catch limits put in place for 2002 (IPHC 2003).

Pacific halibut have shown a decrease in size at age over time, with fish today weighing approximately a third of what fish of the same age weighed 20 years ago (Clark and Hare 2001). It is currently hypothesized that this change may be due to a density dependent factor, and not to removal of prey by groundfish fisheries (Clark *et al.* 1999). It is not yet clear how Pacific halibut density affects growth. However, it has been widely observed that flatfish growth rates tend to increase under exploitation (Clark and Hare 2001).

The nature of the Pacific halibut commercial fisheries has changed in recent years. Both Canadian and U.S. fisheries have moved from an open access fishery with short fishing seasons to an IFQ fishery that lasts eight months each year. In addition, quota allocations have been implemented for Native American treaty, commercial, and recreational fisheries for waters from Washington to California. With closer management of quota allocations, an overall decrease in fleet size has occurred. Vessels licensed to fish in Canada remained at 435, while 1,850 vessels fished in the U.S. fisheries in 1999, a reduction from 3,400 vessels in 1993.

Currently the Pacific halibut resource is considered to be healthy, and the total catch has been near record levels. It is inferred that any direct or indirect effects of bycatch on Pacific halibut in past groundfish fisheries were taken into account under the IPHC management process and mitigated by the numerous BSAI and GOA FMP management measures to reduce bycatch in the federal groundfish fisheries.

Pacific Halibut Cumulative Effects Analysis Status

FMP 2.1 proposes to eliminate the groundfish fishery PSC limits. This in itself might not affect Pacific halibut biomass since the IPHC takes into account the groundfish fishery bycatch as part of their management process. However, if bycatch increased, it would lower the IPHC catch limit and could impose an economic hardship in the directed fishery. Therefore, Pacific halibut will be carried forward for the proposed alternative cumulative effects analysis.

3.5.2.2 Pacific Salmon and Steelhead Trout

Five species of Pacific salmon , pink *(Oncorhynchus gorbuscha)*, chum *(O. keta)*, sockeye *(O. nerka)*, coho *(O. kisutch)*, and chinook salmon *(O. tshawytscha)*, as well as steelhead trout (*O. mykiss*) occur in Alaska. With some important variations, all species have a similar appearance and anadromous life history. Salmon spawn in freshwater and during the fall their eggs incubate, hatch, and go through several developmental stages taking several months to several years depending on species, then migrate to the ocean as fry or smolt. The young salmon feed and grow to maturity in saltwater, ranging widely over the North Pacific Ocean and Bering Sea. They return to freshwater, often migrating tremendous distances to reach their natal streams where they spawn. This adaptation to spawning in freshwater has resulted in the tremendous seasonal abundance of spawning salmon, that is easily harvested, and has sustained human populations for millennia. Adult salmon do not compete directly with juveniles for the food resources found in freshwater environments. Carcasses left in the streams after spawning fertilize the freshwater environment, ultimately providing food for the developing young.

No stocks of Pacific salmon originating from freshwater habitat in Alaska are listed under the ESA. The ESA- listed species that migrate into marine waters off Alaska originate in freshwater habitat in Washington, Oregon, Idaho, and California. Threatened and endangered salmon species are discussed in further detail in Section 3.4.2 of this Programmatic SEIS.

Steelhead trout populations are generally stable throughout Alaska. No commercial fishery is held for steelhead trout. Steelhead trout are very rarely taken in GOA groundfish fisheries; no catch was observed in the GOA groundfish fisheries between 1997 and 1999. Most incidentally caught steelhead are taken in the commercial salmon fisheries where the state requires that steelhead be treated as a prohibited species and released (ADF&G 1998). Steelhead are managed by the state exclusively as a recreational sport fish. Steelhead trout will not be analyzed in this document due to their rare occurrence in the BSAI groundfish fisheries.

NOAA Fisheries group salmon species into two categories: chinook salmon and other salmon. The other salmon category includes chum, pink, coho, and sockeye salmon species. The analysis in this section will follow this practice.

Pacific Salmon Life History and Distribution

<u>Chinook Salmon</u>

These are the largest salmon, often exceeding 14 kg. The largest sport-caught chinook salmon was a 44-kg fish taken from the Kenai River. Some chinook salmon outmigrate to the ocean soon after hatching in late winter or early spring (ocean-type), while others remain in freshwater for over one year before outmigrating to the ocean as smolts (stream-type). Chinook salmon become sexually mature in 2 to 7 years; females tend to be older than males at maturity. Fish in any spawning run vary greatly in size; a mature three-year-old will weigh less than 2 kg, while a mature seven-year-old may exceed 23 kg. Chinook salmon often make extensive freshwater migrations to their natal steams in some of the larger river systems. Yukon River chinook salmon bound for the headwaters in the Yukon Territory, Canada, and will travel more than 2,000 miles in 60 days (Groot and Margolis 1991).

Chinook salmon occur from California through the North Pacific Ocean, Bering, and Chukchi seas, to the Anadyr River in Siberia and Hokkaido, Japan. Marine distribution data indicate that stream-type chinook move offshore early in their ocean life and maintain a mostly offshore distribution throughout their ocean life (some stream-type chinook are found in coastal waters). The reverse is found for the ocean-type chinook, which are more common in coastal waters and less common in offshore waters (Healey 1991). Only stream-type chinook occur in Asia and western Alaska.

Information on the oceanic distribution of chinook salmon in relation to their area of origin comes from two sources: tagging studies and analysis of scale patterns. Neither source provides an adequate picture of oceanic distribution for many chinook stocks. Oceanic distribution of Asian and Alaskan stream-type chinook is not clearly defined; however, some general ideas have been put forth. Asian stream-type chinook are likely distributed throughout the BSAI , but concentrated west of 180°W. In the North Pacific Ocean, the Asian stocks appear to be distributed as far east as 175°W. Their southern distribution limit is not known (Healey 1991).

Western Alaska and Canadian Yukon stream-type chinook are distributed throughout the Bering Sea, probably with higher concentrations in the central and eastern areas. Western Alaskan chinook also travel into the North Pacific south of the Aleutian Islands, but the limits of their distribution are not known. Central Alaskan chinook are also thought to be widely distributed in the central and western North Pacific as well as in the Bering Sea. Chinook stocks from southeastern Alaskan/British Columbia, as well as those from Washington, Oregon, and California, are rare in the Bering Sea and western North Pacific. Their main oceanic distribution is thought to be in the eastern North Pacific, with the greatest concentrations occurring over the continental shelf waters (Healey 1991).

Chum Salmon

Chum salmon are the second largest of the Pacific salmon after chinook salmon. Chum salmon are the most important commercial and subsistence species in Alaska's arctic, northwest, and interior. Chum salmon vary in size from 2 to over 13 kg, but usually range from 3 to 8 kg, with females usually smaller than males. Chum salmon spend little time in freshwater as juveniles, and are therefore thought to be more affected during the juvenile stage by estuarine and marine conditions than by freshwater conditions relative to other salmon species. Chum salmon generally return to freshwater to spawn after 3 to 5 years at sea (Johnson *et al.* 1997).

Chum salmon have the widest distribution, ranging from California to Japan. In the Arctic Ocean, they range from the Mackenzie River in Canada to the Lena River in Siberia. Research conducted by the North Pacific Fisheries Commission has contributed to the understanding of chum salmon distribution during the high-seas phase of their life. At-sea migrations of Asian and North American immature chum salmon overlap in the North Pacific Ocean during the winter, but the salmon appear to migrate independently in the following spring and summer (Salo 1991). The known winter distribution of Asian age-1 chum salmon extends as far east as the central Aleutian Islands. Western Alaskan chum salmon, by comparison, leave the Bering Sea to join North American immatures from more southerly locations in the GOA. Western Alaska chum salmon are not thought to re-enter the Bering Sea prior to returning as mature fish (Salo 1991). There is evidence that immature Asian chum salmon from the northwestern Bering Sea also migrate to the GOA. By age-2 there is a more pronounced intermingling between the Asian and North American chum salmon. The Asian stock moves eastward and southeastward into the northeastern Pacific Ocean, and the North American stocks move to the north and west from the GOA region (Salo 1991).

Maturing chum salmon are widely distributed in the GOA and in the northeastern Pacific Ocean along the Aleutian Islands. The formation of aggregations for inshore movement to spawning grounds is not well understood. Typically Asian stocks with extensive distances to travel begin their spawning migration into the Bering Sea in April and May. Asian chum continue to migrate from the North Pacific Ocean in a northwestern pattern into the Bering Sea through June (Salo 1991). Maturing Alaskan chum salmon begin their homeward migrations from June through July. Western chum salmon begin their migrations from as far east as the British Columbia coast and as far west as the central Aleutian Islands. Typically their spawning migrations through the Aleutian passes begin in June and peak in July. GOA chum stock begin their homeward migrations from May to July.

Pink Salmon

Pink salmon are the smallest salmon species; adults average 1.6 to 2 kg with an average length of 50 to 65 cm. In Alaska, adult pink salmon enter spawning steams between June and mid-October. Most pink salmon spawn within a few miles of the coast, and spawning within the intertidal zone or stream terminuses is very common. The female carries 1,500 to 2,000 eggs and digs a nest, or redd, with her tail and releases the eggs into the nest. Eggs are immediately fertilized by one or more males. After spawning, both males and females die, usually within two weeks. The eggs hatch sometime in early to midwinter. In late winter or spring, the fry emerge from the gravel and quickly migrate to the ocean, usually during the darkness (Groot and Margolis 1991). Pink salmon grow rapidly while at sea, with mature fish typically returning to spawning areas after 18 months (Heard 1991). Pink salmon have a fixed two-year life span. Therefore, pink salmon spawning in the same freshwater system are reproductively isolated during even and odd years, developing into different genetic lines (Heard 1991).

Pink salmon occur from northern California to Russia and Korea and are the most common species in Alaska. Large spawning populations of pink salmon occur in southeastern, central, and western Alaskan coastal waters. Smaller concentrations of pink salmon occur north of the Bering Strait, in the Chukchi Sea coast, and along the Beaufort Sea coast (Heard 1991).

Coho Salmon

Adults average between 3.6 and 5.4 kg, but may reach as much as 13.6 kg. Spawning coho enter freshwater from July to November. The fry remain in the gravel, feeding on the yolk sac until they emerge in May or June. Coho spend from one to five years in freshwater streams and lakes before migrating to the sea. The amount of time spent at sea varies greatly, but most coho spend 18 months feeding and growing before returning as full-size adults (Groot and Margolis 1991).

Coho salmon occur from California through the North Pacific Ocean and southern Bering Sea to Siberia, Japan, and Korea. In the spring and early summer, Asian coho are generally distributed in the southern part of the western Pacific Ocean (Sandercock 1991). As water temperatures warm during the summer months, Asian coho move progressively northward throughout the North Pacific Ocean and the Bering Sea (Sandercock 1991). The known eastern limit of Asian coho distribution is about 177°W and 45°N. Asian and North American coho stocks intermingle near the end of the Aleutian chain. The known western limit of Alaskan coho is 177°30'E and 44°30'N. Immature Alaskan coho from streams along the EBS begin to migrate south to the Aleutian Islands and some into the GOA when temperatures begin to decline in late summer. When temperatures begin to increase in the spring, coho from the Bering Sea tributaries begin their migration northward to their spawning streams (Sandercock 1991).

Sockeye Salmon

Sockeye are the most important commercial species in Alaska. Adults average from 2 to 3.6 kg. After hatching, juvenile sockeye may spend one to four years in freshwater before migrating to the ocean as smolt, weighing only about 5 g. Sockeye grow quickly and spend one to four years feeding and growing to maturity in the ocean before returning to spawn. Those fish returning to spawn after only one year in the ocean—called jacks—are almost all males. Although sexually mature, they are much smaller in size (often less than 25 cm in length and 250 g in weight) than adult males that have spent several more years feeding in the ocean. Jacks are also common in chinook and coho salmon populations (Groot and Margolis 1991).

Sockeye salmon occur widely through the North Pacific Ocean and the Bering and Chukchi seas, from California to northern Hokkaido in the Pacific, and from Bathurst Inlet in Canada to the Anadyr River in Siberia. Asian and North American sockeye distributions in the North Pacific Ocean and Bering Sea have broad areas of overlap. Asian sockeye distribution bounds are generally west of 175°W (Burgner 1991). The bounds of North American sockeye, particularly western Alaskan stocks, are found in the North Pacific Ocean to 160°E and in the Bering Sea they are found to 170°E (Burgner 1991). The center of abundance for Asian stocks is generally west of 175°E, and the North American stocks are concentrated east of this longitude (Burgner 1991).

Pacific Salmon Trophic Interactions

The composition of prey for salmon species depends on life stage, availability, and relative abundance of prey, which vary with season and location. Chinook salmon feed on small fish (particularly herring), pelagic amphipods, and crab megalopa, with fish being the largest single contributor to their diet (Healey 1991). Chum salmon diets are composed of amphipod, euphausiid, pteropod, copepod, fish, and squid larvae (Salo 1991). Pink salmon are opportunistic and generalized feeders and are known to feed on epibenthic harpacticoid copepods, pelagic copepods, barnacle nauplii, mysids, eggs of invertebrates and fishes, and fish larvae (Heard 1991). Coho salmon are also opportunistic feeders with diets consisting of marine invertebrates, chum and pink salmon fry, smelts, sand lance, sticklebacks, squid, and crab larvae (Sandercock 1991). Sockeye are known to feed on euphausiids, amphipods, and small fish (lantern fish and juvenile cod in central North Pacific Ocean; in the EBS larval caplin, sand lance, and herring; in GOA sand lance, herring, pollock and capelin) (Burgner 1991).

A wide variety of predators feed on migrant salmon smolts. Predators of large salmon include all toothed whales, seals, sea lions, and shark (Sandercock 1991).

Pacific Salmon Management

Pacific salmon off the Alaska coast are managed under a complex mixture of domestic and international bodies, treaties, regulations, and other agreements. Federal and state agencies cooperate in managing salmon fisheries. The ADF&G manages salmon fisheries within state jurisdictional waters, where the majority of harvest occurs. Management in the EEZ is the responsibility of NPFMC. Under Amendment 4 of the Federal Salmon FMP, regulation of the directed salmon fishery occurring in the EEZ off southeast Alaska is deferred to the State of Alaska (NPFMC 1990). The EEZ off central and western Alaska is closed to directed salmon fisheries. Management of Alaska salmon fisheries is based primarily on regional stock groups of each species and on time and area harvesting by specific types of fishing gear. Over 25 different commercial salmon fisheries in Alaska are managed with a special limited-entry permit system that specifies when and what type of fishing gear can be used in each area. These fisheries, extending from Dixon Entrance in southeast Alaska to Norton Sound in the Bering Sea, are allowed to catch salmon in different fisheries, either with drift gillnets, set gillnets, beach seines, purse seines, hand troll, power troll, or fish wheel harvest gear. Sport fishing is limited to hook-and-line, while subsistence fishermen may use gillnets, dipnets, or hook-and-line. Some subsistence harvesting of salmon is also regulated by special permits.

Salmon fisheries are managed by ADF&G to meet an escapement goal of a certain number of spawners for each river system. Meeting escapement goals is considered equivalent to maintaining healthy stocks. In general, spawners are counted on their way upstream, after their numbers have already been reduced by natural mortality at sea, bycatch at sea, and directed fisheries downstream.

The well-being of salmon in Alaska is also directly influenced by land management practices. The quality of freshwater habitats determines the success of reproduction and initial rearing of juveniles. Several agencies, entities, and groups have significant influence on the quality of freshwater spawning and rearing habitats for salmon throughout Alaska. Included among these are the U.S. Forest Service (in the U.S. Department of Agriculture); the U.S. Bureau of Land Management, National Park Service, and National Wildlife Refuges (in the U.S. Department of the Interior); state parks and forests, Alaska Native regional and village corporations; and various municipalities, boroughs, and private land owners that exert some control over watersheds used by salmon.

International Management

Some fisheries, including the southeast Alaska chinook, coho, and sockeye fisheries, have harvest limits that are subject to negotiations with Canada under the Pacific Salmon Treaty. This treaty also covers salmon that are intercepted in fisheries that are returning to Idaho, Oregon, and Washington. This treaty was signed in 1983, but, in recent years, the treaty process was stalled due to disagreements between the two countries on allocations for certain fisheries and species. On June 30, 1999, a new agreement was signed by the negotiators and agreed to by both countries in December 1999. These new treaty agreements will expire in 2008. The extended time span of the new agreements should add stability to the fisheries of both countries. The agreements are complex, however, and will require continuous coordination between both countries to be successful. Fisheries in the Yukon River are covered under a separate agreement, but a treaty has not been signed. However, joint research and management programs in that large transboundary river system are nearing final agreement.

On a broader international scope, the management of salmon harvest in the high seas of the North Pacific Ocean from 1957 to 1992 was authorized by the INPFC, and via bilateral and multilateral agreements and negotiations with Taiwan and the Republic of Korea (South Korea). In 1993, the NPAFC was formed to replace INPFC. This four-country commission (Canada, Japan, the Russian Federation, and the U.S.) now provides a framework for international cooperation in salmon management and research in the North Pacific Ocean. The NPAFC Convention prohibits high seas salmon fishing and trafficking of illegally caught salmon. Coupled with United Nations General Assembly Resolution 46/215, which bans large-scale pelagic driftnet fishing in the world's oceans, the NPAFC has eliminated legal harvesting of Pacific salmon on the high seas. This allows for effective management control to fully return to the salmon-producing nations.

NOAA Management

There are no GOA FMP amendments that directly limit salmon bycatch. However, in the GOA, the timing of seasonal openings for the pollock fishery in the central and western GOA has been adjusted to avoid periods of high historical chinook and chum salmon bycatch.

In the BSAI, a PSC limit of 48,000 chinook salmon between January 1 and April 15 was established for trawl gear in the Chinook Salmon Savings Area (Figure 3.5-18) (50 CFR 679.21 (e)(1)(v)) and a limit of 42,000 non-chinook salmon between August 15 and October 15 was established in the Catcher Vessel Only Area (50 CFR 679.21 (e)(1)(vi). In 1999, NPFMC reduced the cap to 41,000. This cap was further reduced annually thereafter and currently stands at 29,000, applicable only to pelagic pollock fishing. In the event that these PSC limits are reached, no further groundfish trawling in the specified area is allowed for the remainder of the year.

Salmon bycatch limits are expected to trigger closures only during years when exceptionally high bycatch rates are encountered by the trawl fleet. During the first year of implementation in 1994, the Chum Salmon Savings Area was closed to all trawling from August 20 through November 12 (Figure 3.5-8).

Past/Present Effects Analysis

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-42 provides a summary of the Pacific salmon past effects analysis presented below.

Groundfish fisheries take place at sea, not in the freshwater spawning habitat occupied by spawning aggregations of anadromous Pacific salmon. While other human activities may affect spawning salmon and their habitat, federal groundfish fisheries do not. The quality of salmon spawning habitat is influenced by land management practices (e.g., logging, mining, and oil and gas developments) and climatic events (e.g., flooding that scours streams). Several agencies, entities, and groups exert control over watersheds used by spawning salmon. A relationship between the groundfish fisheries and salmon spawning habitat that could have the potential to cause population-level effects was not identified during screening.

The following direct and indirect effect indicators were identified as potentially having population-level effects on Pacific salmon:

- Mortality due to catch/bycatch of salmon (direct effect).
- Mortality associated with spatial/temporal concentration of salmon bycatch (indirect effect).
- Bycatch mortality of prey species (indirect effect).
- Salmon mariculture (indirect effect).
- Climatic influences (indirect effect).
- Oil pollution (indirect effect).

The past/present events determined to be applicable to the Pacific salmon past effects analysis include the following:

- Past/Present External Events
  - State of Alaska directed salmon fisheries
  - Subsistence fisheries
  - Foreign fisheries (pre-MSA in U.S. EEZ)

- Foreign fisheries (outside U.S. EEZ)
  - Salmon mariculture (Canada)
  - Climatic shifts
  - EVOS

- Past/Present Internal Events
  - Pollock trawl fisheries

- Past/Present Management Actions
  - ADF&G management
  - Foreign fisheries management
  - Industry self-imposed management
  - FMP groundfish fisheries management

<u>Mortality: State of Alaska Directed Salmon Fisheries</u>

Federal management of Alaska salmon in the pre-statehood era was weak and heavily influenced by the processing sector. The state took over salmon management after statehood in 1959. By the 1970s, state managers realized that salmon stocks were being over prosecuted by an ever-growing fleet and initiated a limited entry system. Hatchery enhancement programs were also initiated to augment commercial salmon harvests (ADF&G 2000b).

<u>Mortality: Subsistence Fisheries</u>

Alaska Native peoples have a bond with salmon that is part of their heritage, as an economic, cultural, and subsistence necessity. Salmon are harvested and used by Alaskan Native populations along the coast of southeastern and southwestern Alaska, comprising the most highly developed aboriginal fishing complex on the continent (Cooley 1961).

<u>Mortality: Foreign Fisheries (pre-MSA in U.S. EEZ)</u>

Direct catch and bycatch of salmon are both associated with past pre-MSA foreign fisheries. U.S. bilateral agreements with Japan and Russia attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries and allocate salmon resources to the state fisheries. It is inferred that the past foreign fisheries bilateral agreements were marginal management measures at best and probably did not provide any significant benefit to salmon stocks.

<u>Mortality: Foreign Fisheries (outside US EEZ)</u>

Salmon have a transboundary nature; hence western Bering Sea stocks have the potential to be caught in high-seas and Russian EEZ fisheries. The NPAFC coupled with the United Nations General Assembly Resolution 46/214, both established in 1993, prohibit high seas salmon fishing and ban large-scale pelagic driftnet fishing, respectively. In 1992, the U.S. and Russia signed a bilateral agreement calling for a ban on direct salmon fishing within both country's EEZs, but allowed for directed salmon fishing within 25 nm of the baseline from which the EEZ is measured (Pautzke 1997). With the exception of the occasionally-caught illegal fishing vessel, these measures are thought to provide effective management for salmon catch and bycatch outside the U.S. EEZ.

Mortality: Salmon Mariculture (Canada)

Salmon mariculture began in the Pacific Northwest in the 1970s. By the 1980s, salmon farms raising Atlantic salmon were established in British Columbia and Washington State. Fish farming is perceived as having the potential to increase disease in wild stocks, cause marine water pollution in localized areas, displace wild stock with escaped farm fish, and to lead to interbreeding between wild stocks and escaped farm fish. Studies conducted in British Columbia indicate that farm Atlantic salmon are able to spawn successfully in the wild (Gaudet 2002). Storms, tides, marine mammals, and/or accidents can damage the floating net pens used in fish farms and allow for the escapement into the marine environment of farm fish of all life stages (Gaudet 2002). Sexually mature Atlantic salmon can currently be found in both freshwater and marine environments throughout the Pacific Northwest and Alaska (Gaudet 2002). Alaska banned the farming of finfish in 1990 in order to protect Alaska wild stocks. In 2002, ADF&G proposed that British Columbia phase out their marine fish farms and allow only land-based lake rearing farms to eliminate risks to marine environments while minimizing disruption of local economies (Gaudet 2002).

Mortality: Climatic Influences

Climate variability can have an influence on salmon populations and their prey, both beneficial and adverse. Ocean conditions that have favored high marine survivals in recent years; however, fluctuate due to interdecadal climate oscillations (Mantua *et al.* 1997). Recent evidence suggests that a change in ocean conditions in the North Pacific Ocean may be under way, possibly reflecting the downturn in abundance of Alaska salmon runs in 1996 and 1997. Studies indicate that salmon have improved marine survival during periods of warmer than normal ocean temperatures (Salo 1991).

Pacific salmon prey also respond to climatic conditions. For example, capelin and eulachon, two species of smelts, have been observed to shift abundance and/or distribution during climate changes. Capelin have shown abrupt declines in occurrence in small-mesh trawl survey samples in the GOA (Piatt and Anderson 1996, Anderson and Piatt 1999). In survey data from both NOAA Fisheries and ADF&G, capelin first declined along the east side of Kodiak Island and bays along the Alaska Peninsula. Subsequent declines took place in the bays along the west side of Shelikof Strait. These declines happened quickly, and low abundance has persisted for over a decade. The decline corresponded with increases in water temperature of the order of 2°C, which began in the late 1970s. Capelin have fairly narrow temperature preferences and probably were very susceptible to the increase in water column temperatures (Piatt and Anderson 1996, Anderson *et al.* 1997). Mapping of relative densities of capelin showed defined areas of relative high abundance. The Shelikof Strait region showed relatively high catches in Kujulik, Alitak, and Olga bays. Most catches of capelin were closely associated with bays, except for high catches offshore of Cape Ikolik at the southwest end of Kodiak Island. Isolated offshore areas east of Kodiak Island showed some high catches, with most of the high catches associated with Ugak and Kazakof Bays. Only isolated catches of less than 50 kg were evident in the database from PWS, the Kenai Peninsula, and lower Cook Inlet.

Furthermore, evidence from fishery observers and survey data suggests that eulachon abundance declined in the 1980s (Fritz *et al.* 1993). This data should be interpreted with caution because surveys were not designed to sample small pelagic fishes such as eulachon, and fishery data were collected primarily to estimate total catch of target groundfish. Causes of this presumed decline are unknown, but may be related to variability in year-class strength, as noted for capelin. Small-mesh shrimp trawl surveys in the GOA coastal areas suggest that eulachon have remained at a low level of relative abundance since 1987. Eulachon are currently at the lowest recorded level in the survey series (1972–1997) at 0.01 kg/km (Anderson and Piatt 1999) (see Appendix B).

Mortality: Oil Pollution

The EVOS affected pink salmon in PWS and sockeye salmon in the Kodiak Island area (EVOS Trustee Council 2002a and 2002b). Commercial salmon fishing was closed in PWS, portions of the Cook Inlet, and near Kodiak in 1989 as a result of the spill to avoid possibility of contaminated fish being sent to market. The recovery goal for affected pink and sockeye stocks was a return to stock conditions that would have existed prior to the spill. The EVOS Trustee Council considers both of these species to be recovered from effects of the EVOS (EVOS Trustee Council 2002a and 2002b).

Mortality: Bycatch in MSA Groundfish Fisheries

Although all groundfish fisheries in the Bering Sea and the GOA are prohibited from retaining any salmon they catch, they do encounter them as bycatch. Most salmon bycatch is taken by vessels using pelagic trawl gear targeting pollock. Chinook salmon seem most vulnerable to trawl gear, accounting for 36 to 44 percent of total numbers of salmon bycatch. Chum salmon is next in vulnerability and can reach bycatch proportions as large as those for chinook. Figures 3.5-9 and 3.5-10 show chinook and other salmon bycatch trends by area and gear type from 1998-2001.

The highest bycatch rates for chum salmon occur during August, September, and October, with almost no chum salmon taken in other months (NPFMC 1995a). According to groundfish fishery observer data in the BSAI, the overwhelming majority (96 percent between 1997 and 1999) of other salmon bycatch is chum salmon. Chum salmon from Asia account for a significant part of the chum bycatch in the Bering Sea. Bycatch percentages of coho, sockeye, and pink salmon are small (less than 1 or 2 percent of total salmon bycatch). Chum salmon dominate other salmon bycatch in the GOA as well (56 percent between 1997 and 1999, but higher in prior years).There are also catches of coho salmon (14 percent), pink salmon (3 percent), and sockeye salmon (1 percent) in the GOA. The recent history of salmon bycatch is listed in Table 3.5-43.

Chinook salmon bycatch appears to be concentrated somewhat relative to the overall distribution of pollock fishing (Figure 3.5-11). Although some amount of chinook salmon bycatch occurs throughout the year, it is higher in September and October (pollock B season during 1997 to 1999). Chinook salmon bycatch in the Bering Sea is likely composed mainly of western Alaska and Canadian Yukon stocks (Healey 1991).

Regulations implemented under the BSAI FMP amendment process successfully reduced the foreign fisheries bycatch of salmon. The foreign fisheries salmon bycatch reductions were offset by increased salmon bycatch in the growing JV operations and domestic groundfish fisheries. Establishment of new salmon bycatch limits were issued to address the increase in JV and domesticbycatch levels.

Trawling is prohibited in the Chinook Salmon Savings Areas upon attainment of a bycatch limit of 48,000 chinook salmon in the BSAI under FMP Amendment 21b (NPFMC 1995b, Figure 3.5-18). Currently, an other salmon bycatch level of 42,000 fish is set in the BSAI, and a Chum Salmon Savings Area has been established, which is closed to all trawling during the period of high chum salmon bycatch(August 1 to 31 of each year) (Figure 3.5-8). These measures were implemented under BSAI FMP Amendment 35 (NPFMC 1995a). Like the chinook salmon bycatch level, the other salmon action level serves as a trigger to close the Chum Salmon Savings Area seasonally if that level is reached in a given year, and not as an absolute limit on chum salmon catch. Unlike the chinook salmon bycatch level, catch of other salmon only counts toward the limit of 42,000 fish if it is taken within a limited area of the BSAI, the catcher vessel operation area. Thus, catch of other salmon generally exceeds 42,000 fish per year, and the Chum Salmon Savings Area has never been closed to fishing outside of August 1 to 31. However, catch of other salmon has been considerably lower since these management measures were implemented in 1995 than in the years immediately prior to implementation.

Salmon are always prohibited species in any groundfish fishery; however, they only accrue against the PSC limit when caught with trawl gear from January 15 to April 15 for chinook salmon and within the catcher vessel operational area from August 15 to October 14 for non-chinook salmon. Accrued CDQ trawl salmon PSC catch must be retained and delivered to a shoreside processor, where it is sorted by species, counted, and reported to NOAA Fisheries by the shoreside processor on a CDQ delivery report. Although observer data are not used directly to estimate salmon PSC limits, they are used to verify the species reported on the CDQ delivery report.

Mortality: Bycatch of Salmon Prey Species in MSA Groundfish Fisheries

Bycatch of Pacific salmon prey species, such as sand lance, capelin and euphausiids (i.e., forage fish), in the BSAI and GOA groundfish fisheries tends to be minimal, remaining under 75 mt in the BSAI and 130 mt in the GOA in recent years and would likely have no effect on prey availability to Pacific salmon (Section 3.4.2).

Spatial/Temporal Concentration of Bycatch

The spatial/temporal concentration of bycatch could cause overharvesting of a distinct genetic component of a stock. Current spatial/temporal concentration of salmon bycatch in the BSAI seems to be relative to the distribution of the pollock fishery (Figure 3.5-12). Potential impacts to salmon from past and current BSAI and GOA groundfish fisheries bycatch distribution have not been determined due to the uncertainty of bycatch stock composition; therefore, the magnitude of any such influences is unknown.

Spatial/temporal salmon bycatch is also controlled by non-regulatory means. Many measures have been embraced by the trawl and longline fleet to control and reduce bycatch of Pacific halibut, crab, and salmon. A GIS application has been used by the BSAI trawl and longline fleet to identify hotspots by using bycatch rates reported by individual vessels (Gauvin *et al.* 1995; Smoker 1996). Bycatch rate information from individual vessels is received at a central location, aggregated daily, and then quickly relayed back to the entire fleet in the form of maps, so that hotspot areas can be avoided. PSC rates are reduced and correspondingly higher groundfish catches can then be realized by the fleet. Unfortunately, because this is a voluntary program, non-participating vessels with high bycatch rates may keep the fleet as a whole from catching the entire quota of flatfish. Some bycatch reduction may also come in the form of peer pressure. Individual vessel bycatch rates are now published on the Internet. Vessels with high bycatch rates may face pressure to lower their bycatch.

Comparative Baseline

All five species of Alaska salmon are fully utilized, and stocks in most regions of the state generally have been rebuilt to or beyond previous levels (Table 3.5-44). The high abundance of Alaska salmon up to 1995 should not be interpreted as an absence of some of the same factors affecting declines of salmon in the Pacific Northwest. Unspoiled habitats, favorable oceanic conditions, and adequate numbers of spawning salmon are likely the paramount issues positively affecting current Alaska salmon abundance. Alaska salmon management continues to focus on maintaining pristine habitats and ensuring adequate escapements.

Alaska commercial salmon harvests have generally increased over the last three decades, but may have peaked in 1995 (Figure 3.5-13). After reaching record low catch levels in the 1970s, most populations have rebounded, and fisheries are now at or near all-time peak levels in many regions of the state (Burger and Wertheimer 1995, Wertheimer 1997). The record-high commercial landing of 217 million salmon in 1995 was 11 percent higher than the previous record of 196 million in 1994. However, significant declines in the commercial catches followed in both 1996 and 1997 (Figure 3.5-13). The 1998 Alaska commercial salmon harvest was 151 million salmon (322,055 mt), distributed as 22.6 million sockeye (57,607 mt), 18.9 million chum (73,937 mt), 105 million pink (169,646 mt), 4.6 million coho (16,284 mt), and 563 thousand chinook (4,581 mt). Recreational fishermen caught over 1.8 million salmon in Alaska in 1995 (Howe *et al.* 1996), and subsistence fisheries for salmon in 1994, the most recent year available, harvested over 1 million fish (ADF&G 2001a). Based on preliminary data, the 2002 Alaska commercial salmon harvest (exvessel values) totaled approximately 130 million salmon (275,987 mt). This total was distributed among species as follows: 539,000 chinook (4,064 mt), 22.5 million sockeye (61,914 mt), 4.8 million coho (16,717 mt), 87.6 million pink (135,509 mt), and 15 million chum (57,783 mt) (ADF&G 2003).

The annual commercial harvest of chinook salmon in Alaska has averaged between 500,000 and 700,000 fish in recent years. The statewide 10-year (1988-1997) average annual harvest was 627,000 fish (Savikko 1997). Spawning escapements of chinook and other salmon in southeast Alaska are stable or increasing in 99 percent of the management units, indicating that stocks are healthy (NOAA Fisheries 2003). Of the 407 chinook stocks harvested in the southeast, 81 percent are classified as not threatened, and 15 percent are special concern or at risk (Slaney *et al.* 1996). Large portions of the southeast chinook harvest originate from the Columbia river upriver bright chinook, Middle Columbia River bright chinook, and north-migrating Oregon coastal chinook; these stocks are considered stable (NOAA Fisheries 2003). Chinook stocks listed under the ESA make up a small portion of the southeast harvest, and nearly all coho salmon harvested originate from Alaskan streams (Weitkamp *et al.* 1995).

An exception to the above stock status summary resides in the AYK region of Alaska. After two previous years of very low runs, the summer 2000 chinook and chum salmon runs in the Yukon and Kuskokwim River drainages (ADF&G Region 3, Figure 3.5-14) were so low that even subsistence fishing was prohibited, resulting in a federal disaster declaration. A subsistence closure emphasizes the serious concern for the health of salmon stocks in this region.

Pacific Salmon Cumulative Effects Analysis Status

Chinook salmon and other salmon will be carried forward for the cumulative effects analysis based on the current depressed status of some stocks and the lack of recovery shown to date.

3.5.2.3 Pacific Herring

Life History and Distribution

Pacific herring (*Clupea pallasii)* occur from California through the GOA and Bering Sea to Japan. Pacific herring may grow to a length of 45 cm with a weight of over 500 grams but average 23 cm and about 225 grams. Pacific herring migrate in schools. In Alaska, Pacific herring begin spawning in mid-March in southeastern Alaska and as late as June in the Bering Sea. The timing of spawning is related to water temperatures (NPFMC 1998a). Spawning occurs in shallow, vegetated intertidal and subtidal areas. The eggs are adhesive, and survival is greater for those eggs that stick to vegetation than for those that fall to the bottom. Milt released by the males drifts among the eggs, fertilizing them. The eggs hatch in about two weeks, depending on water temperature. Herring spawn every year after reaching sexual maturity at 3 or 4 years of age. The average life span of herring is about 8 years in southeastern Alaska and 16 years in the Bering Sea. The young larvae drift and swim with the ocean currents. After developing to their juvenile form, they rear in sheltered bays and inlets and appear to remain segregated from adult populations until they mature. After spawning, most adults leave inshore waters and move offshore to feed. They are seasonal feeders and accumulate fat reserves for periods of relative inactivity. Herring schools often follow a diel vertical migration pattern, spending daylight hours near the bottom and moving upward during the evening to feed (Hart 1973). Following spawning, Bering Sea herring move clockwise along the Alaska Peninsula to feed. They typically reach the Unimak Pass area by mid-summer. In late summer, Bering Sea herring move to overwintering areas in the vicinity of the Pribilof Islands (NPFMC 1998a).

In the GOA, spawning concentrations occur mainly off southeastern Alaska, in PWS, around Kodiak Island, and in Cook Inlet. However, little is known about GOA herring overwintering locations.

Trophic Interactions

Pacific herring feed on zooplankton, larvae of pollock, sand lance, and smelt during all their life stages (Schweigert 1997, Livingston 1985, ADF&G 1985). Herring eggs and young larvae are preyed upon extensively by other vertebrate and invertebrate predators (Funk 1994). Juvenile and adult herring are also important prey for other fish, marine mammals, and seabirds.

Management Overview

A draft FMP for BSAI herring was prepared in the early 1980s, but never finalized because herring was deemed fully utilized in Alaska state waters. Management authority was delegated to the State of Alaska. Pacific herring are managed by the ADF&G with annual quotas allocated by the Alaska Board of Fisheries. All directed herring fisheries occur in state waters from Dixon Entrance north to Norton Sound. The fishery fluctuates depending on market demands. Alaska herring fishing quotas are based on a variable exploitation rate of 20 percent. Lower exploitation rates are used when stocks decline to near-threshold levels. Herring fisheries are managed by regulatory stocks (i.e., geographically distinct spawning aggregations). Herring fisheries include the following:

- Subsistence harvest of spawn on kelp or artificial substrate.
- Herring spawn on open pound spawn-on-kelp and wild spawn-on-kelp.

- Purse seine and gillnet fisheries sac roe harvest.

- Food and bait harvest.

Past/Present Effects Analysis

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-45 provides a summary of the Pacific herring past effects analysis presented below.

The following direct and indirect effects were identified as potentially having population-level effects on Pacific herring:

- Mortality due to catch/bycatch (direct effect).

- Nutritional stress due to climatic influence on prey species (indirect effect).

- Reduced recruitment due to oil pollution (EVOS; PWS population) (indirect effect).

The past/present events determined to be applicable to the Pacific herring past effects analysis include the following:

- Past/Present External Events
  - Alaska State directed herring fisheries
  - Foreign fisheries (pre-MSA)
  - Climatic shifts
  - EVOS

- Past/Present Internal Events
  - Pollock trawl fisheries

- Past/Present Management Actions
  - ADF&G management
  - FMP groundfish fisheries management

Federal groundfish fisheries do not take place in the nearshore shallow environments where herring congregate to spawn, so no impacts to herring spawning habitat or aggregations are predicted as a result of these fisheries. Herring prey on zooplankton, including larvae of pollock, sand lance, and smelt. Zooplankton are not caught in groundfish fisheries. The only way groundfish fisheries might possibly have any impact on herring prey would be severe overfishing of species such as pollock to an extent that limited pollock larval abundance. This level of groundfish overfishing has not been observed over the course of FMP management, and is not likely to occur in the future. The spatial/temporal concentration of bycatch could have adverse effects by overharvesting a distinct genetic herring stock. GOA herring are considered to be genetically distinct from EBS herring. BSAI herring bycatch appears to be evenly spread throughout the federal pollock fishery (Figure 3.5-15). Herring bycatch in the GOA groundfish fisheries is very small compared to the bycatch in the BSAI. Examples of indirect impacts to Pacific herring would be spatial and temporal concentrations of bycatch resulting in the overharvest of a distinct genetic component of the stock, destruction of spawning habitat and disruption of spawning aggregations, and competition for prey. Herring bycatch does not appear to be concentrated in space, but rather is spread throughout the pollock fishery under status quo management (Figure 3.5-15). Although there is some amount of herring bycatch throughout the year, it is higher in September and October (pollock B season during 1997 to 1999). No significant impacts to herring stocks from spatial or temporal concentration of herring bycatch have been identified.

Past/Present Events and Management Actions

External Mortality: Catch in the State Directed Herring Fisheries

During the 1920s herring was valued for oil and meal. Reduction plants sprang up all over Alaska from Craig to Kodiak to process herring into oil and meal. Reduction and food herring harvests peaked in the 1920s and 1930s (Figure 3.5-16). By the 1950s, Peruvian anchoveta harvest had severely impacted the Alaska herring oil and meal markets due to lower costs (ADF&G 2000). Herring reduction plants began closing and by1966 the last herring reduction plant in Alaska had closed. The herring for bait fishery began in the early 1900s and has remained relatively stable to the present time with a slight increase in demand due to the development of the crab fisheries in the 1970s (Figure 3.5-16). Herring fisheries continue to occur; however, they are highly managed by the state. Annual stock assessments from trawl surveys are conducted with quota setting processes responsive to fluctuations in herring biomass.

External Mortality: Catch in the pre-MSA Foreign Fisheries

A foreign fishery for herring food products existed in the Bering Sea during the 1960s and 1970s (Figure 3.5-16). Foreign harvesting of herring was discontinued around 1980 under the provisions of the MSA when inshore domestic fisheries began to fully utilize Bering Sea herring (ADF&G 2000b).

Internal Mortality: Bycatch in Groundfish Fisheries

Herring bycatch is taken primarily in the trawl pollock fisheries. Herring caught as bycatch in trawl fisheries do not survive. Overall herring bycatch is higher in the BSAI than the GOA. It is estimated that herring bycatch may have been as high as 7,300 to 9,100 mt in the late 1980s. JV operations peaked in 1987, giving way to a rapidly developing domestic fishery. Bycatch further increased with development of the fully domestic fleet, but was quickly limited by regulation. By 1989, unrestrained bycatch in the trawl fisheries had jumped to high levels relative to exploitable biomass. Past federal groundfish fisheries bycatch combined with the state fisheries direct take have exceeded the state's herring harvest policy in the past. (Appendix C, BSAI FMP Amendment 16a).

Pacific herring bycatch limitations in the groundfish fisheries apply to trawl gear in the Bering Sea. The PSC limit for trawl gear is determined each year when TAC specifications are reset. Amendment 16a, implemented on July 12, 1991, established a herring bycatch cap of one percent of the estimated EBS herring biomass, which is further apportioned by target fishery (50 CFR 679.21 (e)(1)(iv)) (Funk 2003). Should the PSC limit for any groundfish fishery be reached during the fishing year, one or all of the three designated Herring Savings Areas close, depending on the time of year (Figure 3.5-17) (50 CFR 679.21 (e)(7)(v)). Three time and area closures were established, taking into account herring migration patterns. Area 1 closes from June 15 to July 1, Area 2 from July 1 to August 15, and Area 3 from September 1 through March 1. Areas with relatively high bycatch rates of herring were identified from data collected by observers on foreign and joint venture vessels. Pacific herring closures have been effective at maintaining an acceptable level of bycatch in years when herring are abundant on the fishing grounds. This situation occurred in 1992, 1993, 1994, and 1995, when herring savings areas 2 and 3 were closed to trawling for fisheries directed at pollock, rock sole, yellowfin sole, and other flatfishes. Area 3 experienced a total closure from November 4, 1994 to March 1, 1995, for the pollock midwater trawl fishery. From 1993 to present, the pollock fishery has primarily driven herring bycatch rates with the yellowfin sole fishery playing a secondary role (Figure 3.5-19) (Funk 2003).

PSC bycatch is also controlled by non-regulatory means. Many measures have been embraced by the trawl and longline fleet to control and reduce bycatch of Pacific halibut, herring, crab, and salmon. A GIS application has been used by the BSAI trawl and longline fleet to identify hotspots by using bycatch rates reported by individual vessels (Gauvin *et al.* 1995, Smoker 1996). Bycatch rate information from individual vessels is received at a central location, aggregated daily, and then quickly relayed back to the entire fleet in the form of maps, so that hotspot areas can be avoided. PSC rates are reduced and corresponding higher groundfish catches can then be realized by the fleet. Unfortunately, because this is a voluntary program, non-participating vessels with high bycatch rates may keep the fleet as a whole from catching the entire quota. Some bycatch reduction may also come in the form of peer pressure. Individual vessel bycatch rates are now published on the Internet. Vessels with high bycatch rates may face peer pressure to lower their bycatch.

<u>External Nutritional Stress: Climatic Influence on Prey Species</u>

Climate variability can have an influence on herring prey. However, these interactions are not fully understood nor defined and research on climatic effects is ongoing.

<u>External Reduced Recruitment: EVOS Contamination (PWS)</u>

Herring spawning habitat in PWS was contaminated by oil from the EVOS in 1989. Subsequent laboratory studies have indicated that larval and adult herring exposure to oil can cause increased rates of egg mortality, larval deformities, and compromise adult herring immune systems. In 1993, there was a crash in the PWS herring population. This crash was correlated with a viral disease, increasing biomass, and lowering plankton production. The extent that exposure to oil contributed to the disease outbreak and consequent population crash is uncertain (EVOS Trustee Council 2002c). The EVOS Trustee Council continues to monitor the recovery of the PWS herring population.

Comparative Baseline

ADF&G makes herring biomass projections for each regulatory stock using postseason escapement estimates, historical mean rates of survival, and current mean weights and assumed recruitment rates for each age class.

Herring fisheries continue to occur; however, they are closely managed by the state. Although most herring are harvested in the sac-roe season in spring, fall seasons are also designated for food and bait harvesting. The ADF&G regulates and monitors the resource by 20 separate fisheries. Annual stock assessments from trawl surveys are conducted and quota setting processes are responsive to fluctuations in herring biomass.

In the Bering Sea, catches peaked dramatically in 1970 at more than 108,000 mt and fell to 19,050 mt in 1977 (Figure 3.5-20, NMFS 1999d). Since then, catches have risen slowly but steadily, reflecting improving stock conditions. A portion of the Bering Sea harvest is taken as bycatch in the groundfish fishery. Regulations now limit bycatch to about 1,000 mt. In more recent years, statewide herring harvests have averaged about 45,000 mt. The majority of the harvest was roe-bearing herring (about 90 percent) and the remainder was food-and-bait herring (about 10 percent). The herring roe-on-kelp harvest (about 150 mt) is minuscule in percentage terms.

Herring populations, like those of other small pelagic fish species, are subject to wide fluctuations in abundance. The causes suggested for these fluctuations range from natural causes to overfishing (and underfishing), pollution effects (including the 1989 EVOS), disease, climate variability, and combinations of factors (Pearson *et al.* 1999). From catch records (Figure 3.5-20), it is evident that herring biomass fluctuates widely due to influences of strong and weak year-classes. The period since the mid-1970s seems to be one of low-to-moderate herring abundance. Abundance of the stocks depends mostly on highly variable year-class strengths. A strong 1988 year-class, which dominated the stock, declined rapidly in abundance, and was replaced by another strong year-class (1992), which should sustain abundance levels in the near future. In PWS, herring collections in 2002 indicate that a large proportion of this population (over 30 percent) is now comprised of 3-year olds. If this trend holds up through successive sampling, it could signal that recovery is underway for the PWS herring stock (EVOS Trustee Council 2002c).

Pacific Herring Cumulative Effects Analysis Status

FMP 2.1 proposes to eliminate the groundfish fishery PSC limits and inseason bycatch triggered closures. These measures have the potential to affect herring biomass levels and could impose further economic hardship on the state herring fisheries. Therefore, Pacific herring will be carried forward for the alternative cumulative effects analysis.

3.5.2.4 Crab

The commercially important crab species are red king crab (*Paralithodes camtschaticus*), blue king crab (*P. platypus*), golden king crab (*L. aequispinus;* also called brown king crab), bairdi Tanner crab (*Chionoecetes bairdi*), and opilio Tanner crab *(C. opilio;* also called snow crab). King and Tanner crab share a similar life cycle, although particular life cycle traits are distinct for each species. After males and females mate, the female carries the eggs for approximately a year, at which time the eggs hatch into free-swimming larvae. After drifting with the currents and tides and undergoing several development changes, the larvae settle to the ocean bottom and molt into non-swimmers, looking very much like miniature adult crab. The juvenile crab settle on preferred habitat, where they continue to molt and grow for several years until they become sexually mature. Each life stage of crab stocks is concentrated at some combination of depth, habitat, geographic area, and time of year.

Crab, being benthic organisms, depend on specific habitat types throughout their life stages. Settlement on habitat with adequate shelter, food, and temperature is imperative to the survival of first settling crab. Young-of-the-year red and blue king crab require nearshore shallow habitat with significant protective cover (e.g., sea stars, anemones, microalgae, shell hash, cobble, shale) (Stevens and Kittaka 1998). Early juvenile stage bairdi and opilio Tanner crab also occupy shallow waters and are found on mud habitat (Tyler and Kruse 1997).

King and Tanner Crab Life History and Distribution

Red king crab are widely distributed throughout the BSAI, GOA, Sea of Okhotsk, and along the Kamchatka shelf up to depths of 250 m. King crab molt several times per year through age three, and annually thereafter. At larger sizes, king crab may skip molt as growth slows. Females grow more slowly and do not get as large as males. In Bristol Bay, males attain 50 percent maturity at 120-mm carapace length and females at 90-mm carapace length (about 7 years). Ages of crab referred to in this document are inferred from tagging and growth, since currently crab cannot be aged. For crab which undergo a terminal molt, radiometric aging of the shell has provided estimates of age since the last molt (Nevissi *et al.* 1996). Maximum age for the largest red king crab caught near Kodiak may be about 24 years based on growth and tagging data(Stevens and Kittaka 1998). Mean age at recruitment into the fishery is eight to nine years. Red king crab in Norton Sound mature at smaller sizes and do not attain the maximum sizes found in other areas. In Bristol Bay, red king crab mate when they enter shallower waters (less than 50 m), generally beginning in January and continuing through June. Males grasp females just prior to female molting, after which the eggs (43,000 to 500,000 eggs) are fertilized and extruded on the female's abdomen. The females carry the eggs for 11 months before they hatch, generally in April. Red king crab spend two to three months in larval stages before settling to the benthic life stage. Young-of-the year crab occur at depths less than 50 m. They are solitary and need high-relief habitat or coarse substrate, such as boulders, cobble, shell hash, and living substrates, such as bryozoans and stalked ascidians (Stevens and Kittaka 1998). At 1.5 to 2 years, crab form pods consisting of thousands of crab. As crab grow, they migrate to deeper water.

Blue king crab have a discontinuous distribution throughout their range and tend to form discrete populations along rocky coasts, rocky islands, and fjord-like areas. In the Bering Sea, discrete populations exist around the Pribilof Islands, Saint Matthew Island, Saint Lawrence Island, and Little Diomede Island in the Bering Straight. Smaller populations have been found around Nunivak and King Islands. Adult male blue king crab occur at an average depth of 70 m and an average water temperature of 0.6 °C. Blue king crab molt multiple times as juveniles. Skip molting occurs with increasing probability for males larger than 100-mm carapace length. In the Pribilof Islands, males attain 50 percent maturity at 108-mm carapace length, and females attain 50 percent maturity at 96-mm carapace length (about five years) (Somerton and MacIntosh 1983). Blue king crab in the Saint Matthew Island area mature at smaller sizes (50 percent maturity at 77-mm carapace length for males and 81-mm carapace length for females) and do not get as large overall. Blue king crab have a biennial ovarian cycle and a 14-month embryonic period before hatching in late spring. Juveniles require cobble habitat with shell hash. These habitat areas have been found at 40 to 60 m around the Pribilof Islands. Unlike red king crab, juvenile blue king crab do not form pods, but instead rely on cryptic coloration for protection from predators.

Golden king crab, also called brown king crab, range from the Japan Sea to the northern Bering Sea, around the Aleutian Islands, on various sea mounts, and as far south as northern British Columbia. In the BSAI, golden king crab are found at depths from 200 m to 1,000 m, generally in high-relief habitat such as inter-island passes on extremely rough bottom strata. Size at sexual maturity depends on latitude, with crab in the northern areas maturing at smaller sizes. In the Saint Matthew Island area, males attain 50 percent maturity at 92-mm carapace length and females at 98-mm carapace length. In the Pribilof Islands and western Aleutian Islands, males attain 50 percent maturity at 107-mm carapace length and females at 100-mm carapace length. Further south, in the eastern Aleutian Islands, males attain 50 percent maturity at 130-mm carapace length and females at 111-mm carapace length.

Bairdi Tanner crab are distributed on the continental shelf of the North Pacific Ocean and Bering Sea from Kamchatka to Oregon. Off Alaska, bairdi Tanner crab are concentrated around the Pribilof Islands and immediately north of the Alaska Peninsula, and are found in lower abundance in the GOA. After molting many times as juveniles, bairdi tanner crab reach sexual maturity at about age-6 with an average carapace width of 110 to 115 mm for males and 80 to 110mm for females (Tyler and Kruse 1997). At maturity, females undergo a terminal molt. Molting frequency for males decreases after maturity; however, terminal molt for males has not been determined (Zheng *et al.* 1998). Male bairdi Tanner crab reach a maximum size of 190-mm carapace width and have a maximum age of at least 15 years (Donaldson *et al.* 1981). Males of commercial size may range between 9 and 11 years old and vary in weight from 1 to 2 kg (Adams 1979). Bairdi Tanner crab females are known to form high-density mating aggregations, or pods, consisting of hundreds of crab per mound. These mounds may provide protection from predators and attract males for mating. Research shows that female bairdi Tanner crab prefer mating with large, old-shell males (Paul and Paul 1996, Paul *et al.* 1995). Mating occurs from January through June. Some females can retain viable sperm in spermathecae for up to two years. Females carry clutches of 50,000 to 400,000 eggs for one year after fertilization. Hatching occurs between April and June (Tyler and Kruse 1997). Spawning habitat for bairdi Tanner crab in the BSAI has not been identified.

Opilio Tanner crab are distributed on the continental shelf of the Bering Sea, the Arctic Ocean, and in the western Atlantic Ocean as far south as Maine. Opilio Tanner crab are not present in the GOA. In the Bering Sea, they are common at depths of no more than 200 m. The EBS population within U.S. waters is managed as a single stock; however, the distribution of the population extends into Russian waters to an unknown degree. Opilio Tanner crab reach sexual maturity at about age 5 to 8, with 50 percent mature at carapace width of 79 mm for males and 49 mm for females. The mean size of mature females varies from year to year over a range of 63-mm to 72-mm carapace width. Females cease growing with a terminal molt upon reaching maturity, and rarely exceed 80-mm carapace width. Males may also cease growing upon reaching a terminal molt when they acquire the large claw characteristic of maturity. Male opilio Tanner crab reach a maximum size of 150-mm carapace width and may live up to 19 years. Large, old -shelled males out-compete new-shell adolescent and small adult males in mating with females (Sainte-Marie *et al.* 1999). Commercial-sized males may range between 9 and 11 years old and average about 0.6 kg (Saint-Marie *et al.*1999). Female opilio Tanner crab are able to store spermatophores in seminal vesicles and fertilize subsequent egg clutches without mating. At least two groups of eggs can be fertilized from stored spermatophores, but the frequency of this occurring in nature is not known (Sainte-Marie *et al.* 1997). In Bristol Bay, podding behavior is unique to red king crab and incorporates male and female crab of different ages. These pods may result in a patchy distribution of red king crab in this region as opposed to a random or continuous distribution often observed for other species (Dew and McConnaughey in review).

King and Tanner Crab Trophic Interactions

In the trophic structure, crab are members of the inshore benthic infauna consumers guild (NPFMC 1994). During each life stage, crab consume different prey and are consumed by different predators. Planktonic larval crab consume phytoplankton and zooplankton. Post settlement juveniles feed on diatoms, protozoa, hydroids, crab, and other benthic organisms.

Food eaten by king crab varies with size, depth inhabited, and species, but includes a wide assortment of worms, clams, mussels, snails, brittle stars, sea stars, sea urchins, sand dollars, barnacles, fish parts, and algae. Bairdi and opilio Tanner crab feed on an extensive variety of benthic organisms including bivalves, brittle stars, other crustaceans, polychaetes and other worms, gastropods, and fish (Lovrich and Sainte-Marie 1997).

Planktonic larval crab are prey for pelagic fish, such as pollock, salmon, and herring. King crab fall prey to a wide variety of species including Pacific cod, Pacific halibut (Alaska plaice, yellowfin sole, flathead sole) arrowtooth flounder, octopus, and large king crab (Livingston *et al.* 1993). Bairdi and opilio Tanner crab are consumed by a wide variety of predators including groundfish, walrus, bearded seals, sea otters, octopi, Pacific cod, Pacific halibut and other flatfish, eelpouts, sculpins, and adult tanner crab (Tyler and Kruse 1997). Opilio Tanner crab comprise a large portion of the diet of many skate species (Orlov 1998).

King and Tanner Crab Management

Alaska king, bairdi Tanner crab, and opilio Tanner crab (also called snow crab) fisheries are managed by the State of Alaska, with federal oversight and following guidelines established in the BSAI king and Tanner crab FMP (NPFMC 1989). Annual trawl surveys for crab stock assessments are conducted by the NOAA Fisheries in the BSAI. A length-based analysis, developed by ADF&G, incorporates survey, commercial catch, and observer data into more precise abundance estimates (Zheng *et al.* 1998, Zheng *et al.* 1995). Abundance estimates generated by this model are used to set guideline harvest levels for the crab fisheries. Catches are restricted by GHLs, seasons, permits, pot limits, and size and sex limits that restrict landings to legal-sized male crab. Fishing seasons are set at times of the year that avoid molting, mating, and softshell periods, both to protect crab resources and to maintain product quality. Observers are required on all vessels processing king and tanner crab. Crab are captured with baited pots, and most of the catch is landed in Dutch Harbor, Alaska. Most crab vessels target different crab species during different seasons, and many crab vessels also participate in the groundfish fisheries.

King crab along with bairdi and opilio Tanner crab are prohibited species for the state scallop and groundfish fisheries and federal groundfish fisheries, meaning that any crab bycatch must be discarded. Although crab are always prohibited species in any groundfish fishery, they accrue against a CDQ PSC limit only when caught with trawl gear in Zone 1 for red king crab, Zone 1 and 2 for bairdi Tanner crab, and the opilio Tanner Crab Bycatch Limitation Zone for opilio Tanner crab (Figure 3.5-8). PSC limits are set for each species by zone for each fishery. When the PSC limit is reached the fishery closes for the remainder of the season .

The PSC limit for red king crab is based on abundance of the Bristol Bay red king crab stock as follows:

- When the number of mature female red king crab is equal to or below the threshold number of 8.4 million crab, or the effective spawning biomass is less than 14.5 million pounds, the Zone 1 red king crab PSC limit is 35,000 crab.

- When the number of mature female red king crab is above threshold, and the effective spawning biomass is equal to or greater than 14.5, but less than 55 million pounds, the Zone 1 red king crab PSC limit is 100,000 crab.

- When the number of mature female red king crab is above threshold, and the effective spawning biomass is equal to or greater than 55 million pounds, the Zone 1 red king crab PSC limit is 200,000 crab.

BSAI FMP Amendment 57 modified the red king crab bycatch by reducing the limits by an additional 3,000 crab as part of the conversion of the pollock fishery to pelagic trawling only.

Based on the 2002 abundance estimate of the effective spawning biomass at 37.7 million pounds (NPFMC 2002e; Appendix B - Prohibited Species Catch in the BSAI), the current PSC limit is 97,000 crab. The red king crab cap has generally been allocated among several groundfish fisheries. Once a fishery exceeds its red king crab PSC limit, Zone 1 is closed to that fishery for the remainder of the year, unless further allocated by season.

Bairdi tanner crab PSC limits are set separately for Zone 1 and Zone 2. PSC limits in both zones are based on total abundance of tanner crab as determined by the annual NOAA Fisheries trawl survey, as follows:

	Abundance	PSC Limit
Zone 1	0-150 million crab	0.5 percent of abundance
	150-270 million crab	750,000 crab
	270-400 million crab	850,000 crab
	Over 400 million crab	1,000,000 crab

	Abundance	PSC Limit
Zone 2	0-175 million crab	1.2 percent of abundance
	175-290 million crab	2,100,000 crab
	290-400 million crab	2,550,000 crab
	Over 400 million crab	3,000,000 crab

These PSC limits are further reduced by 50,000 crab as part of BSAI FMP Amendment 57.

Based on the 2002 abundance estimate of 464.9 million crab, the 2003 PSC limit is 980,000 crab in Zone 1 and 2.97 million crab in Zone 2 (NPFMC 2002e; Appendix B - Prohibited Species Catch in the BSAI). The bairdi tanner crab cap may be further allocated among several groundfish fisheries. When a fishery exceeds its bairdi tanner crab PSC limit in a zone, trawling is closed in that zone for the remainder of the year.

PSC limits for opilio tanner crab also are based on their total abundance as estimated by the NOAA Fisheries trawl survey. The opilio tanner crab PSC limit is set at 0.1133 percent of total opilio tanner crab abundance, with a minimum PSC of 4.5 million opilio tanner crab and a maximum of 13 million crab. PSC limits are further reduced through BSAI FMP Amendment 57 by 150,000 crab. Based on the 2002 abundance estimate of 1.49 billion crab (NPFMC 2002e; Appendix B - Prohibited Species Catch in the BSAI), the 2003 PSC limit is 4.35 million crab. The opilio tanner crab PSC limit applies to the *C. opilio* Bycatch Limitation Zone. The total PSC limit is allocated among several groundfish trawl fisheries. Upon attainment of a opilio crab PSC limit for a particular trawl target fishery, that fishery is prohibited from fishing within the *C. opilio* Bycatch Limitation Zone.

NOAA Fisheries Management

Crab regulations have been based on concerns that trawling impacts crab populations directly in terms of trawl-induced mortality and indirectly through habitat degradation. Observed mortality, as measured by crab bycatch, has accounted for a small percentage of crab populations. For example, bycatch amounted to only

0.5 percent of the red king crab, 1.2 percent of the bairdi Tanner crab, and 0.1 percent of the opilio Tanner crab population on average, for 1992 through 1995 (NPFMC 1996). Because bycatch is currently considered to be minor relative to other sources of mortality, time and area closures are thought to be more effective than PSC limits in reducing impacts of trawling on crab stocks (Witherell and Harrington 1996). As such, numerous trawl closure areas have been instituted to address concerns about unobserved mortality (crab wounded or killed but not captured), and possible habitat degradation due to trawling and dredging.

BSAI Crab Closures

Nearshore Bristol Bay Closure

BSAI FMP Amendment 10 prohibits all trawling at all times in the EEZ within the area east of 162°W with the exception of an area bounded by 159° to 160°W and 58° to 58°43'N which remains open April 1 to June 15; this amendment addresses concerns that commercial trawl fishing was contributing to increased mortality of crab due to incidental capture and mutilation.

Bristol Bay Red King Crab Area

BSAI FMP Amendment 37 closed this area seasonally to non-pelagic trawling to protect important red king crab habitat and rebuild the red king crab stock. The red king crab commercial fishery was closed in 1994 and 1995.

Pribilof Islands Habitat Conservation Area

BSAI FMP Amendment 21a closed trawling year-round in important habitat areas for blue king crab and Korean hair crab.

Crab Protection Zones

Zone A closed to trawling year-round; Zone B closed to trawling March 15 to June 15.

Crab Bycatch Limitation Zones

Closed to specified trawl fisheries when limits are reached.

C. Opilio Bycatch Limitation Zones

BSAI FMP Amendment 40 closed this area to specified trawl fisheries when limits are reached.

GOA Crab Closures

Permanent Kodiak Crab Protection Zones

GOA FMP Amendment 15 and 26 established Type I, II, and III areas for special bottom trawl within the GOA region to protect king crab, rebuild crab stocks, and protect habitat. Alitak Flats/Towers and Marmot

Flats are closed to non-pelagic trawls year-round, Chirikof Island and Barnabas are closed to non-pelagic trawls from February 15 to June 15.

Past/Present Effects Analysis

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-46 provides a summary of the king and Tanner crab past effects analysis presented below.

Crab species prey on a wide assortment of organisms that varies with life stages. fisheries bycatch of crab prey species ranges from very low (e.g., worms, snails, brittle stars, et cetera) to none (e.g., phytoplankton and zooplankton). A relationship between the groundfish fisheries minor bycatch of crab prey and prey availability for crab that could have the potential to cause population-level effects on crab species was not identified during screening. Therefore, effects on crab prey species will not be part of the analysis.

The following direct and indirect effect indicators were identified as potentially having population-level effects on crab:

- Catch/bycatch mortality (direct effect).
- Mortality from predation (direct effect).
- Climatic influences on marine survival (indirect effect).
- Mortality associated with spatial/temporal concentration of bycatch (indirect effect).

The past/present events determined to be applicable to the crab past effects analysis include the following:

- Past/Present External Events
  - Foreign fisheries (pre-MSA in U.S. EEZ)
  - Alaska State directed crab fisheries
  - Alaska State groundfish and scallop fisheries
  - Subsistence fisheries
  - Predation
  - Climate variability
- Past/Present Internal Events
  - FMP groundfish fisheries
- Past/Present Management Actions
  - Bilateral agreements
  - ADF&G management
  - Industry self-imposed management
  - FMP groundfish fisheries management

Mortality: Foreign Fisheries Direct Catch and Bycatch

Directed Japanese (1953 to 1975) and Russian (1959 to 1972) red king crab fisheries were conducted in the EBS and Bristol Bay. By the mid-1960s, there were signs that exploitation rates were at or approaching limits. Bristol Bay data showed that increased catches were being maintained by increases in the number of tangle nets being fished and in the average time the nets were being soaked. The Bristol Bay red king crab stock began to decline in 1964 after peak catches not related to crab biomass increases. Declines in the Kodiak and GOA crab fisheries led to a renewed interest of the domestic crab fleet in the Adak and Bering seas. The Adak fishery declined in the early 1970s and has never fully recovered.

During the mid-1960s, foreign fleets in the BSAI took record numbers of yellowfin sole and Pacific ocean perch. Crab bycatch is associated with both of these fisheries. Crab bycatch and unobserved mortality also occurred due to interactions with the foreign fleet's bottom trawl gear and state crab fixed gear fisheries. In the mid-1960s, the U.S. initiated several bilateral agreements with Japan and Russia to reduce gear conflicts between State of Alaska fixed gear crab fisheries and foreign fisheries and to allocate crab resources between the foreign fisheries and state fixed gear crab fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stock in the Bering Sea (Dew and McConnaughey in review). Although the MSA effectively eliminated trawling by foreign vessels, it did not provide for observers on domestic vessels (roughly between 1977-1990). Thus, the lack of observer coverage aboard vessels fishing in Bristol Bay may have led to inaccurate bycatch numbers being reported to managers who in turn, evaluated the potential impacts of trawling on red king crab (Dew and McConnaughey in review).

Mortality: Direct catch and Bycatch in State Directed Crab Fisheries

Bycatch consists of females and sublegal-sized males of the target species and non-target crab species. In the crab fisheries, this bycatch may comprise up to 60 percent of the total catch (Zhou and Shirley 1997a, Zhou and Shirley 1997b). The main concern of bycatch in the crab fishery is handling mortality of discarded crab, which leads to some reduction in fishery production (MacIntosh *et al.* 1995, Murphy and Kruse 1995). Mortality of crab bycatch is not well known, but is estimated to be 20 percent, although, handling mortality may be higher in winter fisheries when crab are exposed to low air temperatures and wind (NMFS 2004). Research is being conducted to reduce the amount of bycatch in the crab fisheries, such as improving pot design (Zhou and Shirley 1997a, Zhou and Shirley 1997b). Crab FMP regulations prohibit the landing of females and sublegal-sized males. State crab fisheries continue to occur and are closely managed by the state in cooperation with NOAA Fisheries. Quota setting processes are responsive to fluctuations in crab stocks but are limited in their ability to account for other factors possibly affecting crab populations such as changes in sex-ratio and spawning-recruitment success. Crab bycatch in the state and federal groundfish fisheries is taken into account under the state management processes.

Mortality: Bycatch in State Groundfish and Scallop Fisheries

Crab bycatch and unobserved mortality due to interactions with bottom trawl gear is associated with past state groundfish fisheries and state scallop fisheries. In the domestic groundfish fisheries, bycatch of red king crab and bairdi Tanner crab have been kept in check with PSC limits for trawl and scallop fisheries.

Mortality: Egg Mass Predation

Egg masses of king crab are often infested by a variety of symbionts and predators. Of particular importance is the nemertean worm, *Carcinonemertes regicides* (which means "king killing crab worm"). These worms have been observed in egg masses of king crab from multiple locations in Alaska (Kuris *et al.* 1991). Prevalence of worms (the proportion of crab infested with worms) was 100 percent in crab collected from southeastern Alaska, Cook Inlet, and many Kodiak sites. The worms were essentially absent from crab collected in the Bering Sea. Almost 100 percent of eggs were killed by worm predation in crab collected from Kachemak Bay, near Homer, Alaska, from 1983 to 1984. This predator could be responsible for limiting recruitment of crab populations in southcentral Alaskan waters, but does not seem to be a major factor in the Bering Sea.

Mortality: Climate Variability

Climate can have an influence on crab populations and their prey, both beneficial and adverse. Wind speed and duration can affect coastal upwelling of colder water from deeper depths. This process of upwelling promotes primary and secondary production, thus affecting the production of food for crab larvae. At the present time a causal relationship between phytoplankton and larval crab abundance and survival has not been established. However, it is thought that community composition and relative abundance of various phytoplankton species, in particular specific diatoms, could potentially be critical to the survival of red king crab larvae. Current regimes over the EBS influence the transport of crab larvae during their planktonic life, and eventual deposition on appropriate or non-appropriate settlement habitat for post-settlement juvenile survival (NMFS 2004).

Mortality: Bycatch in MSA Groundfish Fisheries

Crab bycatch in past foreign fisheries was replaced with increased crab bycatch in the JV fisheries until 1987 when new bycatch limits were put into effect. As the JV fisheries were being phased out and the domestic fisheries phased in, crab bycatch increased once again, but was quickly addressed by the establishment of new crab bycatch limits. Bycatch of opilio Tanner crab was unconstrained through 1996. Overall crab bycatch has been a function of crab abundance and PSC limits. High bycatch of king and Tanner crabs (mostly opilio Tanner crab) were taken in the 1970s by foreign fisheries. However, regulations and incentives implemented with the groundfish FMP in 1982 reduced crab bycatch to much lower levels. Bycatch of opilio Tanner crab increased drastically in the early 1990s, corresponding to an expanding crab population, so opilio Tanner crab PSC limits were established in 1996. Figures 3.5-21, 3.5-22, 3.5-23, and 3.5-24 show bycatch trends for red king crab, other king crab, bairdi Tanner crab, and other Tanner crab by area and gear during 1998-2001 (Hiatt *et al.* 2002).

Bycatch of prohibited species is also controlled by non-regulatory means. Many measures have been embraced by the trawl and longline fleet to control and reduce bycatch of crab, herring, Pacific halibut, and salmon. A GIS application has been used by the BSAI trawl and longline fleet to identify hotspots by using bycatch rates reported by individual vessels (Gauvin *et al.* 1995; Smoker 1996). Bycatch rate information from individual vessels is received at a central location, aggregated daily, and then quickly relayed back to the entire fleet in the form of maps, so that hotspot areas can be avoided. PSC rates are reduced and corresponding higher groundfish catches can then be realized by the fleet. Unfortunately, because this is a voluntary program, non-participating vessels with high bycatch rates may keep the fleet as a whole from catching the entire quota. Some bycatch reduction may also come in the form of peer pressure. Individual vessel bycatch rates are now published on the internet and vessels with high bycatch rates may face pressure to lower their bycatch.

Habitat Destruction

Major spawning areas have been identified for BSAI red king crab and western GOA red king crab. These important habitats are protected by trawl closures and conservation zones. Areas currently closed to non-pelagic trawling in the Bering Sea to protect crab species are the Red King Crab Savings Area, the nearshore Bristol Bay No Trawling Zone, and the Pribilof Islands Habitat Conservation Area. Blue and golden king crab habitat areas are protected by conservation zones in the Pribilof Islands and indirectly by the lack of groundfish effort near Saint Matthew Island. It has been hypothesized that the elimination of the Japanese pot sanctuary in Bristol Bay in 1976, with the subsequent establishment of a major trawling area amidst a large broodstock of red king crab, resulted in adverse impacts to important inshore crab habitat (Dew and McConnaughey in review). The importance of living and non-living habitat to various life stages of crab populations throughout the BSAI and GOA has not been determined to date. However, habitat research continues.

Comparative Baseline

Red King Crab

The 2002 length based analyses show mature female crab abundance has decreased slightly from the 2001 level; however, legal males show a slight increase and pre-recruit males have decreased in abundance. Legal male abundance in Bristol Bay increased from 7.5 million crab in 1997 to 9.4 million crab in 1999, decreased to 8.3 million crab in 2001, then increased slightly to 8.6 million crab in 2002 (NPFMC 2002f). Mature females (>89 mm) declined from 28.2 million crab in 1997 to 18.9 million crab in 2000, increased slightly in 2001 to 21.8 million crab, then declined to 18.6 million crab in 2002. Due to the decrease in abundance of mature females, ADF&G decreased the 1999 GHL from a 15 percent to a 10 percent exploitation rate; this rate has continued to be used for the 2001 and 2002 fishery (NPFMC 2002f). The Bristol Bay red king crab stock remains depressed compared to past abundance levels. Survey estimates of Pribilof Islands red king crab have been highly variable over the last ten years and have a high degree of uncertainty due to the patchy distribution of the animals. Model estimates of mature male abundance shows a decline from about 2 million in 1992 to 1 million in 1997, and then an increase to about 1.7 million in 2002. Legal male abundance was estimated at 1.36 million in 2002 (NPFMC 2002f). The red king crab Pribilof Islands fishery was closed in 1999 and has continued to be closed into 2002 due to uncertainty in the abundance estimates. A small Aleutian Island red king crab fishery occurs, with a 2002 GHL of 0.5 million pounds. Norton Sound also supports a small summer red king crab fishery (Bowers *et al.* 2002).

Blue King Crab

The blue king crab population in the Pribilof Islands is low, and population trends are not easily detectable (NMFS 1998a). Blue king crab female abundance is considered imprecise because trawling does a poor job of sampling the inshore, rocky substrate preferred by females (Morrison *et al.* 1998). The 2002 NOAA Fisheries survey estimated legal male abundance in the Pribilof Islands at 0.38 million crab, a decrease from the 2001 estimate (NPFMC 2002f). Pribilof Islands blue king crab were declared overfished in 2002 (64 FR

62212). A rebuilding plan is currently has been developed and was passed as BSAI Crab FMP Amendment 17 on March 18, 2004 (NPFMC 2004). Blue king crab in the Saint Matthew Island area have increased from 0.8 million crab in 2000 to 1.1 million crab in 2001. However, spawning biomass is still estimated to be below the minimum stock size threshold (Bowers *et al.* 2002). The Saint Matthew Island blue king crab stock was declared overfished and the fishery was closed in 1999 and has continued to be closed into 2002 (64 FR 54791). A rebuilding plan has been developed for the Saint Matthew Island stock and was passed as BSAI Crab FMP Amendment 15 on November 29, 2000 (NMFS 2000b).

Golden King Crab

Population estimates are not available from the NOAA Fisheries trawl survey for golden king crab. Golden king crab are found primarily near the Aleutian Islands. ADF&G conducts the Aleutian Islands golden king crab pot survey; however, there are no absolute estimates of abundance. ADF&G and NOAA Fisheries do not make annual abundance estimates for Bering Sea golden king crab, and commercial harvest is allowed by ADF&G permit (Morrison *et al.* 1998). Catches have declined from the early years of the fishery, as the initial stock was exploited and recruitment was unable to sustain the fishery at its initial harvest levels (Morrison *et al.* 1998). In 1995, the State of Alaska mandated observer coverage for all vessels targeting golden king crab in the Aleutian Islands. Small fisheries for golden king crab exist in the Pribilof Island area and in the Northern District of Saint Matthew Island (Bowers *et al.* 2002).

Bairdi Tanner Crab

In 1996, the bairdi Tanner crab was declared overfished in the Bering Sea. Following this declaration, the bairdi Tanner crab fishery was closed from 1997 to 2002 due to low abundance. During the 1997 survey, 95 percent of legal males encountered were old-shelled and not expected to molt again, and few young males in the 50- to 115-mm carapace width range were surveyed. In the 1998 survey, most legal males encountered were in the eastern district, with the highest abundance in central Bristol Bay. The cohort which began recruiting into the fishery in 1988 to 1992 has declined as a result of natural mortality and fishery removals. Given these two factors, it is likely that the Bering Sea bairdi Tanner crab population will continue to decline for years (Morrison *et al.* 1998). The 2001 survey abundance estimates for large males (135-mm carapace width) and large females have decreased from the 2000 estimates (Bowers *et al.* 2002). NPFMC considers the stock overfished and its crab plan team has developed a rebuilding plan (64 FR 15308). The bairdi Tanner crab rebuilding plan was passed as BSAI Crab FMP Amendment 11 on June 8, 2000 (NPFMC 1999b).

Opilio Tanner Crab (snow crab)

Large male opilio Tanner crab were estimated at 94 million crab in 1999, a decline of 63 percent from 1998. The mature biomass declined below the minimum stock size threshold of 460 million lbs, and the stock was declared overfished on September 24, 1999 (64 FR 54791). A rebuilding plan has been developed by NPFMC's crab plan team. This rebuilding plan was passed as BSAI Crab FMP Amendment 14 on December 28, 2000 (NPFMC 2000a). Since 1999, snow crab abundance has increased; the 2001 NOAA Fisheries survey estimates 77.5 million crabs, 2 percent above the 2000 estimate. A harvest of 33.5 million lbs was landed in 2000, based on a reduced harvest rate from past years. The 2002 Bering Sea opilio Tanner crab GHL is established at 31 million pounds (Bowers *et al.* 2002).

GOA Crab Stocks

GOA crab stock status is limited due to the lack of survey information. GOA red king crab stocks in the vicinity of Kodiak Island remain depressed. The last good year-class produced was in 1973 to 1974, and recent surveys failed to detect signs of rebuilding. No Kodiak red king crab fishery has occurred since 1983. Due to relative low abundance, all GOA direct red king crab fisheries are currently closed with the exception of a sporadic fishery in a few small areas off southeast Alaska. A golden king crab fishery occurs in the Kodiak region, although no more than two boats have participated in the fishery since 1988, with no fishing occurring during most years. The Kodiak bairdi Tanner crab population has been assessed by ADF&G trawl surveys since 1980. The 2001 survey estimates the Tanner crab population to be the highest on record at 175.9 million crab, although the number of legal crab remains similar to the 2000 estimate of 2.6 million crab. A commercial fishery took place in the Northeast and eastside sections of Kodiak Island in 2001 and 2002 (Ruccio *et al.* 2002).

King and Tanner Crab Cumulative Effects Analysis Status

All BSAI and GOA King and Tanner crab species mentioned here will be carried forth for cumulative effects analysis based on declining stock assessments and lack of information regarding current population status of some stocks.

3.5.3 Squid, Skates and Other Species

The other species category was established to monitor and manage groundfish species groups that are not currently economically important in BSAI and GOA groundfish fisheries, but are perceived to be ecologically important and of potential economic importance as well.

Marine species other than fish, including hard and soft deep sea corals, sea pens, sea fans and sea whips, are considered HAPC. They are discussed separately in Section 3.6 of this Programmatic SEIS.

BSAI/GOA Other Species Management

With the exception of squid in the BSAI and skates in the GOA, an aggregate TAC limits the catch of species in the other species category. Although the composition of this category has varied over the course of FMP management, the current configuration has been relatively stable:

- Squid (order Teuthoidea): target species in the BSAI.
- Sculpin (family Cottidae).
- Shark (*Somniosus pacificus, Squalus acanthias, Lamna ditropis*).
- Skate (genera *Bathyraja and Raja*): target species in the GOA.
- Octopi (*Octopus dofleini,Opistholeutis california,* and *Octopus leioderma*).

With the exception of squid and skate species, none of the species in the other species category is currently targeted by the BSAI and GOA groundfish fisheries. As such, they are only caught as bycatch by fisheries targeting groundfish. In the BSAI FMP, squid are managed in a combined squid and other species category, which is composed of squid (considered separately) and sculpin, skate, shark, and octopi (which compose the true other species category). Because data are insufficient to manage each of the other species groups separately, they are considered collectively. Currently, squid are a target species under the BSAI FMP and skate are target species in the GOA, pending the adoption of Amendment 63 (68 FR 67390).

A single estimate of *M* for this diverse assemblage is not feasible. The SSC believes that *M* is conservatively estimated at 0.2 OFL for the other species assemblage and is set using the criteria in Tier 5 (as described in FMP Amendment 44; Appendix C), where $F_{OFL} = M$, and OFL = $M \times$ (total other species survey biomass). Using Tier 5 criteria, ABC is capped at 75 percent of OFL. However, rather than use this method, since 1978 the other species ABC has been calculated as the average annual catch in order to avoid potential five-fold increases in other species catches that could occur if ABC were set at 75 percent of OFL. In 1998 (for the 1999 fishery), NPFMC began a 10-step increase toward full $F = M$ exploitation strategy for the other species complex by implementing the first 10 percent of the difference between that strategy and average catch since 1978. For the 2000 fishery, NPFMC stopped the stepwise increase and kept the ABC at a level approximately 10 percent higher than the stock assessment author's recommendation. BSAI other species TAC has been set equal to the other species ABC by NPFMC. A 2000 ABC for the BSAI other species category set using this process (31,360 mt) represents an exploitation rate of about 5 percent of the best estimate of current biomass (610,400 mt). This estimate was obtained by averaging the three most recent EBS bottom trawl survey estimates of other species biomass (561,600 mt from 1997 to 1999), and adding the most recent Aleutian Islands bottom trawl estimate (48,800 mt from 1997). A TAC for other species in the GOA is set at 5 percent of the sum of target species TACs each year, although a preliminary stock assessment was conducted for GOA other species in 1999 (Gaichas *et al.* 2003).

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the target species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003). The NPFMC has requested a separate OFL and ABC for combined big and longnose skates in the Central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway and improved collection of data is expected under this amendment.

BSAI/GOA Other Species Past/Present Effects Analysis

The geographic scope for the BSAI and GOA other species past/present effects analysis is the same as the BSAI and GOA FMP management areas (Figures 1.2-2 and 1.2-3). The temporal scope for this analysis begins in the 1960s with the availability of bycatch estimates of other species and ends in 2002, the most recent year of which stock assessment information is available on the resource category.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. The following direct and indirect effects were identified as potentially having population level effects on BSAI/GOA other species (including BSAI squid and GOA skate species):

- Mortality due to catch/bycatch (direct effect).

- Reduced recruitment due to habitat/feeding/spawning disruption and spatial/temporal concentration of bycatch (indirect effect).

The following past/present effects determined to be applicable to the squid past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (pre-MSA)
  - State of Alaska groundfish fisheries
  - Directed fisheries

- Past/Present Internal Events
  - Foreign groundfish fisheries (post-MSA)
  - JV groundfish fisheries
  - Domestic groundfish fisheries

- Past/Present Management Actions
  - FMP groundfish fisheries management
  - Data limitations

A past/present effects analysis is conducted for the other species category as a whole and for the individual taxonomic groups where information is available. Any information presented here for the entire group is not repeated in the subsections.

<u>External Mortality: Foreign Groundfish Fisheries (Pre-MSA)</u>

Reported catches of other species increased in the late 1960s and early 1970s with the increase in groundfish harvests. Similarly, other species catch peaked in 1972 at 133,000 mt, the same year that target groundfish harvest peaked.

<u>External Mortality: Directed Fisheries</u>

Directed fisheries have existed for squid, octopi and some species of shark in the past, and some fisheries persist today. See the subsections of these taxonomic groups for further details.

<u>External Mortality: State of Alaska Groundfish Fisheries</u>

See the subsections of specific other species groups for further details.

<u>External Mortality: State of Alaska Crab Fisheries</u>

See the subsections of specific other species groups for further details.

Internal Mortality: JV and Domestic Groundfish Fisheries

Beginning in 2000, a new method was used to estimate species group catch within the other species complex in the BSAI. The new method is similar to the NOAA Fisheries, Regional Office blend catch estimation system; the ratio of observed other species group catch to observed target species catch was multiplied by the blend-estimated target species catch within each area, gear, and target fishery to obtain the total annual catch by species group between 1997-2001 (Gaichas 2002).

Within the other species group, only shark are identified to the species level by fishery observers. Observers are currently instructed to concentrate on higher-priority target and prohibited species for data collection. Furthermore, accuracy of catch estimates depends on the level of coverage in each fishery. Estimates of observer coverage in the BSAI are 70 to 80 percent, whereas the GOA has only approximately 30 percent observer coverage. Coverage can also vary for certain target fisheries and vessel sizes (Gaichas 2002).

Other species catch occurs largely in the flatfish bottom trawl, Pacific cod longline and bottom trawl and pollock fisheries in the BSAI and in the sablefish and Pacific cod fisheries in the BSAI. Other species catch is made up mostly of skate and sculpin (66-96 percent from 1992 to 1997) and can vary from year to year (Gaichas 2002).

Recommendations have been made by the AFSC staff to reduce other species bycatch. For squid, limiting pelagic trawl fishing in areas with high squid abundance has shown successful reduction in bycatch. Steller sea lion closures have reduced squid bycatch in recent years, demonstrating the effectiveness of area closures on squid bycatch. In 1999 and 2000, the pollock fishery was limited in an area of historically concentrated squid bycatch, cutting squid bycatch to less than half than was observed in 1997-1998 (NPFMC 2002e). Shark and skate bycatch can be reduced through the use of specialized gear; excluder devices that are used to avoid halibut bycatch may be effective and improve survival by releasing skates from trawl nets before they are captured (Craig Rose, AFSC, NMFS, and John Gauvin, The Groundfish Forum, personal communication). A similar configuration could be used to release sharks before capture. For sculpin, by determining the general location of certain genuses, management may be able to incorporate area-specific TACs to achieve individual species management (Gaichas 2002). Estimated total catch of other species in the EBS and the Aleutian Islands from 1977-2002, and in the GOA from 1977-2001 is listed in Gaichas (2002) and Gaichas *et al.* (2003).

It is possible under current other species management that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. This potential is a concern because the other species category includes groups with extremely diverse habitats and life history strategies. In addition, data limitations plague different groups within this category. The lack of biomass estimates for cephalopods (squid and octopi) has been a source of difficulty for determining stock status relative to bycatch, and the lack of adequate species identification in catch data hampers the analysis of catch trends for skate and sculpin species. Moreover, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. It is difficult to determine how much protection is afforded by a TAC set with the use of these data-poor criteria.

Stock assessments are conducted for other species, including squid (in the BSAI) and skates (in the GOA), although TACs are established separately for other species and squid in the BSAI (Fritz 1999), and skates in the GOA (pending adoption of Amendment 63). An aggregate TAC limits the catch of species in the other species category.

In 1999, FMP Amendments 63/63 were initiated to remove the shark and skate species groups from other species in both the BSAI and GOA to better protect these vulnerable, long-lived species (NPFMC 1999a). Based on the 1999 stock assessments for other species (discussed below), the Plan Teams recommended that all other species be considered in an expanded FMP amendment to establish TACs at the species group level. While this amendment was being revised, NPFMC recommended to NOAA Fisheries that other species be placed on bycatch only status to prevent a directed fishery from developing in the interim. NOAA Fisheries determined that it did not have regulatory authority for such an action; therefore, aggregate other species TACs remain in place in the BSAI and the GOA despite efforts to limit directed fisheries and develop more protective management within this category. Final action on the revised plan amendments to set other species as bycatch only and to redefine the GOA TAC setting process will be scheduled in the future.

Beginning in 1999, smelt was removed from the other species category and placed—along with a wide variety of other fish and crustaceans including krill, deep-sea smelt, and lantern fishes—in the forage fish category. This action was accomplished through Amendments 36 and 39 to the BSAI and GOA groundfish FMPs (see Appendix C and D)

Management Tier/Stock for Sculpin, Shark, Skate and Octopi

<u>BSAI/GOA Other Species Comparative Baseline</u>

Reliable biomass estimates exist for two groups (skate and sculpin) that comprise the bulk of the biomass and fishery catches in the other species category. Survey biomass estimates for shark, smelt, and octopi, while not reliable, represent the best data available on the abundance of these species. Fluctuations of biomass have been shown within the other species group. This may be a result of changes in distribution of particular species among regions and during various times of the year (NPFMC 2002c).

Data from NOAA Fisheries surveys in both the BSAI and GOA provide the only abundance estimates for the various groups and species comprising the other species category. Biomass estimates for the EBS are from a standard NOAA Fisheries survey area of the continental shelf. The 1979, 1981, 1982, 1985, 1988, and 1991 data include estimates from continental slope waters (200 to 1,000 m in 1979, 1981, 1982, and 1985; 200 to 800 m in 1988 and 1991), but data from other years do not. Slope estimates were usually 5 percent or less of the shelf estimates, except for grenadiers (see Section 3.5.5). Stations as deep as 900 m were sampled in the 1980, 1983, and 1986 Aleutian Islands bottom trawl surveys, while surveys in 1991 and 1994 obtained samples to a depth of only 500 m. Trends in the biomass of GOA other species were investigated using the NOAA Fisheries triennial trawl survey data from 1984 through 1999. There are inconsistencies associated with some of these studies. Thus, some of the GOA data is not as comprehensive as the data for the BSAI.

Since the BSAI survey biomass estimates for species other than squid vary substantially from year to year due to different distributions of the component species, it is probably more reliable to estimate current biomass by averaging estimates of recent surveys. The average biomass of other species from EBS surveys in 1997, 1998, and 1999 is 561,600 mt; adding the estimate from the 1997 Aleutian Islands survey (48,975 mt) yields a total BSAI other species biomass estimate of 610,575 mt. The average biomass of other species from the last three EBS shelf and slope surveys (2000, 2001, and 2002) is 637,578 mt; adding the estimate from the 2002 Aleutian Islands survey (51,600 mt) results in a current total BSAI other species biomass estimate of 689,178 mt (NPFMC 2002e).

Trends in the biomass of GOA other species (shark, skate, sculpin, smelt, octopi, and squid) were investigated using the NOAA Fisheries triennial trawl survey data from 1984 through 1999. GOA biomass trend discussion should be viewed with the following caveats in mind:

- Survey efficiency may have increased for a variety of reasons between 1984 and 1990, but should be stable after 1990 (Robin Harrison, AFSC, NMFS, personal communication).

- Surveys in 1984, 1987, and 1999 included deeper strata than the 1990-1996 surveys. Therefore, the biomass estimates for deeper-dwelling components of the other species category are not comparable across all years.

The average biomass within the other species category in the GOA, using all six survey biomass estimates (from 1984 to 1990), is 160,000 mt; much less than the average of the more recent BSAI surveys. The most recent estimate of other species biomass (1999) is 213,000 mt. Skate represent 30 to 40 percent of the other species biomass from all surveys and are the most common species in each year except 1984 when sculpin biomass was highest within the category. Total biomass for the other species category increased between 1984 and 1999. This is the result of apparent increases in skate, shark, and smelt biomass, some of which may be difficult to resolve from changes in survey efficiency. Sculpin biomass appears relatively stable over this period. Biomass estimates of other species in the EBS and Aleutian Islands, from various AFSC surveys, are included in Gaichas (2002).

<u>BSAI/GOA Other Species Cumulative Effects Status</u>

It is possible under current other species management that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. This potential is a concern because the other species category includes groups with extremely diverse habitats and life history strategies. In addition, data limitations plague different groups within this category. The lack of biomass estimates for cephalopods (squid and octopi) has been a source of difficulty for determining stock status relative to bycatch, and the lack of adequate species identification in catch data impedes the analysis of catch trends for skate and sculpin species. It is difficult to determine how much protection is afforded by a TAC set with the use of these data-poor criteria.

<u>Trophic Interactions of Other Species</u>

Many species in the squid and other species category are important prey for marine mammals and birds, as well as commercial groundfish species. Squid and octopi are consumed primarily by marine mammals such as Steller sea lions (Lowry *et al.* 1982), northern fur seals (Perez and Bigg 1986), harbor seals (Lowry *et al.* 1982, Pitcher 1980b), sperm whales (Kawakami 1980), Dall's porpoise (Crawford 1981), Pacific white-sided dolphins (Morris *et al.* 1983), and beaked whales (Loughlin and Perez 1985). Sculpin have also been found in the diet of harbor seals (Lowry *et al.* 1982). Squid are important prey for albatross, especially during nesting season.

3.5.3.1 Squid

Life History and Distribution

Squid (order Teuthoidea) are cephalopod mollusks that are related to octopi. Squid are considered highly specialized and organized mollusks, with only a vestigial mollusc shell remaining as an internal plate called the pen, or gladius. They are streamlined animals with 10 appendages (2 tentacles and 8 arms) extending from the head, and lateral fins extending from the rear of the mantle. Squid are active predators that swim by jet propulsion, reaching swimming speeds of up to 40 km/hour, the fastest of any aquatic invertebrate. Members of this order (*Archeteuthis* species) also hold the record for largest size of any invertebrate (Barnes 1987).

Little is known about the reproductive biology of squid. Fertilization is internal and juveniles have no larval stage. Eggs of inshore species are often enveloped in a gelatinous matrix attached to substrate, while the eggs of offshore species are extruded as drifting masses. Squid are characterized by their rapid growth, patch distribution and high variable recruitment; being described as the "marine equivalent of weeds" (O'Dor 1998). Squid travel in schools of similarly sized individuals. Lipinski (1998) conjectured that these schools may migrate, forage and spawn at different times of the year. The importance of squid to the North Pacific ecosystem and our limited knowledge of their life history, distribution and abundance makes squid a good case study to illustrate management of an important resource with little information.

The most commercially important (and therefore best studied) squid in the western North Pacific is the magistrate armhook squid, *(Berryteuthis magister)* (Figure 35-25). It is abundant over continental slopes throughout the North Pacific Ocean from Oregon to southern Japan (Nesis 1987). It is the basis of fisheries in both Russian and Japanese waters. The maximum size reported for *B. magister* is 28-cm mantle length. The internal vestigial shell, or gladius, and statoliths (similar to otoliths in fish) were compared for aging this species (Arkhipkin *et al.* 1996). *B. magister* from the western Bering Sea are described as slow growing (for squid) and relatively long lived (up to 2 years). Males grow more slowly to earlier maturation than females. *B. magister* were dispersed during summer months in the western Bering Sea, but formed large, dense schools over the continental slope between September and October. Stock structure in this species is complex, with three seasonal cohorts identified in the region: summer-hatched, fall-hatched, and winter-hatched. Growth, maturation, and mortality rates varied between seasonal cohorts, with each cohort using the same areas for different portions of the life cycle. For example, the summer spawned cohort used the continental slope as a spawning ground only during the summer, while the fall spawned cohort used the same area at the same time primarily as a feeding ground, and only secondarily as a spawning ground (Arkhipkin *et al.* 1996). There are many fisheries directed at squid species worldwide, although most focus on temperate squid in the genus *Ilex* and *Loligo* (Agnew *et al.* 1998, Lipinski 1998).

Trophic Interactions

Squid are important components in the diets of many seabirds, fish, and marine mammals, as well as being voracious predators of zooplankton and larval fish (Caddy 1983, Sinclair *et al.* 1999). Squid are consumed primarily by marine mammals such as Steller sea lions (Lowry *et al.* 1982), northern fur seals (Perez and Bigg 1986), harbor seals (Lowry *et al.* 1982, Pitcher 1980b), sperm whales (Kawakami 1980), Dall's porpoise (Crawford 1981), Pacific white-sided dolphins (Morris *et al.* 1983), and beaked whales (Loughlin and Perez 1985). Perez (1990) estimated that squid comprise over 80 percent of the diet of some whales. Seabirds and some salmon species are also known to feed heavily on squid at certain times of the year.

BSAI/GOA Squid Management

In the BSAI, squid are managed within their own category under a species complex TAC, which is set each year based on Tier 6 criteria at 75 percent of the average catch of squid over the period 1978 to 1995. This criteria has been used for establishing ABC for squid in 2003 as well (BSAI SAFE 2002) Squid bycatch is taken almost entirely (97 percent) in the pelagic pollock fishery (NMFS 2001a) . The estimated total catch of squid in the BSAI for 2001 reached 1,801 mt, being the highest in the past five years (Gaichas, BSAI SAFE 2002).

In the GOA, squid are managed as part of the other species category. The 14,270 mt TAC for this complex is set at 5 percent of all target species TACs for the GOA. When combined with the predicted catch of all animals in this category (about 5,400 mt) this catch would not exceed the other species TAC for the GOA. As in the BSAI, squid bycatch in the GOA is taken primarily in pollock fisheries (74 percent), although small amounts are from bottom trawl fisheries such as those targeting the deepwater flatfish complex (10 percent).

The catch of individual squid species cannot be estimated because they are not identified to species in the catch at present. In contrast with the skate and grenadier, reasonable assumptions about the catch composition within the squid complex cannot be developed and analyzed because of the lack of biomass estimates by species.

BSAI/GOA Squid Past/Present Effects Analysis

The geographic scope for the BSAI and GOA squid past/present effects analysis is the same as the BSAI and GOA FMP management areas (Figures 1.2-2 and 1.2-3). The temporal scope for this analysis begins in 1977 when the Japanese squid fishery begins and ends in 2002, the most recent year of which information is available on the resource category.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this Programmatic SEIS. Table 3.5-47 provides a summary of the BSAI and GOA squid past effects analysis presented below. The following direct and indirect effects were identified as potentially having population level effects on BSAI/GOA squid:

- Mortality due to catch/bycatch (direct effect).
- Reduced recruitment due to habitat/feeding/spawning disruption and spatial/temporal concentration of bycatch (indirect effect).

The following past/present effects determined to be applicable to the squid past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (pre-MSA)

- State of Alaska groundfish fisheries
  - State of Alaska shrimp fisheries
  - Directed squid fisheries

- Past/Present Internal Events
  - Foreign groundfish fisheries (post-MSA)
  - JV groundfish fisheries
  - Domestic groundfish fisheries

- Past/Present Management Actions
  - FMP groundfish fisheries management
  - Data limitations

External Mortality: Foreign Groundfish Fisheries

Due to poor identification and incomplete reporting, bycatch rates for squid are unknown for the foreign fisheries prior to 1977, however they are assumed to have increased from the 1960s and 1970s and then decreased following the peak other species catch in 1972, similar to the other species complex trends discussed above.

External Mortality: Directed Fisheries

The Japanese and the Republic of Korea conducted a directed fishery on squid from 1975-1987 in the EBS and the Aleutian Islands. Catches were limited by the 1973 U.S. and Japan bilateral agreement and were further limited by the passing of the MSA.

External Mortality: State of Alaska Groundfish Fisheries and Shrimp Fisheries

Currently, catch data for squid is incomplete for State of Alaska groundfish fisheries and shrimp fisheries for the BSAI and GOA regions. Due to this lack of data, reliable estimates cannot be drawn at this time.

Internal Mortality: Foreign, JV and Domestic Groundfish Fisheries (post-MSA)

Foreign fishery catch of squid peaked in the EBS in 1978 at 6,886 mt and steadily dropped until the foreign fisheries were phased out by the domestic fisheries in 1987. In the Aleutian Islands, foreign catch peaked in 1980 at 2,332 mt. Presumably, these catch statistics reflect both directed catch by Japan and the Republic of Korea, and incidental catch in the foreign target fisheries (Gaichas 2002).

JV target fisheries began reporting squid bycatch in 1981 in the EBS and in 1983 in the Aleutian Islands region. Reported bycatch of squid remained low throughout the duration of these fisheries, at less than 200 mt annually. The domestic fisheries entered in the EBS and Aleutian Islands in 1987, with squid bycatch ranging from 1 to 1,500 mt annually, combined for both regions. Bycatch peaked in 1997, declined, and peaked again in 2001 at 1,766 mt.

Squid represent a low proportion of non-target groundfish bycatch relative to other species. Squid are primarily caught in pelagic trawl fisheries along the outer continental shelf and slope, especially around submarine canyons or in deep waters of the Aleutian Basin. Squid do not survive capture. Squid bycatch is higher in EBS than GOA. In the EBS pollock trawl domestic fishery (1990-2001) the squid bycatch ranged from 364 to 1,761 mt. In the Aleutian Islands pollock trawl domestic fishery (1990-2001) the squid bycatch ranged from 5 to 95 mt/year (Gaichas 2002). In the GOA, squid are caught as bycatch mostly in the pollock fisheries, and in small amounts from bottom trawl fisheries such as rockfish and the deepwater flatfish complex. Estimated catch between 1997-2000 ranged from 14 to 98 mt (NPFMC 2002c).

In 1980, GOA FMP Amendment 8 created four species management categories (target, other species, unallocated, and non-specified) and three regulatory districts for sablefish in southeast Alaska. Its purpose was to make the GOA FMP conform to the newly adopted BSAI FMP, enhance target species management, and protect incidentally caught species. Information on squid, rockfish, and several other species was found insufficient to warrant OYs for the three main regulatory areas in the GOA; therefore, their management was changed to a Gulf-wide management strategy.

Reported catches of squid in the EBS and Aleutian Islands since 1977 show that after reaching 9,000 mt in 1978, total squid catches have steadily declined to only a few hundred tons in 1987-1995. Thus, squid stocks have been comparatively lightly exploited in recent years. Discard rates of squid (discards/total squid catch) by the BSAI groundfish fisheries have ranged between 40 and 85 percent in 1992-1998 (NOAA Fisheries Regional Office, Juneau, personal communication). The 2001 estimated catch of squid, 1,810 mt, is the highest in the past five years and much closer to the ABC of 1,970 mt than any estimated catch since the 1980s. The recommended ABC for squid in 2003 is calculated as 0.75 times the average catch from 1978-1995, or 1,970 mt; the recommended overfishing level for squid in the year 2002 is calculated as the average catch from 1978-1995, or 2,624 mt. The rationale for a Tier 6-based ABC recommendation is that there is no reliable biomass estimate for squid (Gaichas 2002).

External Reduced Recruitment: Foreign Groundfish fisheries (pre-MSA)

Data is not available to determine whether the foreign fisheries disrupted spawning, feeding, and/or habitat of squid and squid aggregations. However, it is assumed that the foreign fisheries may have had similar impacts on squid recruitment as the current domestic fisheries.

External Reduced Recruitment: Directed Fisheries

Data is not available to determine whether the directed fisheries disrupt spawning, feeding, and/or habitat of squid and squid aggregations. However, it is assumed that they may have similar impacts on squid recruitment as the domestic fisheries.

External Reduced Recruitment: State of Alaska Groundfish fisheries

Data is not available to determine whether the State of Alaska groundfish fisheries disrupt spawning, feeding, and/or habitat of squid and squid aggregations. However, it is assumed that they may have similar impacts on squid recruitment as the domestic fisheries. Timing and location of fishery interactions with squid spawning aggregations may affect both the squid population and availability of squid as prey for other animals (Caddy 1983, O'Dor 1998).

Internal Reduced Recruitment: Foreign, JV and domestic fisheries (post-MSA)

Timing and location of fishery interactions with squid spawning aggregations may affect both the squid population and availability of squid as prey for other animals (Caddy 1983, O'Dor 1998). Whereas the proportion of overall squid complex biomass that is caught in groundfish fisheries cannot be determined, there are some hints as to the potential indirect impacts of bycatch on squid stocks. The concentration of squid bycatch in certain areas over the continental shelf edge (Figure 3.5-26) may indicate that these regions are important to squid stocks for spawning, feeding, or both. In western Bering Sea stocks of *Berryteuthis magister*, these localized aggregations appear to be composed of a single seasonal cohort of related squid. Groundfish bycatch may not represent a significant impact on the basinwide population of squid, but may damage stock structure even with relatively small amounts of bycatch if all bycatch is from a single seasonal cohort in one area. Groundfish fisheries may also disturb squid aggregations or disrupt important habitat, in addition to the direct effect of catch. More information on squid biology in the EBS and GOA is needed to determine whether any of these indirect impacts on the squid complex would occur and whether they represent significantly adverse impacts.

BSAI/GOA Squid Comparative Baseline

Squid are found throughout the Pacific Ocean. Squid species are not well sampled by bottom trawl surveys, and historically, acoustic surveys have not been directed at squid in the FMP areas. At least 7 squid species have been identified in the FMP areas by AFSC surveys, whereas 18 species were identified in the mesopelagic regions off the slope of the EBS (Sinclair *et al.* 1999).

Assessment data are not available for squid from NOAA Fisheries surveys because of their mainly pelagic distribution over deep water. Information on the distribution, abundance, and biology of squid stocks in the EBS and Aleutian Islands is generally lacking. Red armhook squid (*Berryteuthis magister*) predominates in commercial bycatch in the EBS and GOA, and *Onychoteuthis borealijaponicus* is the principal species encountered in the Aleutian Islands.

As a group, squid represent a relatively low proportion of non-target species catch (about 2 percent), however they serve a crucial role in marine ecosystems. No reliable biomass estimates or stock assessments for squid exist. Sobolevsky (1996) cites an estimate of 4 million tons for the entire Bering Sea made by squid biologists at the Pacific Research Institute of Fisheries and Oceanography (Shuntov 1993), and an estimated 2.3 million tons for the western and central Bering Sea (Radchenko 1992), but admits that squid stock abundance estimates have received little attention. NOAA Fisheries bottom trawl surveys almost certainly underestimate squid abundance. Squid catches and ABCs are a very small percentage of the total squid biomass in the EBS and GOA.

In theory, a squid survey could be conducted with midwater trawls and or hydroacoustics. There is such a survey for pollock, but the existing survey would need to extend out across shelf break, at least, which would greatly expand the scope of the current survey. As far as seasonality, squid appear in the catch data during all pollock seasons in the areas around the shelf break. The highest observed fishery CPUE of squid might indicate when a survey would be most efficiently conducted. According to fishery information from 1997 to 1999, a peak in squid CPUE occurs in January; however, it is also all in one location (Pribilof Canyon), making it difficult to tell if the high CPUEs are seasonally or spatially related. The life history information reported for western Bering Sea *Berryteuthis magister* suggests that any survey for squid would have to occur over multiple seasons to fully assess the biomass available in a given year and would require significant information on the life cycles and migratory routes of local squid to maximize efficiency.

Lacking this information, a survey to provide the biomass estimates would have to cover so much territory and so many seasons as to be prohibitively expensive, especially considering that there is no target fishery for squids in the FMP areas at this time. A more realistic approach might be to initiate smaller scale surveys, perhaps coordinated with the existing pollock surveys, to conduct squid species identification and life history investigations in the area to determine how a larger scale survey might be conducted in the future.

BSAI/GOA Squid Cumulative Effects Status

Assessment data is limited for squid from NOAA Fisheries surveys and no reliable biomass estimates or stock assessments for squid exist. However, they will be brought forward as part of the other species complex for cumulative effects analysis due to their ecological importance and essential role as prey species.

3.5.3.2 Sculpin

Life History and Distribution

Despite their abundance and diversity, sculpin life histories are not well known in Alaska.Forty-one sculpin species have been identified in the EBS and 22 species in the Aleutian Islands (Bakkala 1993, Bakkala *et al.* 1985, Ronholt *et al.* 1985). Sculpin are small, bottom-dwelling fish that lay adhesive eggs in nests and exhibit parental care for eggs (Eschemeyer *et al.* 1983). Life history information varies for each species in this group; the great sculpin is the largest sculpin species reaching 70 cm in length and 8 kg in weight in the western North Pacific. These species appear to be relatively short-lived with late maturity; the great sculpin does not reach maturity until 5-8 years (Tokranov 1985) and lives only 13 to 15 years.

Trophic Interactions

Little is known of the trophic interactions of sculpin. Sculpin are important benthic predators and serve as prey for many groundfish species such as halibut (*Hippoglossus stenolepis*), salmon (*Onchorynchus gorbuscha*), and hakes/burbots (*Brosme brosme*) (Gaichas 2002). Currently, data relating to the trophic interactions of sculpin in the BSAI is unavailable.

In the GOA, the main prey items for sculpin are shrimp and small flatfish. They also feed on crab, eelpouts, other sculpin, and smelt. Sculpin are prey for numerous species of marine life including: Steller sea lions, halibut, cod, other sculpin, toothed whales, seals, skate, sablefish, arrowtooth flounder, thornyhead rockfish, pollock, and small flatfish (Aydin *et al.* 2002, Gaichas 2003).

BSAI/GOA Sculpin Management

See above in the BSAI/GOA Other Species Management section.

BSAI/GOA Sculpin Past/Present Effects Analysis

The geographic scope for the BSAI and GOA sculpin past/present effects analysis is the same as the BSAI and GOA FMP management areas (Figures 1.2-2 and 1.2-3). The temporal scope for this analysis begins in the 1960s with the availability of bycatch estimates of other species and ends in 2002, the most recent year of which information is available on the resource category.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this document. Table 3.5-48 provides a summary of the BSAI and GOA sculpin past effects analysis presented below. The following direct effect was identified as potentially having population level effects on BSAI/GOA sculpin:

- Mortality due to bycatch (direct effect).

The following past/present effects determined to be applicable to the sculpin past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (pre-MSA)
  - State of Alaska groundfish fisheries

- Past/Present Internal Events
  - Foreign groundfish fisheries (post-MSA)
  - JV groundfish fisheries
  - Domestic groundfish fisheries

- Past/Present Management Actions
  - FMP groundfish fisheries management
  - Data limitations

External Mortality: Foreign Groundfish Fisheries (pre-MSA)

Bycatch data from the foreign fisheries in the BSAI and GOA is non-existent for sculpin. It is assumed that the sculpin foreign bycatch is comparable to the current level of bycatch; bycatch tends to increase with increase in target groundfish catch.

External Mortality: State of Alaska Groundfish Fisheries

It is inferred that proportionally similar sculpin bycatch could occur in the state groundfish fisheries as compared to the current federal groundfish fisheries. Since sculpin are taken incidentally from the Pacific cod and pollock federal fisheries, it is assumed that sculpin would also be taken in the State of Alaska Pacific cod and pollock fisheries. Although amount of sculpin bycatch may be similar between state and federal groundfish fisheries, the species mix of sculpin within this bycatch may differ between nearshore state fisheries and federal fisheries.

Internal Mortality: Foreign, JV and domestic fisheries (post-MSA)

Past JV fisheries bycatch of sculpin for the BSAI and GOA is non-existent. It is assumed that the bycatch is comparable to domestic bycatch levels; bycatch tends to increase with increase in target groundfish catch.

Skate and sculpin make up the bulk of the other species bycatch (66-96 percent from 1992-1997). This trend continued from 1997-2001 as well. Sculpin are caught largely in the Pacific cod hook and line fishery and trawl fisheries for pollock, yellowfin sole, Atka mackerel and rock sole occurring over the shelf break and slope or in deep waters of the Aleutian Basin (Gaichas 2001).

Internal Reduced Recruitment: JV and Domestic Fisheries

Habitat suitability/Spawning disruption

The sculpin nest-laying reproductive strategy may make sculpin populations more sensitive to changes in benthic habitats than other groundfish species such as cod and pollock, which are broadcast spawners with pelagic eggs. Moreover, the limited information on sculpin species suggest that species may react differently to similar environmental conditions. Within each sculpin species, the spatial effects of fishing may still be important, because observed differences in fecundity, egg size, and other life history characteristics suggest local populations (Tokranov 1985), which are not generally observed in target groundfish stocks. All of these characteristics indicate that sculpin as a group might be managed differently than other groundfish stocks, perhaps most efficiently within a spatial context rather than with a global annual aggregate TAC. It seems clear that sculpin are significantly different from all other members of the other species category as to justify their own management category, despite the potential complexity of effective management of a single group as diverse as the sculpin (Gaichas 2001).

BSAI/GOA Sculpin Comparative Baseline

Sculpin in the BSAI were the major component of other species group until 1986 according to the EBS AFSC surveys, after which skate biomass exceeded that of sculpin. In the EBS, sculpin abundance remained stable through 1998, but has since declined, with a slight increase in the 2002 survey at 181,200 mt (slope and shelf surveys). The Aleutian Islands survey show a decline since 1980, averaging around 13,000-14,000 mt in recent years (Gaichas 2002). Estimated total catch of sculpin in the BSAI from 1997-2000 ranged from 5,470 to 7,670 mt (Gaichas 2002). In the GOA, estimated total catch for the same years ranged from 541 to 943 mt (NORPAC and year-end estimates of target species catch from the NMFS Regional Office blend database).

In the GOA, individual sculpin species display divergent biomass trends between 1984 and 1999. While the biomass of bigmouth sculpin (*Hemitripterus bolini*) decreased over the survey period, great sculpin (*Myoxocephalus polyacanthocephalus*) biomass remained relatively stable, and yellow Irish lord (*Hemiliepidotus jordani*) biomass increased. Yellow Irish lord biomass appears to have increased over time despite general stability in the number of hauls where the species occurred, whereas bigmouth sculpin were encountered in fewer hauls each year. Uncertainty in these estimates varies between years.

BSAI/GOA Sculpin Cumulative Effects Status

Assessment data is limited for sculpin and no reliable biomass estimates or stock assessments for sculpin exist. Thus, they will be brought forward for cumulative effects analysis due to their ecological importance and essential role as prey species.

3.5.3.3 Shark

Life History and Distribution

The three shark species most commonly encountered in the North Pacific are the sleeper shark, *Somniosus pacificus*, the piked or spiny dogfish, *Squalus acanthias*, and the salmon shark, *Lamna ditropis* (Gaichas 2002). Generally, shark are more K-selected species; long-lived, long gestation periods (6 months to 2 years) and few, well-developed offspring (Pratt and Casey 1990).

The Pacific sleeper shark are not well known, but are found often in the shelf and slope waters of the North Pacific. Dense aggregations of sleeper shark were found during the 2000 Bering Sea slope survey, although none have yet been found on the EBS shelf survey. The reproductive mode of the sleeper shark is unknown.

The spiny dogfish can be found from the Bering Sea to the Baja Peninsula in shelf and upper slope waters, and are most common off the U.S. west coast and British Columbia (Hart 1973). Separate stocks of spiny dogfish have been found off the coast of British Columbia and Washington that do not mix (Compagno 1984). Dogfish form feeding aggregations segregated by size, sex and maturity; males are often found in shallower water than females. Females bear small litters of 1-20 pups following a gestation period of 18-24 months, females travel to shallow bays to bear their young. Average age recorded range from 25-30 years, with a maximum up to 100 years; and maximum size of 1.6 m in the eastern North Pacific (Compagno 1984).

Salmon shark are found from Japan, throughout the BSAI and GOA and down to Baja California, most commonly in coastal littoral and epipelagic waters both inshore and offshore. Salmon shark are oviporous bearing an average of 5 pups in the western North Pacific. Uterine cannibalism has been found (Gilmore 1993). Average size ranges from 2 to 2.5 m, with a maximum size of 3.0 m. Salmon shark live to an average age of 25 years in the western North Pacific; females generally reach maturity from 8-10 years and males at 5 years (Tanaka 1980). Little is known about the eastern North Pacific salmon shark population, although research is being conducted to determine the demographics and population parameters (K. Goldman, VIMS, personal communication as referenced by Gaichas 2002).

Trophic Interactions

In recent years, numbers of shark in Alaskan waters seem to be increasing while a decline in pinnipeds (specifically Steller sea lions) has occurred. Although it may be possible that shark predation could introduce a source of mortality to pinnipeds in certain areas of Alaska, much more research is needed to address uncertainty in data collected thus far. Little is known of the trophic interactions of shark in the BSAI. Thus, only GOA will be discussed here.

In the GOA, sleeper shark prey primarily on arrowtooth flounder. Additionally, they may eat salmon, cephalopods, small flatfish, and fishery offal. Salmon shark prey mostly on salmon and cephalopods as well as sablefish, herring, smelt, few rockfish, and flatfish. Dogfish eat large zooplankton, herring, shrimp, small flatfish, cephalopods, smelt, sandlance, and other demersal fish. Shark in the GOA have no known predators. However, salmon shark will prey upon spiny dogfish (Gaichas 2002).

BSAI/GOA Shark Management

See above in the BSAI/GOA Other Species Management.

BSAI/GOA Past/Present Effects Analysis

The geographic scope for the BSAI and GOA shark past/present effects analysis is the same as the BSAI and GOA FMP management areas (Figures 1.2-2 and 1.2-3). The temporal scope for this analysis begins in the 1960s with the availability of bycatch estimates of other species intensity and ends in 2002, the most recent year of which information is available on the resource category.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this Programmatic SEIS. Table 3.5-49 provides a summary of the BSAI and GOA shark past effects analysis presented below. The following direct and indirect effects were identified as potentially having population level effects on BSAI/GOA shark:

- Mortality due to catch/bycatch (direct effect).

- Increased recruitment due to increased habitat suitability (indirect effect).

The following past/present effects determined to be applicable to the shark past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (pre-MSA)
  - State of Alaska groundfish fisheries
  - IPHC halibut longline fisheries
  - Sport fisheries
  - Climate changes and regime shifts

- Past/Present Internal Events
  - Foreign groundfish fisheries (post-MSA)
  - JV groundfish fisheries
  - Domestic groundfish fisheries

- Past/Present Management Actions
  - FMP groundfish fisheries management
  - Data limitations

External Mortality: Sport Fisheries

There are currently no directed commercial fisheries for shark in Alaska State or federal waters. The state prohibited directed commercial fishing for shark in 1998 and set limits for the modest sport fishery that currently exists (2 shark per person per year, 1 on any given day). This made Alaska the first state ever to implement precautionary management before allowing a commercial fishery or large sport fishery to develop (Camhi 1999).

External Mortality: IPHC Halibut Longline Fisheries

Currently, the IPHC does not report shark bycatch specific to fishery. Total catch of shark (dogfish and sleeper) is recorded during IPHC setline surveys in Alaska, but does not reflect accurate bycatch estimates for halibut fisheries in general. Most likely, shark bycatch is lower in the fisheries compared to catch rates that IPHC surveys report because commercial vessels often fish in areas lacking high populations of shark.

External Mortality: State of Alaska Groundfish Fisheries

It is assumed that proportionally similar shark bycatch could occur in the state groundfish fisheries as compared to the current federal groundfish fisheries. Although the amount of shark bycatch may be similar between state and federal groundfish fisheries, the species mix of shark within this bycatch most likely differs between nearshore state fisheries and federal fisheries. Catch of Pacific sleeper shark in the sablefish longline surveys from 1997-2000 in the BSAI and GOA ranged from 9 to 11 sharks (NPFMC 2002c).

Internal Mortality: Foreign, JV and Domestic Groundfish Fisheries (Post-MSA)

Shark bycatch varies for species by region. All shark bycatch tends to be higher in the GOA region, whereas sleeper shark bycatch has been similar between regions. Table 3.5-50 shows estimated total catch of sharks in the BSAI and GOA from 1997-2001. In 2001, sleeper shark bycatch for BSAI showed a large reduction compared to years past of 17.3 mt, while dogfish bycatch seemed to significantly increase at 697 mt (NPFMC 2002c). A possible explanation for these shifts is that observer identification for these two species has improved. Regional shifts in shark abundance could also be occurring.

The majority of bycatch for unidentified shark in 2000 and 2001 was taken by sablefish and Pacific cod longline fisheries (79 percent) while salmon shark bycatch was predominantly taken by pollock pelagic trawl fisheries (90 percent in 2001 and 84 percent in 2000). Total amount of dogfish bycatch increased in 2001 for the BSAI with Pacific cod and flathead sole longline fisheries and pollock pelagic trawl fisheries being primary takers (90 percent). In contrast to dogfish, sleeper shark bycatch decreased in 2001. According to 2000 survey data, sablefish, turbot, and Pacific cod longline fisheries in addition to pollock pelagic trawl fisheries accounted for the majority of the total bycatch in BSAI (90 percent) (NPFMC 2002c).

In the GOA region during 1999 surveys, Pacific cod longline fisheries accounted for the majority of sleeper shark, spiny dogfish, and unidentified shark bycatch. Pelagic trawl pollock fisheries took the largest portion of salmon shark bycatch in 1999 for the GOA. Salmon sharks have been both considered a nuisance for both eating salmon and damaging fishing gear (Macy *et al.* 1978, Compagno 1984).

Due to sharks slow growth to maturity and low productivity of the stocks (Compagno 1990, Hoenig and Gruber 1990), many large-scale directed fisheries for sharks have collapsed, even where management was attempted (Anderson 1990). An EA/RIR for BSAI/GOA FMP Amendments 63/63 has been developed by NPFMC outlining a shark and skate management program in Alaskan federal waters. This amendment would remove shark and skate from the other species complex in an effort to better protect this long-lived species. Salmon shark have been considered as a potential target species in the GOA (Paust and Smith 1989).

Increased Recruitment: Climate Changes and Regime Shifts

It has been speculated that warmer waters in the PWS have lead to an increase in abundance of certain shark species. However, there is limited evidence to support the theory and the effects of climate change and regime shifts on shark remain unknown.

BSAI Shark Comparative Baseline

Until a pilot survey was conducted in 2000 of the EBS, it was thought that bottom trawl surveys did not accurately sample shark. However, sleeper shark were the third highest CPUE on the survey. Thus, showing the ability for this shark to be successfully surveyed by bottom trawls (NPFMC 2002c). During the 2002 EBS slope survey, sleeper shark biomass was estimated and shown to be substantial (NPFMC 2002c). This new information suggests that location and timing of EBS trawl surveys on the shelf during summer months may play a significant role in estimating biomass of shark (NPFMC 2002c). Shark are rarely taken during demersal trawl surveys in the Bering Sea; however, spiny dogfish *(Squalus acanthias*) is a species usually caught, and the Pacific sleeper shark (*Somniosus pacificus*) has been taken on occasion.

Much of the catch and landing data for shark in Alaska is not useful for assessing relative abundance because species are lumped into a single category of “shark”. However, in recent years the NOAA Fisheries groundfish Observer Program, the IPHC, and the ADF&G have documented shark catch by species making preliminary estimates of relative abundance possible. The NOAA Fisheries Observer database contains estimated weights (in mt) for species, while the IPHC and ADF&G databases contain data on shark bycatch from fishery independent halibut and sablefish surveys respectively (Goldman 2001).

IPHC setline surveys in Alaska have reported total catch for dogfish and sleeper shark from 1997-2002 within specific IPHC areas including: southeast Alaska, central GOA, western GOA, eastern Aleutians, and western Aleutians. Although these surveys used varying numbers of skates (one skate containing one hundred hooks) within different IPHC areas from year to year, it is possible to obtain a rough estimate of average stock density for these two shark species in the areas mentioned above over time. Figures 3.5-27 and 3.5-28 show average stock densities of dogfish and sleeper shark estimated by IPHC Setline Surveys throughout five IPHC areas from 1997-2002, respectively (Dykstra *et al.* 2003).

GOA Shark Comparative Baseline

In the GOA, individual species biomass trends were evaluated for the more common and easily identified shark and sculpin species encountered by the triennial trawl surveys. In general, the increasing biomass trend for the shark species is a result of increases in spiny dogfish and sleeper shark biomass between 1990 and 1999. Salmon shark biomass has been stable to decreasing, according to this survey, but salmon shark is unlikely to be well sampled by a bottom trawl (as evidenced by the high uncertainty in the biomass estimates).

It should be noted that both salmon shark and Pacific sleeper shark biomass estimates may be based on a very small number of individual tows in a given survey. No salmon sharks were encountered in the 1999 survey, despite reports of their increased abundance in other areas of the GOA (Gaichas 2001).

BSAI/GOA Shark Cumulative Effects Status

Assessment data is limited for shark and no reliable biomass estimates or stock assessments for shark exist despite recent improvements in their identification. This species group will be brought forward for cumulative effects analysis due to their ecological importance.

3.5.3.4 Skate

Life History and Distribution

NOAA Fisheries surveys have recorded 15 skate species, but inadequate taxonomic keys for this family may have resulted in more species being identified than actually exist (Figures 3.5-29, 3.5-30, and 3.5-31). Species that have been consistently identified during surveys are the Alaska skate (*Bathyraja parmifera*), big skate (*Raja binoculata*), longnose skate (*rhina*), and Aleutian skate (*B.aleutica*). Biomass estimates of sculpin and skate from demersal trawl surveys serve as valuable indices of their relative abundance (Gaichas 2001). A summary of the identified species is shown in Table 3.5-51.

Although little specific life history information exists for most skate species, they are generally thought to have limited reproductive capacity relative to gadids, pleuronectids, and other exploited groundfish and may be vulnerable to overfishing (Sosebee 1998). Skate are oviparous with one to seven embryos per egg in local species (Eschmeyer *et al.* 1983). Skate are similar to shark in that they are long-lived species, have low fecundity and low productivity. Size varies per species; the big skate, *Raja binoculata*, is the largest skate in the GOA. The California big skate reaches a maximum size of 2.4 m, with 1.8 m and 90 kg common (Martin and Zorzi 1993). The longnose skate, *Raja rhina*, is smaller, reaching maximum length of about 1.4 m in California. Maximum age reported for the longnose skate was 13 years, however there are difficulties associated with ageing skates (Zeiner and Wolf 1993).

The most important life history parameter for our purposes is *M*. Natural mortality provides an approximation of the amount of fishing mortality a stock can withstand, so that fractions of *M* are often used to set upper limits on *F* (Clark 1991). The natural mortality rate can be estimated from information on the maximum age attained by a species (in the absence of fishing mortality). We used a relationship developed from data on many marine species including fish, molluscs and marine mammals to estimate *M* for skate using all the information available to us. Admittedly, little is known about the lifespan of many shark and skate species, but some ichthyologists speculate that in larger chondrichhyan fish “maximum ages of 70-100 years or more are likely”. We chose to estimate *M* conservatively at 0.10, a low but reasonable number for larger skate (reflecting a potential maximum age of 40 years), in an attempt to account for the longer-lived species within the complex. We must assume the same natural mortality rate for all skate species in our area until better information is available. (NPFMC 2000c). Life history information available for skate in the BSAI and GOA is presented in Table 3.5-52.

Trophic Interactions

Limited information is available regarding the trophic interactions of skate in the BSAI. Thus, only GOA will be discussed here.

In the GOA, skate prey mainly on pollock, shrimp, crab, and other benthic epifauna. To a lesser degree, small flatfish, sculpin, eelpouts, smelt, and benthic detritus serve as prey for skate as well. Predators of skate include: toothed whales, Steller sea lions, seals, halibut, and Pacific cod.

BSAI/GOA Skate Management

In the BSAI, skate species are managed within the other species category with a TAC specified for the entire complex (see above).GOA Amendment 63 is scheduled for secretarial approval (NPFMC) on March 3, 2004 and will result in skate species being moved from the other species category to the target species category in the GOA. Upon adoption of this amendment, OFL, ABC, and TAC limits with be established. In addition, the NPFMC has suggested that a separate OFL and ABC for combined big and longnose skates be implemented for the central GOA region (NPFMC 2003) . It is presumed that data collection and research will improve for GOA skate species after this amendment has been implemented.

BSAI/GOA Skate Past/Present Effects Analysis

The geographic scope for the BSAI and GOA skate past/present effects analysis is the same as the BSAI and GOA FMP management areas (Figures 1.2-2 and 1.2-3). The temporal scope for this analysis begins in the 1960s with the availability of bycatch estimates of other species and ends in 2002, the most recent year in which information is available on the resource category.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this Programmatic SEIS. Table 3.5-53 provides a summary of the BSAI and GOA skate past effects analysis presented below. The following direct effect was identified as potentially having population level effects on BSAI/GOA skate:

- Mortality due to bycatch (direct effect).

The following past/present effects determined to be applicable to the skate past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (pre-MSA)
  - State of Alaska groundfish fisheries
  - IPHC halibut longline fisheries
  - State of Alaska sport halibut fishery

- Past/Present Internal Events
  - Foreign groundfish fisheries (post-MSA)
  - JV groundfish fisheries

- Domestic groundfish fisheries

- Past/Present Management Actions
  - FMP groundfish fisheries management
  - Data limitations

<u>External Mortality: Foreign Groundfish Fisheries (Pre-MSA)</u>

Pre-World War II foreign fisheries were relatively small with an expansion of large scale fishing operations in the post-war period, ultimately leading to increases in the catches of groundfish in the BSAI and GOA. By 1985, the JV operations and growing U.S. domestic fleet had entered the scene, and continued the harvest of groundfish species. Federal groundfish fisheries have been prosecuted by an all domestic fleet since 1987 in the GOA and 1991 in the BSAI.

Unfortunately, bycatch data from the foreign fisheries' BSAI and GOA FMP foreign fishery Observer Program is non-existent at the level necessary to distinguish skate from other species. It is inferred that the past foreign fisheries had proportionally similar bycatch rates for skate as the current federal groundfish fisheries.

<u>External Mortality: IPHC Halibut Longline Fisheries</u>

The IPHC halibut fisheries do not keep bycatch records (IPHC, personal communication). Since halibut and skate are caught incidentally in the federal sablefish fisheries, it is inferred that skate would also be taken incidentally in the IPHC halibut fishery.

The IPHC halibut fishery continues to occur, and for reasons stated above are considered to have potential external effects on skate in the present and future. Since none of these fisheries record bycatch, the magnitude of the potential effects on skate populations cannot be determined due to lack of pertinent information.

<u>External Mortality: State of Alaska Groundfish Fisheries and State of Alaska Sport Halibut Fishery</u>

The State of Alaska groundfish fisheries do not keep bycatch records (ADF&G, personal communication). It is inferred that proportionally similar skate bycatch could occur in the state groundfish fisheries as compared to the current federal groundfish fisheries.

State of Alaska groundfish fisheries continue to occur, and for reasons stated above are considered to have potential external effects on skates in the present and future. Since none of these fisheries record bycatch, the magnitude of the potential effects on skate populations cannot be determined due to lack of pertinent information.

<u>Internal Mortality: Foreign, JV and Domestic Groundfish Fisheries</u>

Skate are caught about 71 percent of the time by longline gear, 26 percent of the time by bottom trawls, and 3 percent of the time by pelagic trawls; skate catch in pot gear is negligible. Most of this skate catch is taken in the longline fishery directed at Pacific cod (69 percent). They are generally discarded (and may survive depending upon catch handling practices), although skate caught incidentally are sometimes retained and processed. Markets for skate products are currently limited in the North Pacific, but skate is subject to directed fisheries in other areas of the world (Martin and Zorzi 1993, Agnew *et al.* 1998).

Skate species catch may not be proportional to its biomass, for a number of reasons. In particular, the BSAI skate biomass is measured with a bottom trawl survey which takes place in the summer and covers the entire continental shelf. In contrast, most of the skate bycatch is taken by longline fisheries for Pacific cod, which occur in the spring and fall on the outer portion of the continental shelf. Figure 3.5-29 shows a comparison between the locations of EBS fisheries and survey skate catch. There is no information to determine whether the distribution of skate species changes seasonally or whether different skate species have different catch abilities in different gear types. However, these are both viable possibilities. Both longline and trawl fisheries tend to catch skate in the area where the two most common Bering Sea skate, the Alaska skate *(Bathyraja parmifera)* and the Bering or sandpaper skate *(B. interrupta),* are caught together in the survey. Thus, the relative catch rates of these two species in the survey areas may represent relative catch rates in the fishery, which occur in the area of species overlap (NMFS 2001a).

Using the average catch rate of *B. parmifera* to *B. interrupta* from the 1999 EBS survey, the potential catch of each species was estimated. On average, *B. parmifera* were about 4 times more common than *B. interrupta* in terms of weight in the areas where both species are present. In addition, *B. interrupta* were about 50 times more common than any other species of skate when they were caught together. Based on this survey data, the catch composition of skate species in the EBS was assumed on average to consist of about 80 percent *B. parmifera*, 20 percent *B. interrupta*, and negligible amounts of all other skate species in areas where the groundfish fishery occurs. When the high end of the predicted catch range (14,000 mt) is proportioned using this ratio, the catch of *B. parmifera* would be 11,200 mt, which is 3.6 percent of the 1999 estimated biomass for this species (338,000 mt). Assuming this average observed catch rate, the catch of *B. interrupta* would be approximately 2,800 mt, which is 11.7 percent of the estimated biomass of this species (24,000 mt). When the low end of the predicted catch range (12,000 mt) is proportioned, the exploitation rates are 2.8 percent for *B. parmifera* and 10 percent for *B. interrupta*. Under this generally realistic assumption of disproportional catch of rarer species, the fishing mortality rate for *B. interrupta* could potentially equal or exceed the rate estimated to be the OFL (10 percent) with December 6, 2000 information. More extreme assumptions about disproportional catch would, of course, result in even higher estimated rates of fishing mortality relative to OFL for the rarer skate species (NMFS 2001a).

It is unknown which skate species are caught as bycatch in GOA groundfish fisheries; therefore, the catch of each of the nine skate species found in the area cannot be estimated. In the GOA, average catch rates are difficult to determine because of the more diverse skate complex combined with less information regarding skate catch location due to lower observer coverage. There is less information in the GOA to determine whether fisheries take place in areas of skate species overlap or in single-species areas; therefore, average catch rates cannot be estimated from survey information. Because most skate (99 percent) are referred to as "unidentified" in the catch, skate catch is estimated at the family level (Rajidae). Most of this catch is taken in the longline fishery directed at sablefish (39 percent), followed by the Pacific cod longline fishery (21 percent), the Pacific cod trawl fishery (13 percent), and the shallow water flatfish trawl fishery (7 percent).

In the North Atlantic, declines in barndoor skate abundance were concurrent with an increase in the biomass of skate as a group (Sosebee 1998). NOAA Fisheries surveys identified at least 11 species of skate in the FMP areas. Although it is not determined if any individual skate species have declined in the North Pacific during the timeframe of the FMPs, it is determined that there is adequate evidence that fisheries can affect skate populations and that stable or rising aggregate skate biomass does not necessarily indicate that no impact is occurring at the species level (Gaichas 2002).

Skate are presently managed within the other species category in both the BSAI and GOA FMPs through an aggregate TAC set for all other species combined. Management of the skate species within aggregate complexes and the apparent population stability for skate species in aggregate has masked the decline of individual skate species in European fisheries (Dulvy *et al.* 2000). Estimated total catch of skate in the BSAI from 1997-2001 averaged 18, 119 mt (Gaichas 2002) In the GOA, estimated total catch of skate over the same period averaged 2,932 mt (NORPAC and year–end estimates of target species catch from the NMFS Regional Office blend database). The current management of skate within an aggregate other species category TAC could mask declines in individual skate species and therefore lead to overfishing of a given skate species. Due to this reason and the fact that the majority of skate bycatch is taken in the BSAI groundfish fisheries, the current management is considered to have had a lingering adverse effect on skate species in the BSAI.

BSAI/GOA Skate Comparative Baseline

As opposed to aggregate skate biomass, biomass for each individual skate species is more difficult to assess. The knowledge of the number and identity of skate species in an area is developing concurrently with research. Skate have been described as unique among Chondrichthyes for their relatively high species diversity combined with morphological conservatism; in other words, there are lots of species that look alike (NMFS 2001a). For this reason, species identification has been variable over the course of surveys, ranging from skate unidentified to identification of over 10 different species in each area. In addition, skate taxonomy has changed over the course of surveys, with two new species described in the North Pacific; *Bathyraja hubbsi and Bathyraja pseudoisotrachys* (Ishihara and Ishiyama 1985). Therefore, any apparent trends in species abundance within the skate complex over the period of the surveys are not likely to be reliable. In recent years (1996 to present) training with increased emphasis on consistent skate species identification has improved this situation dramatically so that individual skate species may be assessed in the future. Distribution data is also affected by species identification issues. For these reasons, we evaluate biomass and distribution of individual skate species only for recent years where survey scientists are confident of species identification (NMFS 2001a).

Bottom trawl surveys conducted by the AFSC provide reliable estimates of aggregate skate biomass within the timeframe of the FMPs (Gaichas 2002). Bottom trawl gear designed to assess flatfish and demersal groundfish is expected to catch skate at least as well as target species. There are also longline surveys conducted by the IPHC and the AFSC for halibut and sablefish, respectively. These surveys are not used to index the abundance of skate at this time, because they are more specialized, being designed for individual target species, whereas the trawl surveys are designed to assess all groundfish species (NMFS 2001a).

The EBS skate complex is dominated by a single skate species, the Alaska skate (*Bathyraja parmifera*) (Table 3.5-54). This species accounted for about 91 percent of the aggregate skate biomass estimated in 1999. The Bering or sandpaper skate (*Bathyraja interrupta*) was the next most common species in the EBS, making up about 6 percent of the aggregate skate biomass. The other six skate species identified in the survey (Table 3.5-51) made up less than 3 percent of the aggregate skate complex biomass (NMFS 2001a).

The GOA skate complex is more diverse than that found on the Bering Sea shelf. Four skate species were considered common, with an additional five uncommon species. The big skate (*Raja binoculata*) composed nearly 50 percent of the aggregate skate biomass, followed by the longnose skate (*Raja rhina*) at about 30 percent of aggregate biomass. Two *Bathyraja* species, the Aleutian skate (*B. aleutica*) and the Bering skate (*B. interrupta*) were next in abundance, representing about 10 percent, and 3 percent of the aggregate biomass, respectively. All five other skate species identified on the 1999 GOA survey made up about 3 percent of the aggregate skate complex biomass (NMFS 2001a).

The skate community in the Aleutian Islands appears to be different from that described for both the EBS and the GOA. In the Aleutian Islands, the most abundant species in the 1997 survey was the white blotched skate (*Bathyraja maculata*) making up 45 percent of aggregate biomass. Alaska and Aleutian skate were also common, composing about 30 percent and 15 percent of the aggregate biomass, respectively. The mud skate, (*Bathyraja tanaretzi*), was relatively common but represented a lower proportion of total biomass (approximately 3 percent) because it is a smaller skate. All seven other skate species identified in the 1997 Aleutian Islands survey made up approximately 7 percent of the aggregate skate complex biomass.

The biomass of all skate species combined as estimated by the AFSC bottom trawl surveys has generally increased in all FMP areas over the past 15 to 20 years, although it has declined somewhat from the 1990 peak in the EBS (NPFMC 1999c). In 2002, AFSC EBS shelf and slope surveys for skate showed a biomass estimate of 434,525 mt. Skate biomass estimate for the 2002 AFSC AI trawl survey was 34,412 mt, being the highest estimate since 1980.

Skate, as a group, represented the highest proportion of estimated non-target species catch weight (28 percent) from 1997 to 1999 in both FMP areas combined. In the BSAI, skates are by far the highest proportion of non-target species catch at 35 percent of total estimated non-target catch weight. Table 3.5-55 shows estimated skate bycatch rates in BSAI and GOA.

BSAI/GOA Skates Cumulative Effects Status

Although it is not determined if any individual skate species have declined in the North Pacific during the timeframe of the FMPs, there is adequate evidence that fisheries can affect skate populations and that stable or rising aggregate skate biomass does not necessarily indicate that no impact is occurring at the species level (Gaichas 2002). Due to the vulnerability of certain or all skate species to overfishing and lack of accurate bycatch estimates, they will be carried forth for cumulative effects analysis. GOA Amendment 63 is scheduled for secretarial approval on March 3, 2004 which will result in skate species being moved from the other species complex to the target species complex. Upon the adoption of this amendment, OFL, ABC, and TAC levels will be established for skates and skate complexes in the GOA region. The direct and indirect effects analysis as well as the cumulative effects analysis presented in this document will consider skate species as part of the other species complex. As data and research improves for these species, future analyses will incorporate the proposed changes to the GOA FMP.

3.5.3.5 Octopi

Life History and Distribution

Three octopi species have been recorded: the giant Pacific octopus, *Enteroctopus dolfeni* (the principal species), the flapjack devilfish, *Opisthoteuthis california,* and the smoothskin octopus*, Octopus leioderma* (which appears only intermittently). The giant Pacific octopus is found from California to Japan in waters from low tide line to 200 m. In general, the giant Pacific octopi have short life spans ranging from only 1 to 5 years, averaging 3 to 5 years, during which they have only one reproductive period (Boyle 1983). Mating occurs in autumn inshore at less than 100 m in depth; females spawn 18,000-74,000 eggs in May and July in rocky or sandy bottom nearshore nests, while males return offshore and die. The female octopi brood their eggs for 6 to 7 months without feeding, dying soon after the eggs hatch. Hatchling are planktonic at first, settling to the bottom around March of the following year after hatching (Roper *et al.* 1984). The giant Pacific octopus is the largest of the octopods, reaching 10 kg at maturity (3 years for females). Less information is available for eastern North Pacific giant Pacific octopi, although it is thought that spawning occurs more often in the winter months (Hartwick 1983). Little is known of the flapjack devilfish or the smoothskin octopus.

Trophic Interactions

Information on trophic interactions for octopi in the BSAI and GOA regions is lacking. Thus, no further discussion will be presented here.

BSAI/GOA Octopi Management

In the BSAI and GOA, octopi species are managed within the other species category with a TAC specified for the entire other species complex.

BSAI/GOA Octopi Past/Present Effects Analysis

The geographic scope for the BSAI and GOA octopi past/present effects analysis is the same as the BSAI and GOA FMP management areas (Figures 1.2-2 and 1.2-3). The temporal scope for this analysis begins in the 1960s with the availability of other species bycatch information and ends in 2002, the most recent year in which information is available on the resource category.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this Programmatic SEIS. Table 3.5-56 provides a summary of the BSAI and GOA octopi past effects analysis presented below. The following direct and indirect effects were identified as potentially having population level effects on BSAI/GOA octopi:

- Mortality due to catch/bycatch (direct effect).

- Reduced recruitment due to spatial/temporal concentration of catch/bycatch (indirect effect).

The following past/present effects determined to be applicable to the octopi past effects analysis include the following:

- Past/Present External Events
  – Foreign groundfish fisheries (pre-MSA)
  – State of Alaska groundfish fisheries
  – State of Alaska Crab fisheries
  – Directed fisheries

- Past/Present Internal Events
  - Foreign groundfish fisheries (post-MSA)
  - JV groundfish fisheries
  - Domestic groundfish fisheries

- Past/Present Management Actions
  - FMP groundfish fisheries management
  - Data limitations

External Mortality: Foreign Groundfish Fisheries (Pre-MSA)

Unfortunately, bycatch data from the foreign fisheries' BSAI and GOA FMP foreign fishery Observer Program is non-existent at the level of octopi. It is inferred that past foreign fisheries had proportionally similar octopi bycatch to the current federal groundfish fisheries (NMFS 2001a).

External Mortality: Directed Fisheries

In the Bering Sea, the last directed octopus fishery was in 1995. Since then, there have been no directed fisheries for octopus. Directed octopus fishing is prohibited in the Aleutian Islands area as well (Funk 2003). No vessels applied for directed octopus fishing permits in the Alaska Peninsula area in 2001 (Ruccio *et al.* 2002).

The seasonal migrations of octopi for spawning purposes segregates the sexes in different habitats at certain times of the years. Therefore, there is some concern that fisheries could pose different effects on the sexes of octopi. More information is necessary to develop appropriate management for octopus species in Alaska (Gaichas 2001).

External Mortality: State of Alaska Groundfish Fisheries

Prior to 2001, vessels registered for groundfish or shellfish could also register for octopus fishing in addition to the target species. This allowed for 100 percent of octopi to be retained as bycatch in target fisheries. In 2001, ADF&G prohibited this dual registration and placed a retention limit of 20 percent for octopus bycatch (Funk 2003).

In 2000, harvest of octopi in the Alaska Peninsula area was 3.1 mt (state and federal waters) with no vessels formally registering for octopus harvest. In the groundfish fisheries, vessels targeting Pacific cod using pot gear accounted for the majority of the octopus bycatch (Funk 2003). During the 2000 season in the Bering Sea, 7.4 mt of octopus bycatch was reported and 64 percent was taken by pot gear in groundfish fisheries (Funk 2003). Non-pelagic bottom trawl gear accounted for 48 percent of octopus bycatch while pot gear made up 47 percent during the 2001 season in the Bering Sea (Bowers *et al.* 2002). Almost 100 percent of the 2000 and 2001 landings of octopi in the Aleutians area were taken from Pacific cod or other groundfish vessels using pot gear (Funk 2003; Bowers *et al.* 2002).

External Mortality: State of Alaska Crab Fisheries

From 1977 to 1984, a substantial amount of octopus was caught incidentally by Tanner crab pots (Funk 2003). Information regarding current status of octopus bycatch is lacking.

Internal Mortality: Foreign, JV and Domestic Groundfish Fisheries

Octopi bycatch tends to be slightly less in the GOA than in the BSAI, ranging from 88 to 232 mt in the GOA and from 190-418 mt in the BSAI from 1997-2001 (Gaichas 2002). Bycatch is taken largely in the Pacific cod fisheries, mainly the Pacific cod pot fishery. Octopi also have higher estimated retention rates of any group in the other species category, suggesting that a separate management group may be necessary in the future (Gaichas 2002).

BSAI/GOA Octopi Comparative Baseline

Octopi biomass estimates are limited and show large fluctuations from year to year in the BSAI and GOA. The 2002 AFSC shelf and slope surveys for the EBS estimated octopi biomass at 3,400 mt with Aleutian Islands trawl surveys totaling 1,380 mt. Octopi appear to be poorly sampled by demersal trawls and their biomass may be underestimated. Furthermore, biomass may be underestimated due to lack of sampling in important, nearshore, rocky habitats preferred by octopi (Gaichas 2002). Stock assessments are not conducted on octopi by ADF&G for the westward region of Alaska, thus, population status is unknown to date (Ruccio *et al.* 2002).

BSAI/GOA Octopi Cumulative Effects Status

Accurate biomass estimates and bycatch data for octopi are limited. Current population status for octopi in the BSAI and GOA regions cannot be determined at this time. Cumulative effects analysis will be carried forth in order to address uncertainty and data gaps associated with this species group.

3.5.4 Forage Species

Forage fishes, as a group, occupy a nodal or central position in the North Pacific Ocean food web, being consumed by a wide variety of fish, marine mammals, and seabirds. Many forage species undergo large, seemingly unexplainable, fluctuations in abundance. Most of these are r-selected species (e.g., capelin and sand lance), which generally have higher reproductive rates, are shorter-lived, attain sexual maturity at younger ages, and have faster individual growth rates than K-selected species (e.g., rockfish and many flatfish, which are generally long-lived, reach sexual maturity at an older age, and grow slowly). Predators that feed on r-selected fish species (marine mammals, birds, and other fish) have evolved in an ecosystem in which fluctuations and changes in relative abundance of these species have occurred. Consequently, most of them, to some degree, are generalists who are not dependent on the availability of a single species to sustain them, but instead rely on a suite of species, any one (or more) of which is likely to be abundant each year. However, differences in energy content exist among forage species, with herring, sand lance, and capelin containing higher energy content per unit mass than other forage species such as juvenile pollock (Payne *et al.* 1997). It is possible that changes in availability of higher energy content forage may influence growth and survival of the upper-trophic-level species reliant on forage species as their main prey.

Table 3.5-57 shows the biology and habitat attributes of a few of the forage fish species in the BSAI and GOA.

Trophic Interactions

In the EBS, forage fish, as defined here, are found in the diets of walleye pollock, Pacific cod, arrowtooth flounder, Pacific halibut, Greenland turbot, yellowfin sole, rock sole, Alaska plaice, flathead sole, and skates. However, forage fish do not represent a large portion of the diet, by weight, of these predators, with the exception of shelf rock sole (14.3 percent) and slope pollock (12.6 percent). Tables 3.5-58 and 3.5-59 present the ten most important prey, by weight, in the diets of each predator for the EBS shelf and slope regions, respectively. All forage fish species are italicized. Forage fish found in the diet, but not in the top ten prey by weight are also listed. The miscellaneous fish category represents all fish prey not included as one of the ten most important prey categories, primarily unidentified fish. All groundfish diet data are from the AFSC Resource Ecology Fishery Management Division, groundfish food habits database. Tables 3.5-63, 3.5-64, and 3.5-65 depict forage fish species found in the diets of seabirds and marine mammals occurring in the BSAI and GOA regions.

EBS Shelf

Despite the generally piscivorus diet of cod, arrowtooth flounder, Pacific halibut, Greenland turbot, and skates, forage fish are not principal components, by weight, in the diets of EBS groundfish (Table 3.5-58). Sand lance are the most prevalent forage fish in the diet of cod (0.8 percent) while capelin, osmerids, bathylagids, myctophids, and eulachon each represent 0.1 percent or less of the diet by weight. In the diet of arrowtooth flounder, capelin and eulachon each represent 0.2 percent of the diet by weight, while osmerids, myctophids, and sand lance each constitute 0.1 percent or less. The diet of Pacific halibut contains 2.2 percent sand lance and 1.8 percent capelin; osmerids and eulachon each represent 0.1 percent or less. Myctophids represent 0.2 percent of the diet of Greenland turbot; bathylagids, osmerids, and sand lance represent 0.1 percent or less. Sand lance are the most important forage fish in the diet of skates (0.7 percent); capelin, sandfish, and myctophids each represent 0.1 percent or less. Sand lance is the most prevalent forage fish species in the diet of walleye pollock (0.5 percent); osmerids, bathylagids, myctophids, and eulachon each represent less than 0.1 percent of the diet by weight. The total contribution (0.6 percent) of forage fishes to the diet of yellowfin sole is primarily due to sand lance; bathylagids and capelin each represent less than 0.1 percent by weight. Sand lance are the second most important prey in the diet of rock sole, 14.3 percent by weight; osmerids are the only other forage fish present in the diet (less than 0.1 percent). Sand lance are the only forage fish found in the diet of Alaska plaice, representing 0.5 percent of the diet. Flathead sole consume capelin (1.3 percent), sand lance (0.5 percent), osmerids (0.1 percent) and myctophids (less than 0.1 percent).

EBS Slope

Lang and Livingston (1996) studied the diets of groundfish in the EBS slope region. In this region, forage fish are relatively unimportant in the diets of Greenland turbot, flathead sole, arrowtooth flounder, and cod (Table 3.5-59). However, 12.6 percent of the diet of pollock on the slope consists of forage fishes. Greenland turbot consume bathylagids (0.4 percent) and myctophids (0.4 percent) as the only forage fish in their diet. Flathead sole also consumed bathylagids (0.3 percent) and myctophids (0.1 percent). Myctophids (0.2 percent) are the only forage fish found in the diet of arrowtooth flounder. Pollock consume bathylagids (7.0

percent), myctophids (5.5 percent), osmerids (0.1 percent), and sand lance (less than 0.1 percent). Forage fish are negligible in the diet of cod; bathylagids represent less than 0.1 percent of the diet by weight.

Aleutian Islands

Yang (1996) studied the diets of groundfish in the Aleutian Islands during summer. He found that main fish prey of groundfish in the Aleutian Islands included Atka mackerel, walleye pollock, Pacific herring, capelin, myctophids, bathylagids, Pacific sand lance, and eulachon (Table 3.5-60). Although Atka mackerel and walleye pollock were important fish prey of arrowtooth flounder, Pacific halibut, and Pacific cod, other forage fish species comprised from 1 to 37 percent of groundfish diets. Most of the Atka mackerel consumed by the groundfish were located near Attu, Agattu, Amchitka, Tanaga, Atka, and Unalaska Islands. Myctophids were an important forage fish. Large amounts of myctophids were found in the diets of Greenland turbot, walleye pollock, Pacific ocean perch, and shortraker rockfish. They were also found in arrowtooth flounder, Pacific cod, rougheye rockfish, Atka mackerel, and northern rockfish. Most myctophids consumed by the groundfish were located near Kiska, Adak, Seguam, and Yunaska Islands. It is notable that nine out of eleven groundfish species shown in Table 3.5-60 consumed myctophids as food. If the abundance of the myctophids declines dramatically, it could impact the growth of Aleutian Islands groundfish, which depend on myctophids for a main food resource. Bathylagids were found in the diets of Greenland turbot and walleye pollock. Capelin were found in the diet of Pacific halibut and walleye pollock collected in the Akutan Island area, but they contributed only 5 percent and less than one percent of the diets of Pacific halibut and walleye pollock, respectively. Pacific sand lance were food of arrowtooth flounder, Pacific halibut, Pacific cod, and walleye pollock, but they contributed less than one percent of these diets. Only a small amount (less than one percent) of eulachon was found in the diet of walleye pollock. Pacific sandfish was not found in the diets of the groundfish in the Aleutian Islands area.

Gulf of Alaska

Yang and Nelson (2000) studied the diets of groundfish in the GOA shelf during summer. They found that the main fish prey of groundfish in the GOA included pollock, Pacific herring, capelin, Pacific sand lance, eulachon, Atka mackerel, bathylagids, and myctophids (Table 3.5-61). Although walleye pollock was the most important fish prey of arrowtooth flounder, Pacific halibut, sablefish, Pacific cod, and walleye pollock in the GOA, other forage fish species comprised 1 to 23 percent of the diet of groundfish. Capelin was important food of arrowtooth flounder and pollock, comprising 23 and 7 percent of the diet, respectively in 1990. The consumption of capelin by walleye pollock gradually decreased to 3 percent in 1993; to 0 percent in 1996. Compared to 1990, arrowtooth flounder also consumed less capelin in 1993 (4 percent) and in 1996 (10 percent). The capelin consumed by these groundfish were mainly located northeast and southwest of Kodiak Island. Eulachon comprised 6 percent of the diet of sablefish. Myctophids were important forage fish for shortraker rockfish, comprising 18 percent of the diet of shortraker rockfish. Pacific sand lance were found in the stomachs of arrowtooth flounder, Pacific halibut, sablefish, Pacific cod, and walleye pollock, but their contribution to these diets was small (1 percent or less). Bathylagids were only found in the diet of walleye pollock, and they contributed less than one percent. Pacific sandfish was not found in the diet of the groundfish in the GOA.

In the Atlantic, strong interactions between cod and capelin have been recorded (Akenhead *et al.* 1982). Even though Pacific cod did not feed so heavily on capelin in the GOA, capelin was an important fish prey of several groundfish species. The distribution and the abundance of forage fish in the GOA are not well known.

However, a series of years with poor forage fish recruitment, which decreases the availability of small prey fish, may have a large impact on piscivorus groundfishes.

BSAI and GOA Forage Fish Management

The BSAI and GOA FMPs were amended in 1998 to establish a forage species category to prevent the development of directed fisheries on these ecologically important non-target species. This category consists of many fish families (Osmeridae [smelts], Myctophidae, Bathylagidae, Ammodytidae, Trichodontidae, Pholidae, Stichaeidae, Gonatostomatidae, and the order Euphausiacea). These families were removed from the non-specified species category with the smelt species, (dominated by capelin, *Mallotus villosus* and eulachon, *Thaleichthys pacificus*), which were previously removed from the other species category. The forage species rule restricts all species in this category to bycatch only status and establishes a maximum retainable bycatch (MRB) rate (explained in Appendix B) of 2 percent for these species in aggregate. In addition, commerce in forage species is currently prohibited except for the small amounts retained under the MRB rates and for artisanal or subsistence uses.

BSAI and GOA Past/Present Effects Analysis

The geographic scope for the BSAI and GOA forage fish past/present effects analysis is the same as the BSAI and GOA FMP management areas (Figures 1.2-2 and 1.2-3). The temporal scope for this analysis begins in the 1960s with the increase in intensity of the foreign fisheries, and ends in 2002, the most recent year of which information is available on the resource category.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events screened for the past effects analysis is presented in Section 3.1.4 of this Programmatic SEIS. Table 3.5-62 provides a summary of the BSAI and GOA forage fish past effects analysis presented below. The following direct and indirect effects were identified as potentially having population level effects on BSAI forage fish:

- Mortality due to bycatch and marine pollution and oils spills (direct effect).
- Change in reproductive success due to predator removal and climate changes and regime shifts (indirect effect).
- Change in prey availability due to introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).
- Change in important habitat due to fishery gear impacts, introduction of exotic species, marine pollution and oil spills and climate changes and regime shifts (indirect effect).

Mortality caused by marine pollution and change in prey availability and important habitat due to the introduction of exotic species and climate changes and regime shifts by way of ballast water has not been brought forward since the impacts on forage fish in the BSAI and GOA have not been directly observed or documented. However, researchers are attempting to link recent warming trends in the northwest Pacific to an increase in abundance of tropical predators (Northwest Fisheries Science Center 1998). See Section

3.10.1.5 for documentation of occurrences of unusual species in the BSAI and GOA as influenced by climate changes and regime shifts.

The past/present event determined to be applicable to the BSAI and GOA forage fish past effects analysis include the following:

- Past/Present External Events
  - Foreign groundfish fisheries (pre-MSA)
  - State of Alaska directed capelin fishery
  - Subsistence and personal use fisheries
  - Regime shifts and climate changes

- Past/Present Internal Events
  - Foreign groundfish fisheries (post-MSA)
  - JV groundfish fisheries
  - Domestic groundfish fisheries
  - State groundfish fisheries bycatch

- Past/Present Management Actions
  - FMP groundfish fisheries management
  - Data limitations

Mortality

External Foreign Groundfish Fisheries (pre-MSA)

It is inferred that past foreign fisheries had forage fish bycatch rates that are proportionally similar to the current domestic fisheries. It is likely that effects on the populations have occurred; however, magnitude of the effects is unknown due to the lack of pertinent bycatch information.

External State of Alaska Directed Capelin Fishery

Although little commercial fishing occurs on forage fish species, documentation exists of a small and sporadic commercial fishery on capelin as early as the 1960s (ADF&G 1993). The largest harvest of capelin was taken in 1984 (489 mt, sorted), and in 1993, 31 mt of capelin were harvested in Nunavachuk Bay. Data reveal that no more than three vessels per year participated in a capelin fishery. Data from 1992 and 1994 indicate that less than 1 mt of capelin was commercially harvested by one boat. The limited annual harvest of capelin in the North Pacific Ocean is due to sporadic market conditions, processing limitations, and fluctuation of available capelin biomass. However, declining Atlantic stocks have the potential to change the market interest for capelin.

Presently, commercial fishing for capelin is in state waters open by regulation, not managed by emergency order, and is restricted by few regulations. The opportunity for a directed fishery on capelin or the other forage fish species exists under the current management system. Presently, species contained in the proposed forage fish category are not actively managed by the State of Alaska; however, cooperative state and federal management would be necessary for those forage fish that may be distributed in state waters during spawning times.

External Subsistence and Personal Use Fisheries

The ADF&G Subsistence Division conducts household surveys to determine subsistence use of forage fish species. Data from these surveys show that smelt are reported harvested in a large number of coastal communities in the southeast, southcentral, southwest, west, and arctic regions of Alaska. Reported smelt harvests range from a few pounds to several thousand pounds per community, depending on place and year.

In the southeast, southcentral, and southwest regions, eulachon are the smelt most commonly taken. Rainbow smelt, capelin and unknown smelt are also reported harvested in communities in the arctic, west, southwest, and southcentral regions. The ADF&G database contains no records of subsistence harvests of other forage fish categories; however, it is possible that, in particular communities, some subsistence harvests of other forage fish species may occur (B. Wolfe, ADF&G, Subsistence Division, personal communication).

Internal JV and Domestic Groundfish Fisheries (post-MSA)

Forage fish bycatch has been a minimal component of the commercial fisheries, remaining under 75 mt in the BSAI and under 130 mt in the GOA, although in 2001, bycatch exceeded 500 mt in the GOA. Osmerids (smelts) make up the largest portion of the bycatch and tend to be caught in the pollock fishery in both the BSAI and GOA. While it is not known what percentage these values are of their actual biomasses in the BSAI or GOA, this bycatch amount probably has little effect on the reproducibility of each species, nor does it represent significant competition with other apex predators (marine mammals, birds, and other fish).

It is inferred that past JV and domestic fisheries had forage fish bycatch rates that are proportionally similar to the current domestic fisheries. It is likely that effects on the populations have occurred; however, magnitude of the effects is unknown due to the lack of pertinent bycatch information.

Recent changes in predator abundance and significant declines in seabirds (and marine mammals) in the BSAI and GOA have raised concerns that a decrease in the forage fish biomass may contribute to the further decline of seabird, marine mammal, and commercially important fish populations. The previous regulatory regime allowed for the retention of forage fish under the other species category TAC or as a non-specified species, but there was no measure in place to prevent the development of a directed fishery.

In April 1997, NPFMC adopted Amendment 36 to the BSAI FMP and Amendment 39 to the GOA FMP to prevent the development of commercial fisheries for forage fish. NOAA Fisheries published the final rule implementing the regulations on March 17, 1998 (63 FR 13009). Amendments 36/39 defined a forage fish species category and prevented the development of a commercial directed fishery for forage fish. The amendment established a 2 percent MRB amount in other directed fisheries and prohibited the selling, bartering, trading, or receiving any other remuneration for forage fish species. However, within the 2 percent limit, forage fish could be reduced to fish meal and sold.

While NPFMC considered options that would have put forage fish in the other species category or the prohibited species category, the alternative chosen was more effective in that it explicitly prohibited a directed fishery and the sale and barter of forage fish. The amendment also reduced waste by allowing retention (up to the 2 percent MRB amount) and processing (into fishmeal) of those forage fish caught incidentally in groundfish fisheries.

This action is appropriately precautionary and proactive to protect these ecologically important species from the development of target fisheries. However, protection from overfishing and maintenance of healthy stocks for species in this category might be better achieved if limits were set on total catch of these species in addition to MRB rates. These limits are difficult to set at present because biomass estimates are lacking for most of these species.

Change in Reproductive Success

External Foreign Groundfish Fisheries (pre-MSA)

Forage fish are a large prey item of several target species, removal of these predators by the fisheries could potentially have had a beneficial population level effect on forage fish abundance, favoring forage fish recruitment. However, the magnitude of these potential benefits are unknown.

External Climate Changes and Regime Shifts

Some evidence exists that osmerid abundance (see below for life history and distribution information), particularly capelin and eulachon, have significantly declined since the mid-1970s. Evidence for this comes from marine mammal food habits data from the GOA (Calkins and Goodwin 1988), as well as from data collected in GOA biological surveys not designed to sample capelin (Anderson *et al.* 1997) and EBS commercial fisheries bycatch (Fritz *et al.* 1993). It is not known, however, whether smelt abundance has declined or whether the populations have redistributed vertically, presumably due to warming surface waters in the region beginning in the late 1970s. This conclusion could also be drawn from the data presented by Yang (1993), who documented considerable consumption of capelin by arrowtooth flounder, a demersal lower-water-column feeder, in the GOA.

Research by Brodeur *et al.* (1999) has shown some spatial separation of some forage fish species and some changes in distribution in a cold versus warm year. Capelin were associated with colder temperatures in the northen part of the Bering Sea, while age-0 pollock were associated with warmer temperatures than the overall measured temperature. Eulachon were found only in the warmer temperatures at the southernmost part of the sampling area. Although this study did not find any long-term trends in forage fish abundance in the Bering Sea, the study period began in 1982, which is generally considered to be a warmer period in the Bering Sea. Analysis of 36 years of Russian pelagic trawl data indicates different periods of fish abundance, depending on environmental conditions. In the western Bering Sea and Okhotsk Sea, herring and capelin appear to alternate in abundance with pollock. Such a pattern has not been definitively identified for the EBS.

Internal JV and Domestic Fisheries (post-MSA)

Forage fish are a large prey item of several target species; removal of these predators by the fisheries could potentially have a beneficial population level effect on forage fish abundance, favoring forage fish recruitment. However, the magnitude of these potential benefits are unknown.

Change in Prey Availability

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

Change in Important Habitat

External Foreign Groundfish Fisheries (pre-MSA)

See Sections 3.5.1.1 and 3.5.1.13 (past/present effects analysis: change in important habitat) for statistics on the number of bottom trawls occurring in these areas, and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat. The specific effects of foreign fishery gear on forage fish habitat are unknown.

External Climate Changes and Regime Shifts

The effects of climate changes and regime shifts are identified as potentially beneficial or adverse on habitat suitability and prey availability. For example, when the Aleutian Low is strong, water temperatures are higher, and biomass in the catches is dominated by cod, pollock and flatfishes. Community structure in nearshore areas around Kodiak Island changes in this same period with decreasing populations of shrimps and small forage fish, and increasing populations of large, fish-eating species, such as Pacific cod, and flatfishes (see Section 3.10.1.5). Since both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support environmental variance as an important controlling factor for the population (see Section 3.10.1.5).

Internal JV and Domestic Groundfish Fisheries (post-MSA)

See Sections 3.5.1.1 and 3.5.1.13 (past/present effects analysis: change in important habitat) for statistics on the number of bottom trawls occurring in these areas, and also see Section 3.6.4 for a discussion of the potential impacts of fishery gear on habitat. The specific effects of JV and domestic fishing gear on forage fish habitat are unknown. However, trawling efforts in forage fish habitat have been reduced in recent years due to Steller sea lion habitat conservation measures.

BSAI and GOA Forage Fish Comparative Baseline

Most of the fisheries catch is composed of target species, which are rigorously managed under an elaborate system of data collection, inseason management, and stock assessment. The management emphasis on target species, though arguably justified given the observed catch composition, leaves little time and resources for the management of non-target species. Historically, non-target species have been given relatively low priority in both fishery-dependent and fishery-independent data collection programs because of limitations on management resources. Although this has changed in recent years in the North Pacific, data limitation remains the primary assessment and management problem for most non-target species in the forage species, other species, and non-specified species categories (see Appendix B for more information on methods used to assess non-target species).

BSAI and GOA Forage Fish Cumulative Effects Status

The following sections describe the life history, distribution and baseline information for each forage species group where information is available. However, forage fish are only assessed as a group, not as the separate species groups in the past/present effects as discussed above and in the cumulative effects analysis of Chapter 4.

3.5.4.1 Osmeridae

Life History and Distribution

Smelts (capelin, rainbow smelt, and eulachon, family Osmeridae) are slender schooling fishes that can be either marine, such as capelin (*Mallotus villasus*) or anadromous, such as rainbow smelt (*Osmerus mordax dentex*) and eulachon (*Thaleichthys pacificus*). Figure 3.5-32 shows a generalized distribution of these three smelt species in the south EBS based on data collected by NOAA Fisheries summer groundfish trawl surveys and by fisheries observers.

Capelin

Capelin are distributed along the entire coastline of Alaska and south along British Columbia to the Strait of Juan de Fuca. In the North Pacific Ocean, capelin can grow to a maximum of 25 cm at age-4. Most capelin spawn at age-2 or -3, when they are only 11 to 17 cm (Pahlke 1985). Spawning occurs in spring in intertidal zones of coarse sand and fine gravel, especially in Norton Sound, northern Bristol Bay, and around Kodiak Island. Very few capelin survive spawning. The age of maturity of capelin in the Barents Sea has been shown to be a function of growth rate, with fast-growing cohorts reaching maturity at an earlier age than slow-growing cohorts. Thus, it is possible to have slow- and fast-growing cohorts mature in the same year, resulting in large spawning biomasses one year preceded and potentially followed by small spawning biomasses.

In the Bering Sea, adult capelin are only found nearshore during the months surrounding the spawning run. During other times of the year, capelin are found far offshore in the vicinity of the Pribilof Islands and the continental shelf break. The seasonal migration may be associated with the advancing and retreating polar ice front, as it is in the Barents Sea. In the EBS, winter ice completely withdraws during the summer months. If migration follows the ice edge, the bulk of the capelin biomass in the Bering Sea could be located in the northern Bering Sea, beyond the area worked by the groundfish fisheries and surveys. Very few capelin are found in surveys, yet they are a major component of the diets of marine mammals feeding along the winter ice edge (Wespestad 1987), and of marine birds, especially in the spring. In the GOA, which remains ice-free year-round, capelin overwinter in the bays of Kodiak Island and in Kachemak Bay.

Rainbow smelt

Rainbow smelt ascend rivers to spawn in spring shortly after the ice breakup. After spawning, they return to the sea to feed. Surveys have found concentrations of rainbow smelt off Kuskokwim Bay, Togiak Bay, and Port Heiden (Figure 3.5-32), but they also probably occur near many river mouths. Rainbow smelt mature at ages 2 or 3 (19 to 23 cm), but can live to be as old as 9 years and as large as 30 cm. Little is known about abundance trends of this species.

Eulachon

Eulachon also spawn in spring in rivers of the Alaska Peninsula, and possibly other rivers draining into the south EBS. Eulachon live to age-5 and grow to 25 cm, but most die following their first spawning at age-3. Eulachon are consistently found by groundfish fisheries and surveys between Unimak Island and the Pribilof Islands in the Bering Sea (Figure 3.5-32), and in Shelikof Strait in the GOA.

Trophic Interactions

Capelin

The diet of capelin in the North Pacific Ocean, as summarized by Hart (1973) and Trumble (1973), is primarily planktivorous. Small crustaceans such as euphausiids and copepods are common to the diet of capelin, although marine worms and small fish are also part of their diet. In the Bering Sea, adult capelin consume copepods, mysids, euphausiids, and chaetognaths. Juveniles primarily consume copepods (Naumenko 1984). The largest capelin (over 13 cm) consume euphausiids nearly exclusively. Capelin feed throughout the year in the Bering Sea. However, the diet exhibits seasonal variation that is due in part to spawning migration and behavior.

Eulachon

The diet of eulachon in the North Pacific Ocean generally consists of planktonic prey (Hart 1973, Macy *et al.* 1978). As larvae they primarily consume copepod larvae; post-larvae consume a wider variety of prey, including phytoplankton, copepod eggs, copepods, mysids, ostracods, barnacle larvae, cladocerans worm larvae, and larval eulachon. Juvenile and adult eulachon feed almost exclusively on euphausiids, with copepods and cumaceans occasionally in the diet.

The primarily planktivorous diets of eulachon, sand lance, and capelin reduce the potential for dietary competition with the piscivorus and benthic diets of most groundfish. However, the potential for dietary competition is greater between pollock and osmerids due to the importance of planktonic prey, such as euphausiid and copepod in their diets.

BSAI Osmeridae Comparative Analysis

Smelts make up the majority of the forage fish bycatch. Catches tend to be more erratic in the GOA; ranging from 23.1 to 534.8 mt per year from 1997 to 2001. In the BSAI, total bycatch ranges from 29.8 to 80.1 mt from 1997 to 2000. Smelt bycatch drastically increased in 2001in both the BSAI and GOA regions (Mark Nelson, personal communication, 22 January 2003). The cause of this increase is unknown at this time.

In the BSAI, the majority (64 percent - 94 percent) of the smelt bycatch occurs in the pollock fishery. Most of the remainder of the bycatch occurs in various flatfish fisheries. In the GOA, smelt bycatch is almost exclusively (92 percent to >99 percent) attributed to the pollock fishery.

GOA Osmeridae Comparative Baseline

Capelin

Capelin have shown abrupt declines in occurrence in small-mesh trawl survey samples in the GOA (Piatt and Anderson 1996, Anderson and Piatt 1999). In both NOAA Fisheries and ADF&G survey data, capelin first declined along the east side of Kodiak Island and bays along the Alaska Peninsula. Subsequent declines took place in the bays along the west side of Shelikof Strait. These declines happened quickly, and low abundance has persisted for over a decade. The decline was coincident with increases in water temperature of the order of 2°C, which began in the late 1970s. Capelin have fairly narrow temperature preferences and probably were very susceptible to the increase in water column temperatures (Piatt and Anderson 1996, Anderson *et al.* 1997). Mapping of relative densities of capelin showed defined areas of relative high abundance. The Shelikof Strait region showed relatively high catches in Kujulik, Alitak, and Olga bays. Most catches of capelin were closely associated with bays, except for high catches offshore of Cape Ikolik at the southwest end of Kodiak Island. Isolated offshore areas east of Kodiak Island showed some high catches, with most of the high catches associated with Ugak and Kazakof Bays. Only isolated catches of less than 50 kg were evident in the database from PWS, the Kenai Peninsula, and lower Cook Inlet.

Eulachon

Evidence from fishery observer and survey data suggests that eulachon abundance declined in the 1980s (Fritz *et al.* 1993). These data should be interpreted with caution because surveys were not designed to sample small pelagic fishes such as eulachon, and fishery data were collected primarily to estimate total catch of target groundfish. Causes of the decline, if real, are unknown, but may be related to variability in year-class strength, as noted for capelin. Small-mesh shrimp trawl surveys in the GOA coastal areas suggest that eulachon has remained at a low level of relative abundance since 1987. Eulachon are currently at the lowest recorded level in the survey series (1972 to 1997) at 0.01 kg/km (Anderson and Piatt 1999).

3.5.4.2 Myctophidae

Life History and Distribution

Lantern fishes (family Myctophidae) are distributed pelagically in the deep sea throughout the world's oceans. Most species in this family occur at depth during the day and migrate to near the surface to feed (and be fed upon) at night. A common myctophid in the Bering Sea and GOA is the northern lampfish (*Stenobrachius leucopsarus*), which has a maximum length of approximately 13 cm. Lanternfish are important forage fishes for marine birds and mammals.

Trophic Interactions

Because of their large mouth, relatively sparse and denticulate gill rakers, well-developed stomach, and short intestine, lantern fishes mostly consume actively swimming animals such as copepods and euphausiids (Balanov *et al.* 1995).

BSAI and GOA Myctophidae Comparative Baseline

Because they are rarely caught in survey or fishery trawls, nothing is known of recent trends in Myctophidae abundance. Lanternfish make a minor portion of the BSAI and GOA forage fish bycatch (Nelson 2002), less than half a metric ton between 1997-2001.

3.5.4.3 Bathylagidae

Life History and Distribution

Deep-sea smelts (family Bathylagidae) are distributed pelagically in the deep sea throughout the world's oceans. Most species in this family occur at depth during the day and migrate to near the surface to feed (and be fed upon) at night. Deep-sea smelt of the North Pacific Ocean include blacksmelt (*Bathylagus* spp.) and northern smoothtongue (*Leuroglossus stilbius schmidti*), each of which has maximum length of 12 to 25 cm. Deep-sea smelt are important forage fishes for marine birds and mammals.

Trophic Interactions

Because deep-sea smelts have a small mouth, dense flat gill rakers, a small stomach, and long intestine, they consume weak-swimming, soft-bodied animals such as pteropods, appendicularia, ctenophores, chaetognaths, polychaetes, and jellyfishes. Deep-sea smelts in the epipelagic zone can also feed on euphausiids and copepods at night when they are abundant (Balanov *et al.* 1995, Gorelova and Kobylyanskiy 1985).

BSAI and GOA Bathylagidae Comparative Baseline

Because they are rarely caught in survey or fishery trawls, nothing is known of recent trends in Bathylagidae abundance.

3.5.4.4 Ammodytidae

Life History and Distribution

Pacific sandlance (*Ammodytes hexapterus*, family Ammodytidae) are usually found on the sea bottom, at depths between 0 and 100 m except when feeding (pelagically) on crustaceans and zooplankton. Spawning is believed to occur in winter. Sand lance mature at 2 to 3 years and lengths of 10 to 15 cm. Little is known of their distribution and abundance; they are rarely caught by trawls. Given the sand lance's short life span, and the large number of species that prey on it, mortality, fecundity, and growth rates are probably high.

Sand lance in the Kodiak Island region undergo an extensive migration that is counter to the normal pattern found with many inshore species. Spawning takes place in the late fall and winter, and usually is completed in January. Hatching of larvae continues over an extended time, until March and perhaps April (Blackburn *et al.* 1983, Blackburn and Anderson 1997), and some larval fish may spend up to several months in beach sediments. Newly hatched larval sand lance and adults start migrating offshore in the early spring and spend some time in offshore bank areas, where they can often be abundant (Clemens and Wilby 1961). Offshore ichthyoplankton surveys in the GOA indicated high larval abundance, first appearing in early March and remaining high until early July, but then disappearing. In the late summer, massive schools of fish start migrating inshore to suitable beach habitat for spawning and overwintering. These inshore migrating schools provide important forage for species such as offshore migrating seabirds during late summer and early fall. Hence, sand lance are among one of the few fish that migrate inshore during the late summer months to overwinter near-shore while most other fish migrate offshore prior to winter months.

Trophic Interactions

Hart (1973) and Trumble (1973) summarized the diet of sand lance in the North Pacific Ocean as primarily planktivorous, their primary prey changing with ontogeny. Larval sand lance consume diatoms (microscopic one-celled or colonial algae) and dinoflagellates (photosynthetic marine organisms); post-larvae prey upon copepods and copepod nauplii. More recent information on the food habits of age-0 and age-1 sand lance shows a dominance of calanoid copepods in the diet, with barnacle nauplii, larvaceans, and shrimp larvae as other important prey (Blackburn and Anderson 1997). Adult sand lance prey upon chaetognaths, fish larvae, amphipods, annelids, and common copepods. Sand lance exhibit seasonal and diurnal variation in feeding activity and are opportunistic feeders upon abundant plankton blooms.

In the Bering Sea, sand lance are common prey of salmon, northern fur seals, and many marine bird species. Thus, they may be abundant in Bristol Bay and along the Aleutian Islands and Alaska Peninsula. In the GOA, sand lance are prey of harbor seals, northern fur seals, and marine birds, especially in the Kodiak Island area and along the southern Alaska Peninsula.

BSAI and GOA Ammodytidae Comparative Baseline

Little is known about the historical abundance of Pacific sandlance in the BSAI or GOA. Sandlance are not effectively sampled in current NOAA Fisheries surveys and make a very minor portion of the forage fish bycatch (Nelson 2002).

3.5.4.5 Trichodontidae

Life History and Distribution

The Pacific sandfish (*Trichodon trichodon*, family Trichodontidae) lives in shallow inshore waters to about 50 m depth and grows to a maximum length of 30 cm. Some evidence shows sandfish exhibit burrowing behavior in which they bury themselves in the sand and come to rest with only their dorsal surface showing. Nothing is known of trends in their abundance.

Trophic Interactions

In the EBS, the diet of Pacific sandfish is primarily (95 percent by weight) fish, especially gadids (Brodeur and Livingston 1988). They are fed upon by salmon and other fish, as well as pinnipeds.

In the GOA, the diet of sandfish consists of small crustaceans such as mysids, amphipods, and cumaceans (Kenyon 1956, Mineva 1955). More recent information from the GOA shows that sandfish consume sand lance, several types of shrimp, crab larvae, cumaceans, and polychaetes (Paul *et al.* 1997). They are fed upon by salmon and other fish, as well as pinnipeds.

BSAI and GOA Trichodontidae Comparative Baseline

Pacific sandfish make up the second largest portion of the forage fish bycatch, after smelts; however, they are still lightly exploited in both the BSAI and GOA, generally ranging between 0.4 and 3.7 mt in recent years (Mark Nelson, personal communication, 22 January 2003). In 2000 the catch in the BSAI reached a peak of 20.3 mt. This unusually high bycatch came primarily from the flathead sole fishery (14.3 mt). At this time, the cause of this anomalous catch is unknown.

3.5.4.6 Pholidae

Life History and Distribution

Gunnels (family Pholidae) are long, compressed, eel-like fishes with long dorsal fins often joined with the caudal fin. Gunnels have flexible dorsal fin rays; they differ from pricklebacks in that the anal fin is smaller (the distance from the tip of the snout to the front of the anal fin is shorter than the length of the anal fin). Most species in this family live in shallow nearshore waters among seaweed and under rocks and are mostly less than 45 cm in length. Approximately 5 species of pholids occur in Alaska. Nothing is known about their abundance, and little is known about growth rates, maturity, and trophic relationships, although they are believed to grow quickly.

Trophic Interactions

The diets of gunnels (family Pholidae) consist primarily of benthic and epibenthic prey. Amphipods, isopods, polychaete worms, harpacticoid copepods, cumaceans, munid crabs, insects, mysids, algae, ostracods, bivalves, crustacean larvae, and tunicates have been described as their main prey (Simenstad *et al.* 1979, Williams 1994). Juvenile fish prey (English sole, *Parophry vetulus*, and sand lance, *Ammodytes hexapterus*) have also been described as infrequent components of its diet in Puget Sound, Washington (Simenstad *et al.* 1977).

Pholids (saddleback gunnel) were found in Pacific cod stomachs in the Aleutian Islands, but their contribution was less than one percent by weight of the total stomach content. Pholids were not found as a significant portion of the diets of EBS shelf or slope groundfish. Pholids are probably not important prey of the GOA groundfish area because they were not found in a study of groundfish diets in that area (Yang 1993).

BSAI and GOA Pholidae Comparative Baseline

Gunnels make up a very minor portion of the forage fish bycatch in the BSAI and GOA (Nelson 2002).

3.5.4.7 Stichaeidae

Life History and Distribution

Pricklebacks (family Stichaeidae, including warbonnets, eelblennys, cockscombs and shannys) are long, compressed, eel-like fishes with long dorsal fins often joined with the caudal fin. Pricklebacks are so named because of the spiny rays in the dorsal fin in most species (some have soft rays at the rear of the dorsal fins). Most species of this family live in shallow nearshore waters among seaweed and under rocks and are mostly less than 45 cm in length. Approximately 14 species of stichaeids occur in Alaska. Nothing is known about their abundance, and little is known about growth rates, maturity, and trophic relationships, although they are believed to grow quickly. Some cockscombs in British Columbia attain sexual maturity at age-2 years.

Trophic Interactions

The longsnout prickleback (*Lumpenella longirostris*) eats copepods almost exclusively (Barraclough 1967). Young ribbon pricklebacks (*Phytichthys chirus*) eat copepods and oikopleura (Robinson *et al.* 1968). The food of the adults of this species includes crustaceans and red and green algae. Black pricklebacks (*Xiphister atropurpureus*) consume copepods, copepod nauplii, and clam larvae (Barraclough *et al.* 1968). It has also been reported that an important food of high cockscomb (*Anoplarchus purpurescens*) is green algae. Other food of this species include polychaete worms, amphipods, mollusks, and crustaceans.

Stichaeids represent a minimal portion of the diets of several groundfish species in the EBS shelf region. Pacific cod (Livingston 1991b), arrowtooth flounder (Yang 1996), and flathead sole (Pacunski 1991) consume unidentified stichaeids as less than one percent of their diets by weight. Greenland turbot consume a combination of unidentified stichaeids and daubed shanny (*Lumpenus maculatus*) as a small portion (less than one percent) of their diet. Stichaeids represent a small portion (less than one percent by weight) of the diet of Pacific cod, arrowtooth flounder, and Greenland turbot in the EBS slope region (Lang and Livingston 1996). Yang (1996) studied the diets of groundfish in the Aleutian Islands and found that stichaeids comprised 2 percent of the stomach contents weight of arrowtooth flounder. Stichaeids comprised less than one percent of the diets of Pacific cod, walleye pollock, and Atka mackerel.

Yang (1993) also studied the diets of the groundfish in the GOA during summer and found that stichaeids comprised about one percent of the stomach content weight of arrowtooth flounder, Pacific cod, and walleye pollock, respectively. Pacific halibut, sablefish, and Pacific ocean perch also consumed stichaeids, but their contribution to the diets was small less than one percent).

BSAI and GOA Stichaeidae Comparative Baseline

Pricklebacks make up a minor portion of the BSAI and GOA forage fish bycatch (Nelson 2002), ranging between 0 and 0.4 mt in the BSAI from 1997-2001, and 0 and 4.7 mt in the GOA for the same period (Mark Nelson, personal communication, 22 January 2003).

3.5.4.8 Gonostomatidae

Life History and Distribution

This is a large and diverse family (Gonostomatidae) of small (to about 8 cm), mesopelagic and bathypelagic fish that are rarely observed except by researchers. They can be abundant at depths of up to 5,000 m. As many as six species may occur in the North Pacific Ocean and Bering Sea. Bristleworms, lightfishes, and anglemouths have large gill openings and well-developed gill rakers, characteristics of zooplankton feeders.

Trophic Interactions

The primary zooplankton prey of gonostomatids are calanoid copepods. Other food includes ostracods and euphausiids. Some larger gonostomatids also consume some fish (Gorelova 1980).

Gonostomatids were not found to be a significant portion of the diets of EBS shelf or slope groundfish (Livingston and deReynier 1996). However, they were found in pollock stomachs in the Aleutian Islands, but contributed less than one percent by weight of the total stomach content (Yang 1996). Gonostomatids are probably not important prey of GOA groundfish because they were not found in a study of groundfish diets in that area (Yang 1993).

BSAI and GOA Gonostomatidae Comparative Baseline

Members of the Gonostomatidae family are found in mesopelagic waters around the world. Due to their distribution and scope of their habitat members of the genus *Cyclothone* are thought to be the most abundant fish in the world (Moyle and Cech 1988). Nothing is known about the abundance of these fish in the BSAI or GOA region.

3.5.4.9 Euphausiacea

Life History and Distribution

Along with many copepod species, the euphausiids (*Euphausiacea*) form a critical zooplanktonic link between the primary producers (phytoplankton) and all upper pelagic trophic levels. These crustaceans, also known as krill, occur in large swarms in both neritic (nearshore) and oceanic (offshore) waters. Members of at least 11 genera of euphausiids are known from the North Pacific Ocean, the most important (in terms of numbers of species) being *Thysanopoda, Euphausia, Thysanoëssa,* and *Stylocheiron* (Boden *et al.* 1955, Ponomareva 1963).

Euphausiids are generally thought to make diurnal vertical migrations, remaining at depth (usually below 500 m) during the day and ascending at night to 100 m or less to feed. However, this is complicated by the fact that as euphausiids grow they are found at deeper depths, except during spawning, which occurs in surface waters.

Spawning occurs in spring to take advantage of the spring phytoplankton bloom, and the hatched nauplii larvae live near the surface (down to about 25 m). By fall and winter, the young crustaceans are found mainly at depths of 100 m or less, and make diurnal vertical migrations. Sexual maturity is reached the following spring at age-1. After spawning, adult euphausiids gradually descend to deeper depths until fall and winter, when they no longer migrate daily to near-surface waters. In their second spring, they again rise to the surface to spawn; euphausiids older than 2 years are very rarely found. This classical view of euphausiid life history and longevity was recently questioned by Nichol (1990), who reported that Antarctic euphausiids may live as long as 6 to 10 years; annual euphausiid production, then, would be much lower than if they lived only 2 years.

While euphausiids are found throughout oceanic and neritic waters, their swarms are most commonly encountered in areas where nutrients are available for phytoplankton growth. This occurs primarily in areas where upwelling of waters from depths into the surface region is a consistent oceanographic feature. Areas with such features are at the edges of the various domains on the shelf or at the shelf-break, at the heads of submarine canyons, on the edges of gullies on the continental shelf (e.g., Shumagin, Barnabus, Shelikof gullies in the GOA), in island passes (on certain tides) in the Aleutian Islands (e.g., Seguam Pass, Tanaga Pass), and around submerged seamounts (e.g., west of Kiska Island). It is no coincidence that these are also prime fishing locations used by commercial fishing vessels seeking zooplanktivorous groundfish, such as pollock, Atka mackerel, sablefish, and many rockfish and flatfish species (Fritz *et al.* 1993, Livingston and Goiney 1983, Yang 1993).

Trophic Interactions

The species comprising the euphausiid group occupy a position of considerable importance within the North Pacific Ocean food web. Euphausiids are eaten by almost all other major taxa inhabiting the pelagic realm. The diet of many fish species other than the groundfish listed previously, including salmon, smelt (capelin, eulachon, and other osmerids), gadids such as Arctic cod and Pacific tomcod, and Pacific herring, is composed, to varying degrees, of euphausiids (Livingston and Goiney 1983). They are also the principal item in the diet of most baleen whales (e.g., minke, fin, sei, humpback, northern right, and bowhead whales) (Perez 1990). While copepods generally constitute the major portion of the diet of planktivorous birds (e.g., auklets), euphausiids are prominent in the diets of some predominantly piscivorus birds in certain areas (e.g., kittiwakes on Buldir Island in the Aleutian Islands, Middleton Island in the GOA, and Saint Matthew Island in the Bering Sea) (Hatch *et al.* 1990). Euphausiids are not currently sought for human use or consumption from the North Pacific Ocean on a scale other than local, but large (about 500,000 mt per year) krill fisheries from Japan and Russia have been operating in Antarctic waters since the early 1980s (Swartzman and Hofman 1991).

The diets of euphausiids in the North Pacific Ocean consist of planktonic prey. Species of the genus *Euphausia* consume diatoms, dinoflagellates, tintinnids, chaetognaths, echinoderm larvae, amphipods, crustacean larvae, ommatidians, and detritus (Mauchline 1980). Species of the genus *Thysanoessa* consume diatoms, dinoflagellates, tintinnids, radiolarians, foraminiferans, chaetognaths, echinoderm larvae, mollusks, crustacean larvae, ommatidians and detritus (Mauchline 1980). In the GOA, several species of *Thysanoessa* also consume walleye pollock eggs (Brodeur and Merati 1993).

Euphausiids represent a significant portion of the diet of walleye pollock in the EBS shelf region (Livingston 1991a). Euphausiids represent as much as 70 percent of the diet in the winter and spring and are generally more important to larger pollock than smaller ones. Euphausiids are also the primary prey of small (less than 35 cm) Greenland turbot in the EBS shelf, but are of little importance to larger fish (Livingston and deReynier 1996). Small (less than 35 cm) arrowtooth flounder also consume euphausiids as a large (50 percent by weight) portion of their diet; euphausiids are of little importance to the larger ones (Livingston and deReynier 1996). Euphausiids were not found to be a significant diet component of any other EBS shelf groundfish. In the EBS slope region, euphausiids were found in the diets of several groundfish species. They represent 26 percent of the overall diet by weight of walleye pollock, but are more important by season (80 percent by weight in winter) and to smaller fish (less than 50 cm) fish (Lang and Livingston 1996). Euphausiids also play a small role (less than one percent by weight) in the diets of Pacific cod, flathead sole, and arrowtooth flounder (Lang and Livingston 1996). In the Aleutian Islands, euphausiids also comprised 43, 55, 51, and 50 percent of the stomach contents of walleye pollock, Atka mackerel, Pacific ocean perch, and northern rockfish, respectively. Euphausiids were also in the diets of arrowtooth flounder (5 percent), rougheye rockfish (2 percent), shortspine thornyhead (1 percent), and shortraker rockfish (1 percent) in the Aleutian Islands (Yang 1996).

Euphausiids are an important food item of many groundfish species in the GOA and Aleutian Islands. Yang (1993) showed that the diets of plankton-feeding groundfish in the GOA, such as dusky rockfish, Pacific ocean perch, and northern rockfish had large percentages (more than 65 percent) of euphausiids. Euphausiids also comprised 39 percent of the diet of walleye pollock in the GOA.

BSAI and GOA Euphausiacea Comparative Baseline

There are no current data available on the abundance of Euphausiacea in the BSAI or GOA.

3.5.5 Non-Specified Species

The non-specified species category contains a huge diversity of species, including invertebrates, that are not defined in the FMP as target, other, forage, or prohibited species, except for animals protected under the MMPA or the ESA. There is currently no management or monitoring of any species in this category, and the retention of any non-specified species is permitted. No reporting is required for non-specified species, and there are no catch limitations or stock assessments. Most of these animals are not currently considered commercially important and are not targeted or retained in groundfish fisheries.

The complete lack of reporting requirements may be problematic because it allows a species to slip through the system unnoticed. For example, bycatch of grenadiers, a non-specified species group, is higher in the GOA than the catch of all species in the other species category combined (Gaichas *et al.* 1999), and yet bycatch of grenadiers is not regulated. The current non-management of grenadiers could mask declines in individual grenadier species and therefore, lead to overfishing of a given grenadier species. Grenadiers are long-lived species (e.g., Andrews *et al.* 1999) that may be extremely vulnerable to and slower to recover from heavy fishing pressure, similar to rockfish and elasmobranch populations. Information and scientific data regarding the grenadier are very minimal in comparison to other species such as halibut. Due to the lack of information on other species within the non-specified category, grenadier is the only species that will be discussed in this document.

3.5.5.1 Grenadier

Life History and Distribution

Grenadiers (family Macrouridae) are deep-sea fishes that are related to hakes and cods. They have large heads and elongated bodies that taper to a thin pointed tail. Grenadiers are found throughout the North Pacific as far east as the Okhotsk Sea near Japan, north to the Bering Sea and down the west coast of the U.S. to Mexico. There are at least three common species in the BSAI and GOA: the giant grenadier (*Albatrossia pectoralis*) (Figure 3.5-33), the Pacific grenadier (*Coryphaenoides acrolepis*), and the popeye grenadier (*Coryphaenoides cinereus*). An additional eight species from the Pacific Ocean are known, and may be present in the North Pacific. Grenadiers dominate the fish fauna of continental slopes worldwide and may be pelagic or demersal, but are found only in deep waters (Eschmeyer *et al.* 1984).

The grenadiers found in the GOA are very long-lived animals, despite the fact that some do not grow large. The maximum reported age for the giant grenadier is 56 years, and for the Pacific grenadier is 73 years. Giant grenadiers are appropriately named, as they are the largest of all macrourid species. They are usually found between 140 and 1,740 m deep. According to research in Russian waters, giant grenadiers form sex-specific aggregations, with females found in shallower water than males, and they migrate seasonally between shallower and deeper waters according to the timing of ovarian maturation and spawning (Novikov 1970, as referenced in Burton 1999). Giant grenadiers are oviparous, with a planktonic larval stage (Ambrose 1996). The giant grenadier has a pelagic juvenile stage, with settlement to benthic habitats thought to coincide with the onset of maturity (Noikov 1970). This life history strategy may protect immature giant grenadiers from fishing pressure (Burton 1999).

Pacific grenadiers are approximately one-half the size of the giant grenadiers. They are a benthopelagic mid-slope species, usually found in a depth range of 155 to 2500 m, that may wander off slope bottoms into midwater (Ambrose 1996). Pacific grenadier are oviparous, with a planktonic larval stage (Ambrose 1996). According to research near the Oregon and California coasts, spawning depth is not known. Larval stages, however, have been captured in the water column in waters less than 200 m, while older larvae and juveniles are known to occur deeper. Pacific grenadier of the northeast Pacific ocean appear to be a relatively sedentary species, as no migrations have been documented. Iwamoto and Stein (1974) noted that larger Pacific grenadier are found in deeper water off the coast of Oregon, suggesting that the species may move to deep water as they grow.

Popeye grenadier are a benthopelagic species, usually found between 225 and 2,832 m in depth, whose size is approximately two-thirds that of the Pacific grenadier. Because there are no current age and growth information for the popeye grenadier, it is assumed that it has a lifespan similar to the giant grenadier, based on preliminary information (J. Hoff, AFSC, personal communication). Grenadiers dominate the biomass in many deep-sea habitats and are suspected to play an important ecological role in energy transfer, either as pelagic predators, benthic predators, and/or as scavengers on detritus. There is much to learn about grenadier ecology.

Grenadier life history is summarized in Table 3.5-66. There are no distribution maps to date for the grenadier, but there are documented harvest areas for the sablefish, a species with which grenadier bycatch is primarily associated in the GOA (see discussions following). Since the two species share similar habitats and ranges (bathydemersal, deep water, GOA) it can be inferred that the distribution of grenadiers in the GOA would mimic the distribution of sablefish in the harvest area map from the east Yakutat area to the western GOA area (Figure 3.5-34).

Trophic Interactions

Grenadiers that inhabit the upper continental slope generally prey on locally abundant fish and invertebrates and scavenge for carcasses (Okamura 1970, Pearcy and Ambler 1974, Drazen *et al.* In press). The popeye grenadier is the most numerically abundant grenadier in this region (Bohle 1988), and it likely has this type of feeding strategy. The giant grenadier feeds on myctophids, squid, and a variety of benthic and mesopelagic animals in the EBS (Novikov 1970): eelpouts, other fish, and shrimp were identified as its dominant prey from samples taken in the 1980s (Brodeur and Livingston 1988). Pacific grenadier feed on small fish, euphuasiids, prawns, amphipods and cephalopods (Cohen *et al.* 1990). Cannibalism is not uncommon in Pacific grenadier off the coast of Oregon, according to Stein (1978), and may be responsible for high larval and juvenile mortality.

Predators of the grenadier include sablefish (*Anaplopoma fimbria*) and skates (*Bathyraja maculata*), both bathydemersal fishes like the grenadier.

Grenadier Management

There is currently no management or monitoring of grenadiers in either the BSAI or GOA. This complete lack of reporting requirements and protection within the existing non-specified species category can lead to overexploitation of the species. The Pacific grenadiers may be extremely vulnerable to unregulated fishing due to the species' very low resilience, the minimum population doubling time is more than 14 years (Cohen *et al.* 1990).

The original GOA FMP (1978) included three management categories: target species, prohibited species, and other species. The other species category contained all species that are in the current other species category, plus all that are now in the non-specified species category. Each category, including other species, had a MSY/OY cap. It became clear that the inclusion of grenadiers in the other species category could cause the MSY/OY cap for other species to be reached before foreign fisheries had caught their allocations of target species, because bycatch of grenadiers was high even then. In 1979, GOA FMP Amendment 5 established a separate management category and TAC of 13,200 mt for grenadiers to avoid premature closure of target fisheries due to grenadier bycatch. However, they were moved to the non-specified species FMP category in 1980 (Amendment 8), where they have remained ever since. Within the non-specified species FMP category, there are no requirements for reporting catch of grenadiers, and their catch is not monitored, but retention of grenadiers is permitted. Unfortunately, the highest observed catches of non-target species are within the categories receiving the least intensive management under the status quo: other species and non-specified species.

Right now, grenadiers are taken only as bycatch in fisheries directed at target species; consequently, catches of grenadiers are dependent on the distribution and limitations placed on target fisheries. In deep-water longline fisheries, the catch of non-specified species may approach that of target species, due solely to the bycatch of grenadiers (Table 3.5-67), the species which accounts for the higher proportion of non-target species catch in the GOA (Figure 3.5-35). Only PSCs are limited by status quo management of non-target species. At the November 1999 GOA Plan Team meeting, GOA grenadier catches were reviewed, and there was interest in initiating management for grenadier species, at least as part of the other species category. This action is being considered within the revision of the proposed FMP amendment to change the management of sharks, skates, and the rest of the other species category (NPFMC 1999a).

It was attempted to determine which species were likely to be caught in the fisheries by combining species distribution information from surveys with the observed fishery catch information from 1997 to 1999. In this case, information on depth distribution of grenadier species from surveys separated species more clearly than location of catch, because all three species appear to be distributed all along the GOA slope. This depth distribution information is only useful if the depths are known where fisheries catch grenadiers. Fortunately, there is average depth information available associated with each observed catch location which may indicate which species are caught.

Because observers are not trained to identify individual species of grenadiers, the majority (100 percent in 1997–1998 and 90 percent in 1999) of grenadier catch is reported as "grenadier unidentified." The other 10 percent of grenadier catch from 1999 were identified as giant grenadier, (*A. pectoralis*). All available catch information is summarized for aggregated grenadier species, including annual catch and location of catch. Fishery data were examined from 1997–1999 to determine total grenadier catch, and catch in different gear types and target fisheries (Table 3.5-68), and the location and depth of grenadier catch were observed (see latter test regarding spatial analysis). Unlike skates, grenadiers are almost all killed when caught and brought to the surface from the depths they inhabit.

If all grenadier species are caught in proportion to their estimated biomass in the GOA, then bycatch would remove approximately 3.4 percent of the biomass of each grenadier species. The available information on the maximum age of grenadier species indicates that the natural mortality rate M for each species might be 0.074 for giant grenadier (*Albatrossia pectoralis*) and 0.057 for the Pacific grenadier (*Coryphaenoides acrolepis*). The life history of the popeye grenadier (*C. cinereus*) was assumed to be most similar to the giant grenadier, and M was estimated accordingly at 0.074 for this species. If these estimates are correct for each species, current management Tier 5 criteria for establishing ABC would allow taking up to 5.5 percent of the biomass of giant and popeye grenadiers, and the OFL would be reached if 7.4 percent of the biomass of each species were caught in groundfish fisheries, because OFL = $M \times$ biomass, and ABC is 75 percent of OFL. Similarly, the ABC for Pacific grenadier would be reached when 4.3 percent of biomass was removed by fishing, and the OFL would be reached at 5.7 percent of estimated biomass.

The information available on the depth distribution of fisheries as compared to survey estimates of the depth distribution of grenadier species from the 1999 GOA trawl survey indicates that the fisheries likely catch giant grenadiers much more frequently than any other grenadier species. Therefore, the proportional catch assumption may be reasonable for grenadiers. However, the least common grenadier species according to our surveys, the Pacific grenadier (*C. acrolepis*), is also the longest lived, and, therefore, has the lowest OFL of 5.7 percent of biomass. The proportional catch assumption would mean that 2 percent of the grenadier catch is Pacific grenadiers, but if this proportion increased slightly to only 4 percent of catch, the take of Pacific grenadiers would increase to 6.8 percent of estimated biomass, over what we would establish as an OFL for this species using current management Tier 5 criteria. More extreme assumptions about disproportional catch would, of course, result in even higher estimated rates of fishing mortality relative to OFL for the rarer grenadier species.

If a disproportional catch assumption about the species composition of the grenadier complex catch in the GOA is true, then there would be very different impacts on each grenadier species. The impact on the common species in the complex, the giant grenadier (*Albatrossia pectoralis*), would be non-significant because the catch would not even approach the OFL based on $M = 0.074$. However, the catch of the less common species in the complex, the Pacific grenadier (*Coryphaeniodes acrolepis*), could be at or above the OFL based on current management Tier 5 criteria; therefore, the impact could be significantly adverse for this species. The actual proportion of each species in the catch is unknown, and in this case there is additional uncertainty associated with the biomass of Pacific grenadiers. Unfortunately, even with very good recent biomass data from the GOA, it has been impossible to determine whether Pacific grenadiers are truly rare in the GOA, or if the survey simply did not sample deep enough habitats to fully assess the population size of Pacific grenadiers. Given the longevity of the species and the unregulated nature of grenadier catch in general, the impacts of current management would be conditionally significantly adverse for Pacific grenadiers in the GOA.

Past/Present Effects Analysis

The geographic scope for the grenadier past/present effects analysis includes the Bering Sea, Aleutian Islands, and GOA. The temporal scope for this analysis begins in 1978 when the original GOA FMP was initiated and ends in 2002.

A discussion of the direct/indirect effects, external human controlled and natural events, and internal groundfish fishery events for the past effects analysis is presented in Section 3.1.4 of this Programmatic SEIS, Table 3.5-69 provides a summary of the grenadier past effects analysis presented below. The following direct and indirect effects were identified as potentially having population level effects on grenadiers:

- Mortality due to bycatch (direct effect)
- Reduced recruitment due to spatial/temporal concentration of bycatch (indirect effect)

The following past/present effects determined to be applicable to the grenadier past effects analysis include the following:

- Past/Present External Effects
  - Foreign groundfish fisheries (pre-MSA)
  - State of Alaska groundfish fisheries
- Past/Present Internal Events
  - Foreign groundfish fisheries (post-MSA)
  - JV groundfish fisheries
  - Domestic groundfish fisheries
- Past/Present Management Actions
  - Bilateral agreements
  - Industry initiated actions
  - FMP groundfish fisheries management
  - Lack of information

External Mortality: Bycatch in the pre-MSA Foreign Fisheries

Pre-World War II foreign fisheries were relatively small with an expansion of large scale fishing operations in the post-war period, ultimately leading to increases in the catches of groundfish in the BSAI and GOA. By 1979, grenadier bycatch comprised as much as 66 percent of the total foreign fishery sablefish catch in the GOA and was recognized as a significant bycatch problem (GOA FMP Amendment 5, see Appendix D). By 1985, the JV operations and growing U.S. domestic fleet had entered the scene and continued the harvest of groundfish species.

External Mortality: State of Alaska Groundfish Fisheries

State sablefish fisheries do not keep records of grenadier (ADF&G, personal communication). However, since grenadier bycatch is associated with the federal sablefish fisheries, it is inferred that grenadier bycatch would also be associated with the state sablefish fisheries.

Internal Mortality: Foreign, JV and domestic Groundfish fisheries (post-MSA)

Federal groundfish fisheries have been prosecuted by an all-domestic fleet since 1987 in the GOA and since 1991 in the BSAI. Information is lacking with regard to mortality effects on grenadiers from post-MSA groundfish fisheries. Bycatch of grenadier is primarily associated with the sablefish and Greenland turbot longline fisheries on the outer shelf and continental slope regions of the Aleutian Islands and EBS. Bycatch estimates of grenadier have ranged between 2,675 mt (in 1992) and 8,885 mt (in 1993) (Gaichas 2000). Bycatch of grenadiers is higher in the GOA than the catch of all species in the other species category combined (Gaichas *et al.* 1999).

During the period 1997 to 1999, the average estimated bycatch of grenadiers from the GOA sablefish fishery was 92 percent of the total average of grenadier bycatch for all 16 target species fisheries included in the study. The bycatch of grenadiers from the BSAI sablefish and turbot fisheries combined was 84 percent of the total average of grenadier bycatch for all 16 target species fisheries during this same period (Table 3.5-68). In the GOA, grenadiers comprised approximately 55 percent by weight of the total estimated non-target groundfish catch during 1997 and 1999. As has been discussed previously, since grenadier bycatch is not recorded by species, there is the potential for a species to become overexploited.

Internal Reduced Recruitment: Foreign, JV and Domestic Groundfish Fisheries

Since it has been found that the giant grenadier forms sex-specific aggregations (Novikov 1970, as referenced in Burton 1999), there is a potential for fisheries to overexploit a certain sex, thus possibly leading to reduced recruitment. Although bycatch composition estimates the impact on the common species, impact on giant grenadier would be non-significant because the catch would not approach the OFL based on $M = 0.074$. However, if it is found that the long-lived, rarer Pacific grenadier also forms sex-specific aggregations, this species may be more vulnerable to fishery-related impacts.

Grenadier Comparative Baseline

The reliability of grenadier biomass estimates depends on whether AFSC bottom trawl surveys included sampling of deep water strata. Deep strata were sampled in the EBS in 1979, 1981-1982, 1985, 1988, and

1991; in the Aleutian Islands in 1980, 1983, and 1986; and in the GOA in 1984, 1987, and 1999. Aggregate biomass estimates were reported from these bottom trawl surveys only, as others may severely underestimate the biomass of these deep water species. Recent biomass estimates are available for all three common grenadier species from the 1999 GOA bottom trawl survey (Table 3.5-70).

According to the observed depth distribution of biomass from the 1999 GOA survey, almost all grenadiers caught shallower than 700 m are giant grenadiers. This depth distribution also suggests that the surveys do not sample deep enough to fully assess all three common grenadier species found in the GOA; for example, there are indications that the maximum density of Pacific grenadiers occurs at a depth of approximately 1,500 m (Andrews *et al.* 1999). Catch by average depth and gear type indicates that all three species may be caught in longline fisheries, but the predominant catch in trawl fisheries in the GOA is most likely the giant grenadier, (*Albatrossia pectoralis*). The depth distribution of longline catch suggests that much of this catch may also be giant grenadiers; however, the interpretation of the longline depth data is complicated by the use of an average depth without any indication of the potential depth range. It is possible for a longline set at an average depth of 400 to 500 m to extend into waters deep enough to catch species other than giant grenadiers.

There had been no slope surveys in the EBS since 1991 and none in the Aleutian Islands since 1986. A few studies were conducted recently, beginning in 1997 to present. Sablefish longline surveys were conducted in deeper water strata (approximately 200 to 1,000 m) of the GOA and EBS annually from 1997 to 2001. The 2002 bottom trawl survey in the EBS and upper continental slope were also conducted in deep water strata (approximately 200 to 1,000 m). The 2000 and 2002 bottom trawl surveys in the Aleutian regions, however, were conducted in much shallower waters; the depths ranged from approximately 20 to 471 m. While these recent Aleutian studies confirmed the presence of giant grenadiers (grenadier biomass 2000: 219,693 mt, 2002: 22,851 mt) , the sampling most likely did not occur at depths great enough to fully assess all three grenadier species of interest in this document, and so will not be discussed. The results of the sablefish longline and 2002 EBS studies are outlined below.

The sablefish longline surveys were conducted annually from 1997-2001 at approximately the same depths (200 to 1,000 m) using the same sampling stations from year to year. The combined results from both the GOA and EBS areas showed that giant grenadier consistently accounted for 22 percent of the total number of fish caught and recorded (average of 232,000 fish). The giant grenadier followed only the sablefish (35 to 40 percent of the catch) as the second-most frequently caught species (1997-2001).

The 2000 bottom trawl survey of the Aleutian Islands region (western, central, and eastern Aleutians and southern Bering Sea) groundfish resources also resulted in grenadier catch as well. However, the bottom trawl survey was conducted in much shallower water than the sablefish survey with a depth range from 20 to 471 m. The giant grenadier was the third most abundant species (219,693 mt) of the 12 species captured in the four sample areas combined; following only the Atka mackerel (512,511 mt) and Pacific ocean perch (511,706 mt). The giant grenadier was most abundant in the eastern Aleutian region, where its biomass estimate was 203,727 mt, and non-existent in the southern Bering Sea area (AFSC 2000). According to groundfish assessment surveys in the Aleutian region, the catch of giant grenadier has increased approximately eight fold from 1991 to 2000, from an estimated 24,594 to 219,693 mt. This upward trend may have been influenced by survey factors such as improved sampling techniques and possibly survey timing; the 2000 survey was conducted 3 weeks earlier than the 1997 and 1994 surveys, which were 7 weeks earlier than the 1991 survey (AFSC 2000).

The 2002 bottom trawl survey of the EBS upper continental slope groundfish resources was conducted along the EBS from Akutan Island northwest to the International boundary, between depths of 200 and 1,200 meters. The giant grenadier was the dominant species in overall biomass collected, with a total biomass of 81.5 mt. Pacific ocean perch weighed a total of 13.0 mt followed by the popeye grenadier total of 9.2 mt.

The 2002 bottom trawl survey of the Aleutian Islands region was conducted in approximately the same areas and at the same depths as the 2000 study. The giant grenadier was the fifth most abundant species in the three Aleutian areas, following the Atka mackerel, Pacific ocean perch, northern rockfish, and the walleye pollock, respectively. There were no grenadier found in the southern Bering Sea area. The grenadiers are again most abundant in the eastern Aleutian region, where their biomass estimate was 20,908 mt, compared with the combined biomass total in all three Aleutian regions being 22,851 mt.

The species most commonly encountered in the trawl surveys mentioned above was the giant grenadier (*Albatrossia pectoralis*). The Pacific grenadier (*Coryphaenoides acrolepis*) and the popeye grenadier (*Coryphaenoides cinereus*) were also present, but with much lower estimated biomass in all years. Survey coverage of deeper strata is particularly important to grenadier biomass estimates; therefore, the 1990-1996, 2000, and 2002 bottom trawl survey estimates are considered to be of little use for detecting trends in grenadier abundance. Because the 2000 sablefish longline survey and the 2002 bottom trawl surveys were both conducted in deeper strata, the data may be helpful in determining grenadier abundance.

BSAI and GOA Grenadier Cumulative Effects Status

Reliable biomass estimates are limited for grenadier, and species-specific information within the complex is almost non-existent. Since grenadier bycatch is not recorded by species, there is the potential for a species to become overexploited by fishing activities. This lack of information prevents discussion of the mortality effects of grenadiers due to post-MSA groundfish fisheries. Due to the potential vulnerability of this species group to overfishing, they will be brought forth for cumulative effects analysis.

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3.6 Habitat

MSA provisions call for the description of measures to avoid, mitigate, or offset adverse effects to EFH. EFH is defined in the MSA as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (16 USC 1802 3, 104-297). Consistent with these provisions, this analysis focuses on the following question: Do the alternative management policies result in conditions that offer protection to and minimization of adverse impacts to EFH? For Alaska groundfish, this includes the habitat for all target groundfish species, non-target species, prohibited species, other species, and their prey. When viewed in aggregate, across all species, EFH is all pelagic and benthic habitat in the Alaska EEZ. The EFH definitions for all managed species are currently being reviewed by the NPFMC and NOAA Fisheries through its EFH amendment process. A decision on the Alaska EFH definitions will be made by the end of 2004. For purposes of this Programmatic SEIS, we provisionally defined EFH generally, as all benthic habitat.

As explained above, this analysis focuses on benthic habitat, which is generally believed to be at greater risk to the impacts of fishing than non-benthic habitat in the water column. In addition, much of the analysis focuses on the impacts of bottom trawling. It is recognized that fixed gear (longlines, pots, and jigs) or pelagic trawl gear that comes in contact with the sea floor can disturb benthic habitat. Pelagic trawls are fished "lightly on the bottom," and fishing on the sand and mud flats of the Bering Sea during daytime tends to involve a higher percentage of limited bottom contact involving the "fishing line" and leading edge of the first row of meshes. In some types of habitat, fixed gear may cause an impact due to its ability to be more easily fished on rougher substrates (e.g., boulders with coral) than bottom trawl gear. However, most scientific studies of gear impacts have dealt with bottom trawls and dredging because this gear is the most controversial (Auster and Langton 1999, Jennings and Kaiser 1998, Hall 1999a, NRC 2002).

In this analysis, benthic habitat is further divided into two categories: living and non-living. Living substrate is composed of biological communities. Non-living substrate is comprised of boulders, cobbles, sand waves and other seabed features organisms may colonize. The primary components of non-benthic habitat include the biological, physical, and chemical properties of the water column. The biological component of non-benthic habitat consists of non-benthic groundfish prey. HAPC is defined as a subset of EFH, described as habitat types or areas that may require extra protection; HAPC is designated using specific criteria (see Section 3.6.2). In Alaska, HAPC is specifically defined as: "living substrate in shallow and deep water, and freshwater areas used by anadromous fish."

In October 1996, the U.S. Congress reauthorized the MSA through the Sustainable Fisheries Act. The Final Rule EFH provisions of the MSA (50 CFR Part 600) was promulgated in January 2002. The intended effect of the rule is to promote the protection, conservation, and enhancement of EFH. Among other conservation measures, the Final Rule broadly defines EFH as those waters and substrate necessary for fish to spawn, feed or grow to maturity. The Final Rule also includes provisions requiring Regional Fishery Management Councils (RFMCs) to amend their FMPs to describe and protect EFH, and to mitigate for any adverse impacts potentially caused by fishing activities. The Final Rule requires that FMP components include mitigation for the adverse effects of fishing. Fishery management options may include, but are not limited to: fishing equipment restrictions, time area closures, and harvest limits.

At present, environmental and human variables that could affect habitat quality are addressed in the FMPs for both the BSAI and GOA (NPFMC 1999c). However, The EFH EA and FMP Amendments 55/55/8/5/5, along with similar actions prepared by five other RFMCs, were challenged by a coalition of seven environmental groups and two fishermen's associations. The plaintiffs' challenge was twofold. The U.S. District Court for the District of Columbia found that NOAA Fisheries evaluation of fishing gear impacts on EFH in the FMP amendments was in accordance with the MSA. The supporting EAs, however, failed to comply with the requirements of NEPA and the regulations promulgated by the CEQ and NOAA Fisheries. The court determined that the EAs did not consider the full range of relevant alternatives, nor did they fully explain the environmental impact of the proposed action and alternatives. In addition, the EAs failed to address any mitigative efforts to reduce adverse effects from fishing activities.

The Assistant Administrator of NOAA Fisheries determined that NOAA Fisheries would prepare new regional EISs to include all FMPs covered by the EAs. The following are several key areas of guidance provided in his determination:

- The selected range of alternatives should be developed by taking into account comments NOAA Fisheries receives during the scoping process, and that the EIS must evaluate a reasonable range of alternatives for developing the mandatory EFH provisions of the affected FMPs.

- For the designation of EFH, the analysis should include alternative ways of identifying EFH.

- For the identification of HAPC, the analysis should discuss alternative areas or different approaches that could be used to designate HAPCs.

- For the minimization of fishing impacts, the alternatives analysis should identify a range of approaches that could be taken to minimize the adverse effects of fishing on EFH. If information is lacking on the effects of specific fishing practices on EFH, the analysis should examine alternatives that could be taken in the face of uncertainty.

- To the extent feasible, NOAA Fisheries should use the NEPA process as the vehicle for reviewing and revising the information contained in the original EFH FMP amendments. Such a review should include information regarding the description and identification of EFH, threats to EFH from fishing and non-fishing activities, and measures that could be taken to minimize those threats.

The proposed action to be addressed in the EFH EIS is the development of the mandatory EFH provisions of all five FMPs of NPFMC: the BSAI groundfish; GOA groundfish; BSAI king and Tanner crab; scallop fishery off Alaska; and salmon fisheries in the EEZ off the Coast of Alaska. At present NOAA Fisheries and NPFMC are identifying feasible alternatives for analysis in the EIS and for selection of a preferred alternative. The Alaska Groundfish Programmatic SEIS is not intended to replace or supercede the EFH EIS, but will provide overarching policy guidance for EFH and set the stage for future FMP actions.

3.6.1 Identification of Essential Fish Habitat

The 1996 re-authorization of the MSA mandated that NOAA Fisheries and the RFMCs specifically describe and identify EFH within the FMPs. The MSA also required that FMPs minimize to the extent practicable adverse effects on EFH caused by fishing. NOAA Fisheries and NPFMC prepared one EA and a comprehensive set of Habitat Assessment Reports to address the new EFH requirements of the MSA

(NPFMC 1998a, 1998b, and 1998c). EFH FMP amendments for the five FMPs were submitted to the Secretary of Commerce in October 1998; these amendments were reviewed and approved by the Secretary of Commerce and took effect on January 20, 1999 (64 FR 20216). These FMP amendments identified EFH for 80 individual species including target and other fish, and for five species groups incorporating a total of 115 individual species. In cases where information was available, EFH was identified by each particular life stage for a given species (34 of the 80 individual species fell into this category).

According to the Final Rule implementing the EFH provisions of the MSA (50 CFR Part 600), to identify EFH basic information is needed to understand the usage or various habitats by each managed species. Pertinent information includes the geographic range and habitat requirements by life stage, the distribution and characteristics of those habitats, and current and historic stock size as it affects occurrence in available habitats. Temporal and spatial distribution of each life history stage is necessary to understand each species' relationship to, or dependence on, its various habitats. Data summarizing all environmental and habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity of the managed species should be provided.

RFMCs must obtain this information to describe and identify EFH from the best available sources, including peer-reviewed literature, unpublished scientific reports, data files of government resource agencies, fisheries landing reports and other reliable sources. The scientific rigor of the reports, and species-specific data gaps and potential deficits in data quality should be taken into consideration.

In order to analyze habitat information, the EFH Final Rule specifies the following for organizing the data necessary to describe and identify EFH:

- **Level 1:** Distribution data are available for some or all portions of the geographic range of the species. Distribution data may be derived from presence/absence sampling and/or may include opportunistically collected information on species and life stages. In the event that distribution data are available for only portions of the geographic area occupied by a particular life history stage of a species, habitat use can be inferred on the basis of distributions among habitats where the species has been found and on anecdotal information about its habitat requirements and behavior. Habitat use may also be inferred from information on a similar species or another life stage.

- **Level 2:** Habitat-related densities of the species are available. At this level, quantitative data (i.e., density or relative abundance) are available for the habitats occupied by a species or life history stage. Because the efficiency of sampling methods is often affected by habitat characteristics, strict quality assurance criteria should be used to ensure that density estimates are comparable among methods and habitats. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. When assessing habitat value on the basis of fish densities in this manner, temporal changes in habitat availability and utilization should be considered.

- **Level 3:** Growth, reproduction, or survival rates within habitats are available. At this level, data are available on habitat-related growth, reproduction, and/or survival by life history stage. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life history stage).

- **Level 4:** Production rates by habitat are available. At this level, data are available that directly relate the production rates of a species or life history stage to habitat type, quantity, quality, and location. Essential habitats are those necessary to maintain fish production, consistent with a sustainable fishery and the managed species' contribution to a healthy ecosystem.

RFMCs should strive to obtain data sufficient to describe habitat at the highest level of detail (i.e., Level 4). If scientists and managers have no information on a given species or life stage and habitat use cannot be inferred from other means, EFH should not be designated.

The EA for Amendments 55/55/8/5/5 identified EFH information levels for groundfish, crab, scallops, and salmon in the Alaska region. Level 2 data are available for some adult life history stages of groundfish, crabs, and shellfish. Level 2 data are also available for some stocks of red and blue king crab, tanner and snow crab stocks in some regions, at the egg, larval, late juvenile, and adult stages. The remainder of the data for all other crab stocks is either at Level 1 or unknown. Level 1 data are available for the eggs, larvae, early juvenile, and late juvenile stages of pollock, and for the late juvenile stages of most other groundfish species. Even minimal (Level 1) data are not available for forage fish at all life stages, so distribution and habitat use is considered to be unknown. Salmon EFH data are highly variable and crosses Levels 1 through 4 depending on species, stock, and life stage. The majority of the data available for adults in the freshwater stage ranges from Levels 1 to 3. The information levels for all EFH are continually being refined and updated and will be presented in the EIS currently being developed for EFH.

3.6.2 Identification of Habitat Area of Particular Concern

As defined above, HAPC are habitat types or areas that may require extra protection. While HAPC is managed in the non-specified species category (per BSAI and GOA amendment 65), these areas are included with EFH for description and impacts discussions in this Programmatic SEIS. HAPC is defined by the following criteria.

Ecological importance is defined as the value of a habitat type to a species at a particular life stage, based on ecological function. Where there are few studies and observations of ecological function, the ecological importance of a particular habitat type may need to be inferred from the presence of species life stages. When limited data are available about a species presence or absence, ecological importance may need to be inferred from the shelter or food items the habitat is capable of providing.

Sensitivity is defined as the degree to which a habitat feature is susceptible to degradation by exposure to activities, events, or conditions. The sensitivity of a given type of habitat to a disturbance regime depends on its ecological resistance (the ability to resist change during a disturbance) and resilience (the ability to return to its predisturbance condition). Several factors contribute to ecological resistance: 1) redundancy in function of component species; 2) tolerance to environmental fluctuations; 3) physical and chemical buffering capacity or flushing characteristics; and 4) proximity of the system to its ecological limits. Resilience has four components: elasticity, amplitude, hysteresis, and malleability. Elasticity is the time required for recovery, amplitude defines the level of disturbance that allows recovery, hysteresis describes the "path" of recovery, and malleability is a measure of the plasticity of the system (i.e., its capacity to persist in an altered state). Habitat types with low resistance and resilience have high environmental sensitivity, and habitats with high resistance and resilience have low environmental sensitivity.

Exposure is defined as the probability that a habitat feature will be exposed to activities, events, or conditions that may adversely affect it. These activities were discussed in the environmental assessment/regulatory impact review (EA/RIR) to the EFH amendments (NMFS 1998a). In the marine environment, numerous land-based activities expose nearshore habitat to potentially adverse impacts. The most obvious marine activity that affects habitat, and the one activity both NOAA Fisheries and NPFMC are most accountable for, is fishing.

Rarity is defined as how uncommon the habitat feature is relative to other available habitats. In Alaska, little is known of the geographic extent and distribution of many habitat features and types, particularly in the marine environment.

Vulnerability is determined by a combination of the above factors, the area or habitat type and the priority it will be assigned for consultations. Vulnerable habitat can be defined as habitat that is susceptible to perturbation by natural or human events or activities. Such perturbation would include physical damage to or removal of features, or more general degradation of the condition or quality of an area. Physical damage and removal could be caused, for example, by anchors dragging through submerged aquatic vegetation. Degradation of quality could be caused, for example, by activities that negatively affect water quality, which, in turn, could have repercussions such as impeding the reproductive success of submerged aquatic vegetation.

Three habitat types in Alaska that meet all of the above criteria as specified in the interim Final Rule are: living substrates in shallow water, living substrates in deep water; and freshwater areas used by anadromous fish. As such, these three types were adopted as part of the five EFH amendments to Alaska's Fishery Management Plans.

These habitat types have important ecological functions, are sensitive and vulnerable to human impacts, and are relatively rare. The first two types are described below, but given that this Programmatic SEIS is concerned with the groundfish fishery, freshwater areas used by anadromous fish are not discussed further.

3.6.2.1 Living Substrates in Shallow Water

HAPCs include nearshore areas of intertidal and submerged vegetation, rock, and other substrates. These areas provide food and rearing habitat for juvenile groundfish and spawning areas for some species, such as Atka mackerel and yellowfin sole, and may have a high potential to be affected by shore-based activities.

Shallow nearshore areas (less than 50 m depth) provide important structural habitat for early juvenile instars of red king crab. Early juvenile instars are cryptic and occupy the protective refuges provided by high-relief habitat or coarse substrate, such as boulders, cobble, shell hash, and living substrates (macroalgae, bryozoans, stalked ascidians, etc.) (Sundberg and Clausen 1977). Adult red king crabs also use highly structured shallow water habitat during the mating period and will use macroalgae as cover during this period (Stone *et al.* 1993).

All nearshore marine and estuarine habitats used by fish, such as eelgrass beds, submerged aquatic vegetation, emergent vegetated wetlands, and certain intertidal zones, are sensitive to natural or human-induced environmental degradation, especially in urban areas and in areas near intensive development activities.

Juvenile rockfish are known to use eelgrass beds (Murphy *et al.* 2000). Herring also require living substrates in shallow water for reproduction. Spawning takes place near the shoreline between the high tide level and 11 m depth. Herring deposit their eggs on vegetation, primarily rockweed (*Fucus spp.*) and eelgrass (*Zostera spp.*). These seaweeds are found along much of the Alaska coastline, but they often occur in discrete patches.

3.6.2.2 Living Substrates in Deep Waters

HAPCs include offshore areas with substrates of high microhabitat diversity that serve as cover for groundfish and other organisms. These can be areas or habitat types with rich epifaunal communities (e.g., coral, sponges, anemones, bryozoans), or with large particle size (e.g., boulders, cobble). Since many deep water areas are characterized as stable environments dominated by long-lived species, the impacts of fishing can be substantial and long-term (Auster and Langton 1999).

Coral, for example, is a living substrate in deep water that has been defined as a type of HAPC. Coral is a common name for a number of diverse invertebrate species within the phylum Coelenterata. Five major taxonomic groups and at least 34 species of coral occur in waters off Alaska (Cimberg *et al.* 1981): Alcyonacea (soft corals), Gorgonacea (sea fans, bamboo corals, and tree corals), Scleractinia (cup corals or stony corals), Stylasterina (hydrocorals), and Antipatharia (black corals). Heifetz (2002) analyzed the distribution and abundance of corals based on trawl survey data collected during 1975-1998. Soft corals were most frequently encountered in the Bering Sea, while in the Aleutian Islands, gorgonian corals were most common; the Aleutian Islands also were found to have the highest diversity and abundance of corals. In the GOA, gorgonian corals and cup corals were dominant.

Some corals grow upright and branch out, whereas other species are low-growing encrusting forms. In Alaska, gorgonian corals, particularly members of the genera *Primnoa* (red tree coral) and *Paragorgia*, may be especially valuable as fish habitat due to their longevity and large size–they grow up to 3 m high and 7 m wide. Heifetz (2002) found certain fish groups to be associated with particular types of coral. For example, rockfish and Atka mackerel were the most common fish captured with gorgonian, cup, and hydrocorals, while flatfish and gadids were the most common fish captured with soft corals.

Gorgonian corals are colonies of animals composed of individual polyps that deposit a tree or fanlike skeleton that supports the colony. In general, corals are very slow-growing organisms. Some species of gorgonians may live to be over 100 years old (Risk *et al.* 1998, Andrews *et al.* 2002). Large *Primnoa* colonies may be hundreds of years old; a 5 cm diameter specimen of *Primnoa reseda* from Nova Scotia, Canada was estimated at 500 years, using isotope dating (Risk *et al.* 1998). The habitat created by these gorgonians may be occupied by communities with high biodiversity and may provide shelter for fish (Risk *et al.* 1998, Fossa *et al.* 1999). Given their size and longevity, gorgonian corals may be especially vulnerable to fishing impacts and may take over 100 years to recover (Andrews *et al.* 2002). Although scientists have limited understanding of its importance as fish habitat, deep water coral clearly provides vertical structure for fish to use for protection and cover. This has been observed in Alaska during submersible dives (Krieger and Wing 2002).

3.6.3 Management History

Passage of the MSA in 1976 marked the beginning of efforts to integrate habitat considerations into the fishery management process. The MSA directs the RFMCs to recommend management plans for commercial and recreational species of fish occurring in the EEZ. For the most part, the individual states have responsibility for managing fisheries within the territorial sea. Although some early efforts were made to address significant fishery habitat issues, the RFMCs and the NOAA Fisheries concentrated largely on ocean harvest during the first decade after passage of the MSA.

In 1983, NOAA Fisheries adopted a National Habitat Conservation Policy, uniting its MSA authority with its advisory responsibilities and authority under the Fish and Wildlife Coordination Act and NEPA. The Habitat Conservation Policy provides guidance to NOAA Fisheries regarding interactions with the RFMCs and with federal and state agencies. It also focuses NOAA Fisheries' habitat conservation efforts on specific habitat impacts potentially affecting fishery resources, marine mammals, and endangered marine species. Although the policy notifies other agencies and the RFMCs of NOAA Fisheries' intent, it does not clarify the RFMCs' role in fishery related habitat issues.

In 1986, Congress amended the MSA, essentially codifying elements of the NOAA Fisheries Habitat Conservation Policy and giving the RFMCs new authority and responsibility to include "readily available" habitat information in all FMPs. The amendments to the MSA direct the RFMCs, with guidance from NOAA Fisheries, to evaluate any effects that habitat changes may have on managed fisheries. Furthermore, the 1986 amendments give the RFMCs the opportunity to recommend habitat management measures for ongoing and proposed federal and/or state activities that could potentially adversely affect fishery resources. Federal agencies are required to respond specifically and substantively to NPFMCs recommendations within 45 days. The amendments also encourage the RFMCs to monitor state activities and to comment on those activities that could adversely affect NPFMC-managed fishery resources.

In September 1988, NPFMC adopted a policy to guide the review of habitat issues:

> *The Council shall assume an aggressive role in the protection and enhancement of habitats important to marine and anadromous fishery resources. It shall actively enter federal decision-making processes where proposed actions may otherwise compromise the productivity of fishery resources of concern to NPFMC Recognizing that all species are dependent on the quantity and quality of their essential habitats, it is the policy of the NPFMC to:*
>
> *Conserve, restore, and maintain habitats upon which commercial, recreational and subsistence marine fisheries depend, to increase their extent and to improve their productive capacity for the benefit of present and future generations. (For purposes of this policy, habitat is defined to include all those things physical, chemical, and biological that are necessary to the productivity of the species being managed.)*
>
> *This policy shall be supported by three policy objectives which are to:*

(1) Maintain the current quantity and productive capacity of habitats supporting important commercial, recreational and subsistence fisheries, including their food base. (This objective will be implemented using a guiding principle of no net habitat loss caused by human activities).

(2) Restore and rehabilitate the productive capacity of habitats which have already been degraded by human activities.

(3) Maintain productive natural habitats where increased fishery productivity will benefit society.

In light of these policy objectives, NPFMC and NOAA Fisheries have enacted certain measures that are consistent with protecting habitat and ecosystem components from potential negative impacts of fisheries. These measures include gear restrictions, time and area closures, and harvest restrictions. Of these three measures, the most widely used is closure of areas to certain gear types. A chronology of management measures undertaken by NPFMC with the primary intent or secondary effect of protecting habitat is provided in Table 3.6-1. Figure 3.6-1 depicts the groundfish closures presently enacted in Alaska's EEZ.

3.6.4 Effects of Fishing on Habitat

Benthic habitat encompasses seafloor habitat that is generally believed to be at greater risk to the impacts of fishing than non-benthic habitat in the water column. Therefore, the focus of the following analysis of past and present effects is on impacts to benthic habitats. However, discussions concerning the primary components of non-benthic habitat (physical, biological, and chemical properties of the water column) are provided. For example, Section 3.3.1 considers the effects of fishing on the physical and chemical properties of the water column; biological components are discussed in Section 3.5.4, 3.5.5 (discussion forage fish and non-specified species, respectively) and Section 3.10 (ecological relationships including predator-prey relationships and energy removal and flow between target species and other species).

In order to assess the potential effects of fishing gear on benthic habitat it is first important to characterize the type of fishing gear used, the intensity of fishing as determined by trawling patterns, and the type of substrate fished or encountered. The following subsections describe these different factors and their relative importance in predicting effects.

3.6.4.1 Gear Types

Three main classes of fishing gear are used in the Alaskan fisheries: otter trawls, longlines, and pots. Each gear type has several components or characteristics that determine its overall effect on the benthic environment. Effects of the gear are also dependant on the vulnerabilities of the substrate and organisms.

Otter Trawls

Otter trawls pull conical nets through the water; fish that encounter the open forward end are gathered into a restricted bag (codend) at the back of the net. Otter trawls have four main components that can contact the seabed: doors, sweeps, footrope, and netting.

Doors are flattened metal structures that ride vertically in the water column; their weight and force through the water act to horizontally spread the net open and force it down into the water. Some bottom trawl doors use contact with the seafloor to accomplish the spreading and downward pull. On pelagic trawls the net is pulled above the seafloor and the doors are unlikely to contact the bottom. Trawl doors used in Alaska are typically less than 9 ft long.

Sweeps are steel, fiber or combination steel and fiber cables which connect the doors to the trawl net. The cables pass over the bottom at a narrow angle from the direction of travel and herd near-bottom fish toward the net. When used on bottom trawls, these cables commonly contact the seafloor and often have protective disks strung on them. Lengths of the sweeps will vary with target species fished, substrate, and individual vessel preference. A large vessel targeting flatfish on smooth bottom may use 1,000 ft of sweeps, while a small rockfish trawler on rough bottom may only use 100 ft.

The footrope of the trawl is a cable or chain connected along the bottom edge of the trawl net and is designed to contact the seafloor on bottom trawls. The footrope usually has rubber cones, spheres or disks, collectively known as bobbins, strung along its entire length. The bobbins serve to limit damage to the netting and reduce bycatch of crabs and other invertebrates. Alternately, tire gear is used in the center net section, particularly in the Atka mackerel fishery and in the GOA fisheries for cod, rockfish and Dover and rex sole. Tire gear consists of vehicle tires or sections of tires linked side-by-side to form a continuous cylinder. This gear is effective at protecting the netting and allows fishing in areas of rough substrates where fishing would not otherwise be possible.

The netting is the least likely component of bottom trawls to directly contact the seafloor. The bobbins or tire gear act to raise the netting so that only very prominent seafloor features touch the netting without entering the trawl. The codend can contact the seafloor, particularly when it contains rocks, substrate, or numerous fish. In order to allow the net to be pulled up the stern ramp of the vessel, the codend is usually no more that 8 ft in diameter, thereby limiting the amount of bottom potentially impacted by this part of the net. The size of vessel determines the width of the trawl net fished and whether a high opening, or wide, low trawl is selected. Typically bottom trawls range in width from 36 to 90 ft across.

The pelagic trawl is a specially modified otter trawl that is designed for harvesting fish that inhabit the waters above the seabed. These trawls, which are very important in the Alaska groundfish fisheries, have very large mesh opening in the forward sections and the doors are fished above the bottom. By regulation, these trawls must not use bobbins or other protective devises, so the footropes are small in diameter, and typically consist of bare chain. Since they are fished with the doors above the seafloor, the doors have no effects on substrate. The footrope is unprotected; therefore, these trawls are not used on rough or hard substrates and are less likely to contact some of the most vulnerable habitats (Rose In preparation). Night fishing tends to be more "off-bottom" than day fishing, and fishing in high-relief hard bottom areas is all "off bottom."

Longlines

Demersal longlines consist of two buoy systems that are situated on each end of a mainline to which leaders (gangions) and hooks are attached. The mainline is usually made of sinking line and can be several miles long and have several thousand baited hooks attached. Small weights may be attached to the mainline at intervals. At the bottom of each buoyed end is a weight or an anchor. A vessel may set a number of lines, depending on the area, fishery, and site. The principal components of the longline that can contact the seabed are the anchors or weights, the hooks, and the mainline (ICES 2000 as referenced in NMFS 2001b).

In Alaskan waters, longline gear is fished on the bottom. Some vessels attach weights to the longline, especially on rough or steep bottoms so that the longline stays in place and on the bottom. Average set length in 1996 was 6 miles for the sablefish fishery, 10 miles for Pacific cod, and 4 miles for Greenland turbot. The gear is baited by hand or by machine with smaller boats tending to bait by hand. Circle hooks are usually used; however J-hooks are more common with machine baiters. The gear is deployed from the stern of the vessel while traveling at 5 to 7 knots.

Pots

Pots are enclosures that retain entering fish. Pots used in the Alaska cod fishery are generally modified from the designs developed for the crab fishery and include one-way entrances that are modified to prevent fish escape. The most common design is a rectangular frame approximately 6 ft by 6 ft by 3 ft, constructed of welded steel rods with entrances on opposite walls. Pots weigh between 500 and 700 pounds, and the weight is not greatly reduced by immersion in water. In Alaska, regulations require that each pot have its own buoyed line, so there are no underwater lines connecting adjacent pots. Each pot is sufficiently heavy that no additional anchors are required.

3.6.4.2 Trawling Patterns

Bering Sea

The continental shelf and slope region off the coast of Alaska comprises one of the most extensive fishing grounds in the world (NRC 2002). Bottom trawling in the Bering Sea began in 1929 with a Japanese operation and continued through the 1930s and early 1940s, recommencing in the 1950s after World War II. Soviet and other distant water trawl fishing operations intensely fished the Bering Sea and GOA through the 1960s and 1970s. Domestic bottom trawling began as joint ventures in the Bering Sea in 1978 after passage of the MSA in 1976. These U.S. trawl activities grew rapidly during the 1980s and had displaced foreign fishing by the end of the 1980s. Presently the groundfish fleet is divided into catcher vessels and catcher processors. In 1999, the catch was almost equally divided between the two sectors (NMFS 2001a).

Therefore, virtually all areas of the Bering Sea have experienced some degree of exposure to bottom trawls (Figure 3.6-2). However, the intensity of exposure, measured in trawls made per unit area, varies substantially. These patterns reflect the non-random behavior of fishing fleets, which is based on historical patterns of performance and regulatory restrictions. Relatively heavy trawling has occurred in three places: along the shelf edge, along the Alaska Peninsula near Unimak Island, and in Togiak Bay. The primary composition of the catch in these three areas, respectively, was pollock, Pacific cod and Greenland turbot; Pacific cod and pollock; and yellowfin sole (Fritz *et al.* 1998).

Bottom trawling in the Bering Sea during the early 1990s was most intense on the slope and shelf area north of the Aleutian Islands (NRC 2002). The Alaska peninsula in the area of Unimak Island, east of the Pribilofs west of Bristol Bay and off of Cape Constantine, was also heavily fished. However, large areas of the Bering Sea have no trawling activity because of closed management areas, less productive fishing grounds, or unobserved tows. However, both the spatial extent and intensity of fishing effort decreased in the 1990s. Over large parts of the Bering Sea there were either no observed bottom trawls or only about four tows averaged over two years (NRC 2002). Also see: http://www.afsc.noaa.gov/race/groundfish/habitat/hist_trawldata.htm for additional information.

GOA and Aleutian Islands

Coon *et al.* (1999) described the spatial and temporal patterns of bottom trawl effort in the GOA and Aleutian Islands from 1990 to 1998 by analyzing domestic observer data. The greatest bottom trawl effort in the GOA has taken place in the Kodiak Island region (Figure 3.6-3), where directed fisheries have targeted Pacific ocean perch, Pacific cod, and flatfish. In the Aleutian Islands, intense bottom trawl effort (Figure 3.6-4) has been directed at Atka mackerel and Pacific ocean perch. There has been a significant reduction in the geographic extent and intensity of trawling in the Aleutian Islands and the GOA also. The number of tows in the region was reduced by about half due to management area closures and general reductions in fishing effort associated with fisheries management and reduction of TAC. In considering the fishing effort distribution, it is important to consider that, even within depth-area strata, fishing effort is not evenly distributed. Some areas are rarely fished and some are fished frequently.

3.6.4.3 Type of Substrate Fished

Most bottom fishing off the coast of Alaska takes place on the continental shelf and upper slope in water depths of less than 500 m. The seafloor affected, or potentially affected, covers a wide range of habitats, from relatively featureless sand and mud, to more complex rocky areas, or areas of HAPC. Hard substrates and rocky areas provide the most habitat complexity for the benthic community and are likely to be more vulnerable to fishing disturbance.

NOAA Fisheries and the AFSC are currently conducting research to map limited areas of the Alaska EEZ for geographic characterization. During 2001, 900 km^2 of seafloor near Kodiak were mapped using a high-resolution multi-beam echo-sounder. In July 2002, an additional 500 km^2 of seafloor near Yakutat were mapped. Survey depths ranged from 100 m to 760 m and the seafloor consisted of irregular seabed with mixed sediments (sand, mud, gravel) and high-relief areas consisting of boulders. The mapping of the area allows habitat characterization to be compared to fishing intensity for analysis of impacts. See: http://www.afsc.noaa.gov/Quarterly/jas2002/divrptsABL2.htm for additional information on the results of this study.

Four habitat types in the Bering Sea shelf were defined by (Rose, in preparation) using habitat sediment data in Smith and McConnaughey (1999). Figure 3.6-5 depicts these habitat strata. The first, situated around the shallow eastern and southern perimeter of the shelf and near the Pribilof Islands, consists of sand substrates with a small amount of gravel.

The second lies across the central shelf out to the 500 m contour and is composed of mixtures of sand and mud. This sand/mud habitat of the EBS is subject to a high level of effort from a variety of fisheries, pollock fishing accounts for the largest effort with substantial contributions from trawling for flathead (and other) sole, yellowfin, and rock sole and a lesser proportion from cod trawling (Rose, in preparation).

A third strata, west of a line between St. Matthew and St. Lawrence Islands, is composed primarily of mud (silt) substrates with some sand mixed in. The fourth strata is found north and east of St. Lawrence Island including Norton Sound and consists of a complex mixture of substrates that are not easily separated out or defined; however, this areas is subject to very little fishing effort.

A similar compressive substrate data set does not exist for the GOA and Aleutian Islands. Compared to the Bering Sea, the GOA has relatively weaker currents and tidal action near the seafloor and, therefore, a variety of seabed types such as gravely-sand, silty-mud, and muddy to sandy gravel, as well as areas of hardrock are found there (Hampton *et al.* 1986). For both of these areas, sufficient data to describe the spatial distributions of these substrates does not exist. However, data collected from AFSC groundfish surveys regarding "trawlability" were compiled to approximate percentages of hard substrate in the following depth strata (Rose, in preparation):

- Shallow waters (1-100 m) - 19 percent hard substrate.
- Deeper areas on the shelf (gullies; 100-300 m) - 5 percent hard substrate.
- Upper slope (200-500m) - 10 percent hard substrate.

These areas are also depicted on Figure 3.6-5. However, the percentages of hard bottom substrate as derived from "trawlability" data are limited in interpretation due to several factors:

- A standard trawl may function well on hard substrate consisting of smoother pebbles and cobbles.
- Trawlable bottom may be found in areas of mostly hard substrate.
- Patches of soft bottom may exist in otherwise untrawlable areas.

Investigations of the northeast GOA shelf (less than 200 m) have been conducted between Cape Cleare (148°W) and Cape Fairweather (138°W) (Feder and Jewett 1987). The shelf in this portion of the GOA is relatively wide (up to 100 km). The dominant shelf sediment is clay silt that comes primarily from either the Copper River or from the Bering and Malaspina Glaciers. When the sediments enter the Gulf, they are generally transported to the west. Sand predominates nearshore, especially near the Copper River and the Malaspina Glacier.

Most of the western GOA shelf (west of Cape Igvak) consists of slopes characterized by marked dissection and steepness. The shelf consists of many banks and reefs with numerous coarse, clastic, or rocky bottoms, and patchy bottom sediments. In contrast, in the vicinity of Kodiak Island, the shelf consists of flat, relatively shallow banks cut by transverse troughs. The substrate in the area from Near Strait and the vicinity of Buldir Island, Amchitka, and Amukta Passes is mainly bedrock outcrops and coarsely fragmented sediment interspersed with sand bottoms.

The relative significance of seabed disturbance by mobile and other fishing gear must be considered in light of the magnitude and frequency of seabed disturbance due to natural causes. DeAlteris *et al.* (1999) found that in a shallow, sand substrate where natural processes are disturbing the seabed regularly, recovery of the substrate from gear-related disturbance was almost immediate. However, in deep, mud substrates the analyses indicated that natural processes are rarely capable of disturbing the seabed; therefore recovery from gear-related disturbance was slow. Many studies summarized by NRC (2002) and NMFS (2002c) indicate that more stable, biogenic, gravel and mud habitats experience the greatest impacts from trawling and have the slowest recovery rates. By comparison, those areas with less consolidated, coarse sediments that also typically experience high rates of natural disturbance, show fewer impacts. These habitats tend to be populated by opportunistic species that recolonize the area rapidly, thereby reducing recovery times.

3.6.4.4 Fishing Effects

It is important to distinguish between the direct and indirect effects of trawling and dredging on marine habitat (NRC 2002). Direct and immediate effects of fishing gear potentially include the following:

- Mortality either as part of the catch or incidentally by killing benthic and demersal species or increasing their vulnerability to predators.

- Increased food availability for scavengers due to discarded fish, fish offal and dead benthic organisms.

- Loss of habitat due to scraping and plowing thereby destroying seafloor habitat.

Indirect effects are removed in space and/or time from the actual fishing activity. These effects include post-fishing mortality, and reductions in total biomass of target fish. The reductions in biomass could subsequently affect predators, prey, competitors of the targeted species, and the overall benthic community structure. Indirect effects also could also be realized at the ecosystem level due to potential changes in energy flow and shifts in the processes of primary production, primary consumption, and secondary production (NRC 2002).

Therefore, the following are types of potential effects from fishing gear on habitat:

- Alteration of the physical structure.

- Direct mortality of benthic organisms.

- Sediment suspension.

- Physical and chemical modifications to the water column.

- Benthic community changes.

- Ecosystem changes.

Alteration of Physical Structure

Physical effects of fishing gear such as ploughing, smoothing of sand ripples, removal of stones, and turning of boulders can act to reduce the heterogeneity of the sediment surface. Boulder piles, crevices, and sand ripples can provide fish and invertebrates hiding areas and a respite from the need to swim against currents (Rose, in preparation). Removal of taxa such as worm tubes, corals, and gorgonians that provide relief and the removal or shredding of submerged vegetation can also occur, thereby reducing structures available to biota as habitat (see NMFS 2002c, Kaiser *et al.* 1998, Lindebloom and de Groot 1998, Auster and Langdon 1999).

Any type of fishing gear that is towed, dragged, or dropped on the seabed will disturb the sediment and the resident community to varying degrees. The intensity of disturbance is dependent on the type of gear, sediment type, and frequency of disturbance. Heavy gear such as the shellfish dredge and the flatfish beam trawl disturb the seabed intensely. Lighter gear, such as the otter trawl predominately used in Alaska, also cause disturbance mostly due to the trawl doors and foot ropes which can leave tracks or trenches up to several meters wide and can remove or displace boulders (Hall 1999b). There are no studies of fishing gear effects that use gear directly comparable to Alaskan pelagic trawls.

Penetration into soft mud will be considerably greater than into hard-packed sands, and effects on infauna would occur accordingly. For example, Churchill (1989) estimated that coarse sand was typically penetrated to a depth of 1 cm by otter boards whereas the penetration for fine and muddy sand was as much as 2 cm. In a summary of the effects of bottom trawls in muddy substrates, NMFS (2002c) concluded that tracks made by trawl doors can remain visible for up to 18 months. However, in shallow sandy bottom sites, tracks were no longer visible after a few days. Other researchers have determined that parts of mobile gear can penetrate up to 30 cm into the substrate (Drew and Larson 1994 as referenced in the NMFS 2001b).

Specifically, Freese *et al.* (1999) conducted experimental trawling using an otter trawl over a cobble/boulder (93 percent pebble) habitat in the eastern GOA (water depth 206-274 m). The researchers found tire marks from the trawls to be visible as disturbance to substrate or to overlying silt. On compact substrate with more cobble, the trawl path was visible as a darker band because the layer of lighter colored silt was removed. On less compact substrate the trawl path was visible as furrows ranging from 1-8 cm deep. This work concluded that a single trawl pass can displace boulders and remove or damage large epifaunal invertebrates. In a subsequent study conducted at the same site, Freese (2003) found that furrows in the substrate were still prominent after one year. Boulders that had been moved by the trawl in 1996 were also easily identified.

A number of papers describe trawl marks on substrate, including Gilkinson *et al.* (1998), who describe the scouring process in detail as part of a model door study. It is not known if the trenches might compensate for the sediment smoothing actions of other gear (NMFS 2002c). The actions of roller gear trawls can replace one type of natural sediment structures (hummocks, biogenic features, and sand ripples) with other, anthropogenic forms (door, footrope, and roller tracks). In habitats with an abundance of such natural structures, this can represent a decrease in habitat complexity, while in naturally smooth areas, an increase in complexity would be apparent.

Very little information exists regarding the effects of longlining on benthic habitat. The principal longline components that can produce seabed effects are the anchors weights, hooks and mainline (ICES 2000). Rose (in preparation) If very light weight lines are used with longline gear, effects on substrate and benthic organisms would be limited to the impact of anchors and weights (Rose in preparation). These make up less than 1/500th of the total length of the gear, so effects on the soft bottoms should be very small. However, effects in hard bottom areas could be realized through snagging on smaller boulder piles and other emergent structures.

In a report presented by NPFMC (1992b), the authors determined that setline gear often lies slack and can meander for a considerable distance along the bottom, a phenomenon confirmed by observations of halibut gear made by NOAA Fisheries scientists during submersible dives off southeast Alaska. During the retrieval process, the line sweeps the bottom for considerable distances before ascending. It snags on objects in its path, including rocks and corals. Smaller rocks are upended, hard corals are broken; however, soft corals appear unaffected by the passing line. Invertebrates and other lightweight objects are dislodged and pass over or under the line. Fish, halibut in particular, frequently moved the groundline numerous feet along the bottom and up into the water column during escape runs, disturbing objects in their path. This line motion was noted for distances of 50 ft or more on either side of the hooked fish.

Although little research has been conducted to document the impacts to physical structure from pot gear, it is likely that benthic structures (both living and non-living) could be impacted as the pots are dropped or dragged along the bottom. Eno *et al*. (2001) observed that impacted sea pens were able to recover within 72 to 144 hours of the pots being removed. The study concluded that the use of pots and traps had no lasting effects on three different habitat types. However, this study used gear much smaller and lighter than that used in Alaska waters, so the results are not directly applicable. Alaska pots have mesh bottoms that are suspended 2.5 to 5 cm above the weight rails that initially contact the substrate (Rose in preparation). Therefore, the greater weight of the pots is concentrated in a smaller area beneath the pot. Also of concern is the incidence of bottom disturbance by the weight rails as the pot is dragged across the seafloor by bad weather, currents, or during hauling. Rose (in preparation) assumes that the average pressure applied to the seafloor along the rails would be sufficient to penetrate into most substrates during lateral movement. This effect was speculated to be most similar to the effects of pelagic trawls.

Direct Mortality of Benthic Organisms

In addition to effects on the physical habitat, fishing gear can cause direct mortality to emergent epifauna. In particular, erect, foliose fauna or fauna which build reef-like structures have the potential to be destroyed by towed gear, longlines, or pots (Hall 1999b). Within the trawl tracks that could range up to several meters wide, epifauna such as sponges, corals, or gorgonians are often removed, crushed, or broken (Van Dolah *et al.* 1987). Freese *et al.* (1999) found during experimental trawling studies in the GOA that no motile invertebrates showed reductions in density as a result of trawling. The researchers also note that apparent damage to echinoids, holothurians, molluscs, and arthropods was less than 1 percent. However, substantial quantities of broken sponges and other material were brought up by the trawl, but the numbers of individuals impacted could not be enumerated.

In addition to mobility, the physical structure of the biota determines their ability to withstand and recover from the physical impacts of fishing gear. For example, thinner shelled bivalves and seastars often suffer higher damage than solid shelled bivalves (Rumohr and Krost 1991). Animals that can retract below the penetration depth of the fishing gear and those that are more elastic and can bend upon contact with the gear also fare much better than those that are hard and inflexible (Eno *et al.* 2001).

Specifically, Freese *et al.* (1999) conducted trawling impact studies in the GOA in 1996. A total of 29 taxa were identified from video transects. "Vase" sponges accounted for most of the invertebrate biomass because of their large size and high density. These sponges were especially susceptible to trawl damage. Other sponges were damaged by being knocked over onto the substrate when the cobble and pebbles to which they were attached were rolled by the trawl tire gear; individuals attached to boulders usually escaped damage. The only other large erect sessile invertebrate observed in the transects was the reticulate anemones *Arctinauge verelli* and sea whips *Stylea* sp. Over half of the sea whips were either broken or had been pulled out of the substrate, while there was no evidence of trawl damage to *A. verelli.* In a subsequent study done one year later, Freese (2003) revisited three of the transects observed in 1996. He found no new colonization of sponges to be apparent in any of the observed trawl paths, and that unlike sponge communities in warm shallow waters, communities at this site in the GOA did not appear to have the ability to return to pre-trawl population-levels after one year, nor do individual sponges have the ability to recover quickly from wounds suffered from trawl gear. However, since the study only covered a one-year period, recovery rates for these cold water species may be in excess of several years and not enough information exists at present to predict actual long-term recovery rates.

Sediment Suspension

Resuspension of sediment can occur as fishing gear is pulled along or immediately above the seafloor (NMFS 2002c). The resuspension is not unique to mobile fishing gear and can occur with longlines and pots also. The chronic suspension of sediments and resulting turbidity can affect aquatic habitat by reducing available light for photosynthesis, burying benthic biota, smothering spawning areas, and causing negative effects on feeding and metabolic rates. If occurring over large areas, resuspension can redistribute sediments having implications for nutrient budgets by burying fresh organic matter and exposing deeper anaerobic sediments (Messieh *et al.* 1991, Black and Parry 1994, Mayer *et al.* 1991, and Pilskaln *et al.* 1998).

Species' reactions to turbidity depend on life history characteristics of the organism. Effects are likely to be more significant in waters that are normally clear as compared with areas that typically experience high naturally induced turbidity (Kaiser 2000). Mobile organisms can move out of the affected area and quickly return once the turbidity dissipates (Coen 1995). Even if species experience high mortality within the affected area, those with high levels of recruitment or high mobility can repopulate the affected area quickly. Sessile or slow-moving species would likely be buried and could experience high mortality. If effects are protracted and occur over a large area relative to undisturbed area, recovery through recruitment or immigration will be hampered. Furthermore, chronic resuspension of sediments may lead to shifts in species composition by favoring those species that are better suited to recover or those that can take advantage of the additional nutrient supply as the nutrients are released from the seafloor to the euphotic zone (Churchill 1989).

Chemical Modifications to the Water Column

Disturbance due to fishing gear can cause changes in the chemical composition of the water column overlying impacted sediments. In shallow water, the impacts may not be noticeable relative to mixing effects caused by tidal and storm surges, and wave action. However, in deeper, calmer areas with more stable waters, the changes in chemistry may be evident (Rumohr 1998 as referenced in NMFS 2002c). Increases in ammonia content and decreases in oxygen have been observed in the North Sea waters, along with pulses of phosphate. Although these changes have been documented, it is not clear how they affect fish populations. Increased incidence of phytoplankton blooms could occur during seasons when nutrients are typically low. The increase in primary production could have a positive effect on zooplankton communities and on organisms up the food chain. Eutrophication, often considered a negative effect, could also occur. However, it is important to note that these releases of nutrients to the water act to recycle existing nutrients and thereby make them available to benthic organisms rather than add new nutrients to the system (ICES 1992). The recycling is thought to be less influential in the eutrophication process than the input of new nutrients from rivers and land runoff.

Changes to the Benthic Community and Ecosystem

Benthic community structure can be impacted due to direct mortality of benthic organisms potentially causing a shift in the community from low-productive long-lived species (k-selected species) to highly-productive, short-lived, rapidly-colonizing species (r-selected species). Motile species that exhibit high fecundity and rapid generation times will recover more quickly from trawl-induced disturbance that non-mobile slow-growing organisms leading to a potential community shift in chronically trawled areas (Levin 1984, NMFS 2002c).

Those organisms with long-lived larvae were only available for successful recolonization if the timing of disturbance coincided with periods of peak larval abundance; however, these species were able to colonize over much larger distances.

Specifically, McConnaughey *et al.* (2000) examined the effects of chronic trawling on soft-bottom benthos of the EBS. They found that overall species diversity and niche breadth of sedentary taxa were greater in unfished areas, but there were mixed responses within the motile groups. Lower diversity in heavily fished areas was the direct result of greater dominance by the sea star *Asterias amurensis*. To determine niche breadth for the 36 taxa that co-occurred in the heavily fished and unfished areas, the taxa were placed into three functional groups (motile, n = 16; sedentary, n = 13; infaunal, n = 7). Statistically significant differences were observed between the heavily fished and unfished areas for sedentary and infaunal organisms, but not for motile epifauna. The results indicate a more patchy distribution for the attached or non-motile members of the epibenthic community in the heavily fished area. For infaunal organisms (mainly bivalves), niche breadth was consistently greater in the heavily fished area. The authors conclude that macrofaunal biomass was higher in the heavily fished area, but the differences were not statistically significant.

Freese *et al.* (1999) postulate that reducing the number of sponges and associated invertebrate taxa also reduces the shelter value of the invertebrate community. The authors acknowledge that it is not known whether the change produces a measurable response in recruitment for any taxon and subsequent changes in the overall community. The authors conclude that these species (sponges and sea whips) are especially vulnerable to trawl damage, and extensive trawling over wide areas could impact spatial patterns of invertebrate diversity. Freese *et al.* (1999) also found an increase in the density of scavenging organisms in trawl tracks due to a chumming effect from damaged organisms.

As described above under *Direct Mortality*, the physical structure and/or mobility of biota often determines their ability to avoid, or withstand and recover from, the physical impacts of fishing gear. Therefore, a switch in dominant species based on these avoidance and survival traits could be evident in chronically trawled areas.

A potential problem that does occur with longline gear is ghost fishing of lost gear. Lost longline gear may continue to catch fish as long as bait exists on the hooks. Fish caught on the hook, may itself become a form of bait for subsequent fish. This lost gear will not stop fishing until all of the hooks are bare. The extent to which this occurs and its effects on community structure have not been analyzed.

Increased fishing pressure in a given area can also lead to changes in species distribution; changes could be evident in benthic, demersal, and even pelagic species (i.e., localized depletion). Authors have also speculated that mobile fishing may lead to increased populations of opportunistic feeders in chronically trawled areas.

3.6.5 Past and Present Effects Analysis

This section presents a discussion of the direct and indirect effects, external human controlled and natural events, and internal groundfish fishery events used for the past effects analysis. Table 3.6-2 provides a summary of the past effects analysis conducted specifically for EFH.

The past effects discussion focuses on specific direct and indirect effects of fishing on habitat that will be used to model the predicted effects for each alternative in Chapter 4 (Rose in preparation). The six types of potential effects on habitat as summarized in the literature and discussed in Section 3.6.4 are cross referenced to the effects to be modeled as follows:

Direct/ Indirect Effect Discussed from Literature	Corresponding Direct/Indirect Effect to be Modeled
Alteration of the physical structure	Changes to non-living habitat (1)
Direct mortality of benthic organisms	Changes to living habitat (2)
Sediment suspension	Changes to non-living habitat (1)
Physical and chemical modifications to the water column	Changes to non-living habitat (1)
Benthic community changes	Changes to living habitat (2) Epifaunal and infaunal prey effects (3)
Ecosystem changes.	Changes to living habitat (2) Epifaunal and infaunal prey effects (3)
Not applicable	Changes in distribution of fishing effort (4)

These effects are shown on Table 3.6-2. The following subsections describe the external and internal events and management actions applicable to the effects.

3.6.5.1 Past and Present Events

Events are described as activities or occurrences that have or had the potential to induce one or more of the effects listed above. Events can either be external or internal to the groundfish fishery. In addition, external events can either be human controlled or natural. As shown on Table 3.6-2, the following events which occurred both external to the groundfish fisheries and within these fisheries have been identified:

Dredging The action of bringing up sediment, either to deepen channels for navigation purposes, or to remove shellfish such as clams and scallops has the potential to change non-living and living habitat, and to affect epifaunal and infaunal prey. Dredging activities also resuspend large amounts of sediment and can potentially change the chemical and physical composition of the water column. If widespread and chronic these actions can cause overall changes to the benthic community.

Bottom Trawling The effects of bottom trawling and other mobile fishing gears on the physical structure of the benthos, sediment suspension, the chemical and physical composition of the water column, and benthic biodiversity (community structure) have been documented for Alaska (see Section 3.6.4), thereby changing living and non-living habitats and potentially affecting prey. External events related to bottom trawling include foreign fisheries pre-and post-MSA. These fisheries are described in more detail in Appendix B. There is also a small amount of bottom trawling conducted in the state fisheries (past and present). Internal events include the post-MSA JV fisheries and the domestic groundfish fisheries for pollock, rockfish, Atka mackerel, Pacific cod, and various flatfish.

Longline and Pot (fixed gear) Longline and pot fisheries have impacted living and non-living benthic physical structure, caused direct mortality of benthic organisms, resuspended sediment, and if extensive, could have modified epifaunal and infaunal prey in localized areas. It is unlikely that these fisheries would have caused ecosystem-wide effects. External activities or events employing fixed gear include: the IPHC-managed halibut fishery, State of Alaska managed crab fisheries, state shrimp pot fishery for spot shrimp (mainly in PWS, but was more extensive in the past), and subsistence fisheries. Fixed gear fisheries managed within the FMPs include Pacific cod, sablefish, and rockfish.

Offal Discharge This discharge has occurred both externally to the groundfish fisheries and within these fisheries. Offal discharge can alter physical structure of the benthos, cause direct mortality of benthic organisms through smothering, and resuspend sediment, alter the chemical and physical composition of the water column, and if extensive cause impacts to the benthic community or ecosystem. The latter two effects are more likely in a closed bay or system where water circulation is impeded. Significant amounts of deposition could decrease the oxygen available to benthos, creating anoxic conditions in which only a few species (mainly polychaetes) could survive. Examples of this have been observed in the past at Captain's Bay in Dutch Harbor. However, improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions.

Vessel Groundings Within and externally to the groundfish fishery, vessel groundings have impacted the physical structure of the benthos and caused direct mortality of benthic organisms; these impacts if extensive could lead to changes in the benthic community on a very localized scale. It is unlikely that ecosystem impacts would be realized due to vessel groundings, and there are no documented impacts on EFH.

Port Construction and Development The construction and development of ports has occurred in coastal GOA and Aleutian Island regions. Development has likely caused the following impacts on the benthic community: alteration of physical structure, direct mortality, sediment resuspension, chemical and physical modification of the water column, and localized changes in community structure. It is unlikely that the overall ecosystem would not have been affected due to the localized nature of these events.

Petroleum Exploration and Facilities Minimal exploration and development of petroleum facilities has occurred in the GOA. Impacts are likely similar to those described above for Port Construction and Development (particularly in the Port of Valdez). While localized community changes have occurred (i.e., Port of Valdez), extensive ecosystem changes cannot be attributed to these activities.

Oil and/or Hazardous Materials Releases Releases of pollutants into both the BSAI and GOA environments have occurred. These range from small (< 10 gallon) spills to the EVOS incident that impacted areas of the GOA. Large spills cause direct mortality, alter the chemical composition of the water column, and cause changes to the structure of the benthic community. If very large, spills or incidents have the potential to impact the entire ecosystem.

Exotic Species Bilge or ballast water could introduce exotic species to new locations. Should the species survive, community impacts could be realized. It is unlikely that ecosystem impacts could occur unless the introduction was extensive, or other factors are involved. However, impacts on EFH have not been documented and are therefore unknown.

Toxic Algal Blooms These blooms have occurred in localized areas. These external events alter the physical and chemical composition of the water column and can cause mortality to benthic and pelagic organisms. "Toxic algal blooms" applies not only to toxic microscopic algae but also to non-toxic macroalgae (seaweeds) which can grow out of control and cause such ecological impacts as displacing indigenous species, altering habitat suitability, and depleting oxygen. However, long-term community and ecosystem changes are not likely since the community is adapted to their occurrence and unless already stressed by other factors can rebound. If unable to rebound, impacts include: alterations of marine food chains through adverse effects on eggs, young, and adult marine invertebrates (e.g., corals, sponges), sea turtles, seabirds, and mammals.

Storm Surges and Wind Generated Waves These external events have likely impacted EFH through physical alteration of the bottom structure and chemical and physical modification of the water column. Unless these events are long-term and extremely severe, or occur in conjunction with other events to stress the environment, community and ecosystem changes are not expected.

Climate Effects Regime shifts, and large-scale environmental fluctuations associated with ENSO and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific Ocean (NMFS 2001a).

Volcanic Eruptions Impacts to EFH from volcanic eruptions that have occurred in the Aleutian chain, would only be realized if lava or ash reached the water. If so, impacts to the chemical composition of the water column, and indirect impacts to benthic and pelagic communities would have occurred; however, these impacts have not been documented for the BSAI or GOA. Ecosystem changes are only possible if the event was of a long duration or covered an extremely large area.

Earthquakes and Underwater Landslides Earthquakes and landslides have occurred in the GOA and Aleutian Islands. Impacts to benthic community could have occurred through burial and/or changes in the chemical composition of the water column. However, as with volcanic eruptions, impacts have not been documented for the BSAI or GOA. Ecosystem changes are only possible if the event was of a long duration or covered an extremely large area.

3.6.5.2 Past and Present Management Actions

Management actions are specific management decisions that have been determined to have had the potential to mitigate one or more of the direct/indirect effects shown on Table 3.6-2. External management actions are those determinations or regulations that have been enacted by agencies or governments outside of the jurisdiction of NOAA Fisheries and NPFMC. Nevertheless, these actions have been determined to have the potential to affect EFH in either a positive or negative manner. Internal management actions are those regulations internal to the BSAI and GOA FMPs.

External Actions

U.S. Multi- and Bi-Lateral Agreements

A detailed discussion of U.S. fisheries management prior to the MSA is presented in Appendix B. The U.S. had virtually no authority to impose regulations beyond its territorial sea (3 miles prior to 1966, then expanded to 12 miles by public law) and relied primarily on multilateral and bilateral international agreements. For example, in 1973, a bilateral agreement between the U.S. and Japan and the USSR included annual catch quotas, which reduced the catch of walleye pollock to 1.2 million mt by 1976. However, each country was still responsible for monitoring its catch quotas, the only internationally acceptable arrangement at the time. With the passing of the MSA and the increase of U.S. and JV groundfish fisheries, groundfish catch in the Bering Sea had dropped below 1 million mt by 1985 (NPFMC 2002a). Since these fisheries employed bottom trawling for the most part, it can be assumed that impacts to benthic habitat were reduced.

Circa 1980 Closures

The GOA groundfish FMP was implemented in 1978. The BSAI groundfish FMP was implemented in 1980. Both of these management plans were among the first produced under the MSA and reflect an early approach to federal fisheries management. For purposes of this Programmatic SEIS, and to assist in the description of the affected environment, a set of Circa 1980 maps was produced for two gear specific types: trawl gear (Figure 3.6-6) and fixed gear (e.g., hook-and-longline and pot gear; Figure 3.6-7). These figures illustrate a combination of spatial measures that were in effect at around that time.

The trawl map (Figure 3.6-6) is shown with three different closures types:

Blue:	No foreign groundfish fishing
Red:	No foreign groundfish trawling

Red Hatching: Seasonal no foreign groundfish trawling

Although the seasonal closures are illustrated consistently (with the exception of the darker more restrictive seasonal closures around Kodiak Island) some of these seasonal trawl closures existed for the greater part of the year.

Trawl Gear	Percent of Fishable Area: *11.5%	Percent of EEZ *4.3%

* Does not include seasonal closures

The NOAA Fisheries Reporting Areas were not in affect at this time and are for reference only.

The fixed gear map (Figure 3.6-7) is shown with three different closures types:

Blue: No foreign groundfish fishing
Green: No foreign hook and line or pot fishing
Blue Hatching: Seasonal no foreign hook and line fishing

Fixed Gear	Percent of Fishable Area: *21.0%	Percent of EEZ *7.8%

* Does not include seasonal closures

The NOAA Fisheries Reporting Areas were not in effect at this time and are for reference only.

These measures only regulated the foreign fishery conducted under a Governing International Fishing Agreement in the fishery and conservation zone seaward of the State of Alaska. Domestic vessels were not restricted by these spatial regulations. During the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most of the restricted areas were implemented to restrict foreign fishing areas and times so they would not conflict with domestic fisheries through bycatch of species important to U.S. fishermen and to reduce the potential for grounds preemption and gear conflicts. With the exception of the sablefish longline and pot fishery, and the halibut longline fishery, most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that back in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. This again was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds.

Figures 3.6-6 and 3.6-7 only show the spatial restrictions and do not take into account the other regulations affecting the foreign fishery. In 1980, other measures were used including direct allocations of OY to foreign nations and specific gear restrictions. In 1980 the federal and state management of herring was still being developed, but by August 1980 the 35-mile-wide by 30-mile-long ADF&G statistical-reporting areas had been created.

<u>Self-Monitoring of the Foreign Fishery in the EBS</u>

Japan instituted some conservation and management measures independently including a LLP and area restrictions to ease U.S. and Canadian concerns about the Japanese trawl fisheries impact on Pacific halibut (Appendix B). Benthic habitat likely benefitted from these area restrictions.

Industry Self-Imposed Actions: Gear Restrictions

Preliminary FMPs banned bottom trawling in pollock spawning grounds (pre-MSA). Due to intensive bottom trawling by the foreign groundfish and JV groundfish fisheries, a bottom trawling ban was initiated in pollock spawning habitats by the 1977 BSAI Preliminary FMP. Several of the foreign groundfish fisheries also self-imposed regulations in order to reduce their effects on pollock spawning habitats.

Clean Water Act

Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act. The Act established the basic structure for regulating discharges of pollutants into the waters of the U.S. The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. A goal of the Act is to provide for the protection and propagation of fish, shellfish, and wildlife.

Oil Pollution Act of 1990

In the wake of the spill of the Exxon *Valdez*, Congress passed the Oil Pollution Act of 1990. The Oil Pollution Act of 1990 sets forth an extensive liability scheme that is designed to ensure that, in the event of a spill or release of oil or other hazardous substance, the responsible parties are liable for the removal costs and damages that result from the incident. A responsible party includes an owner, operator, or demise charterer of a vessel. A responsible party may be liable for removal costs and damages to natural resources, real or personal property, subsistence use, revenues, profits and earning capacity, and public services.

International Laws Regarding Marine Pollutants

The International Maritime Organization is the United Nations specialized agency responsible for improving maritime safety and preventing pollution from ships. Pollution of the marine environment by ships of all types, including fishing vessels, is strictly controlled by the International Convention for the Prevention of Pollution from Ships (known as MARPOL 73/78). MARPOL 73/78 is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years.

Any violation of MARPOL 73/78 within the jurisdiction of any party to the Convention is punishable either under the law of that party or under the law of the flag state. In this respect, the term "jurisdiction" in MARPOL 73/74 should be construed in the light of international law in force at the time MARPOL 73/78 is applied or interpreted. With the exception of very small vessels, ships engaged on international voyages must carry on board valid international certificates which may be accepted at foreign ports as evidence that the ship complies with the requirements of MARPOL 73/78.

Internal Actions

Groundfish management measures intended to protect habitat, or that indirectly protect habitat by reducing fishing effort are described below:

Fishing Equipment Restrictions

Seasonal and Areal Restrictions on the Use of Specified Equipment

Many gear types and fisheries are prohibited seasonally or in some areas (see Table 3.6-1). For example, trawl fisheries are closed by regulation from January 1 to January 20 (BSAI Amendment 19, GOA Amendment 24). Longline fisheries for sablefish are prohibited from January 1 to March 15. Nonpelagic trawl (e.g., bottom trawl) gear has been prohibited in the directed pollock fishery in the BSAI (BSAI Amendment 57). Figure 3.6-1 shows existing BSAI and GOA areas closed to groundfish trawling. As shown on Table 3.6-1, both the BSAI and GOA had increased trawl area closures beginning in 1994.

Equipment Modifications

Some modifications have been done to equipment to allow escapement of particular species or life stages. Pots that are used to harvest groundfish are required to have a minimum mesh size or rings to reduce the capture of juveniles and female crabs (BSAI Amendment 16, GOA Amendment 21). Escape panels have been used for trawl gear to reduce the capture of halibut and pollock. Although a proposal for trawl mesh restrictions was evaluated several years ago, it was not implemented due to enforcement difficulties and other concerns. Recent research suggests that because many pollock that escape from trawls may have delayed mortality (Alaska Fisheries Development Foundation 1999), a regulation specifying a minimum mesh size may be counter productive.

Prohibitions on Anchoring or Setting Equipment in Sensitive Areas

No anchoring (or fishing) by vessels holding a Federal fisheries permit or by vessels engaged in commercial or sport halibut fishing is allowed in a 2.5 nm^2 area surrounding the pinnacles off Cape Edgecumbe (GOA Amendment 59). Other sensitive areas have been closed to trawling to protect habitat from potential adverse effects (see Time and Area Closures below).

Prohibitions on Fishing Activities that Cause Physical Damage

Many fishing methods (including chemicals, explosives, hydraulic dredges, bottom gillnets, etc.) have been prohibited to protect habitat from physical damage. By regulation, only specified gear types (pot, longline, trawling, jig) may be used.

Time and Area Closures

Seasonal Closures

Seasonal closures have been primarily adopted to reduce the impacts of fisheries on prohibited species and marine mammals. Seasonal time and area closures also provide added protection to the habitat within the closure area. The following paragraphs describe in detail the existing closure areas summarized in Table 3.6-1.

Area 516 exhibits a seasonal closure (BSAI Amendment 12a 1989) in order to protect red king crabs from trawls when the crabs are molting. Area 516 encompasses about 4,000 nm^2.

The Chum Salmon Savings Area was established to limit the amount of chum salmon that can be taken incidentally by trawl gear (BSAI Amendment 35). This hotspot area is closed during the month of August, and remains closed if a trigger is reached. The area encompasses about 5,000 nm^2.

The Chinook Salmon Savings Areas were designated based on high bycatch rates of chinook salmon taken in the pollock fishery. The total area encompasses about 9,000 nm^2. The areas were first established in 1995 (BSAI Amendment 21b), then later modified when the bycatch limit was reduced in 1999 (BSAI Amendment 58). The trigger limit was reduced as follows: 48,000 salmon in 1999, 41,000 in 2000, 37,000 in 2001, 33,000 in 2002, and 29,000 in 2003. Accounting for the cap begins January 1 and continues year-round. Non-pollock fisheries are exempt from the closure, and those fisheries' chinook PSC bycatch is not counted toward the cap because observer data have shown that few chinook salmon are taken by the other fisheries.

Three herring savings areas were established to limit the amount of herring taken as bycatch in trawl fisheries (BSAI Amendment 16a). Two of these areas are closed in the summer months, and one in the winter. These areas were established based on seasonal abundance of herring in given areas. Together, the herring savings areas encompass about 30,000 nm^2.

Two bycatch limitation zones (Zone 1 and Zone 2) were established to limit the amount of Tanner crab taken incidentally in trawl fisheries. These zones were first established under BSAI Amendment 10, then modified under Amendment 12a. Each zone is closed to trawling in designated target fisheries when a specified amount of bycatch is taken in those fisheries. Tanner crab bycatch zones encompass about 80,000 nm^2.

The Opilio Tanner Crab Bycatch Limitation Zone is closed when a limited amount of these crabs is taken incidentally in specified trawl fisheries (BSAI Amendment 40). This area encompasses about 90,000 nm^2.

During the summer months, all fishing vessels are prohibited within 12 nm of the three major Pacific walrus haulouts in Bristol Bay (BSAI Amendment 17).

On July 19, 2000, all trawl fishing was enjoined by court order within Steller sea lion critical habitat area (as defined in 50 CFR 226.202) in the BSAI and the GOA west of 144°W, pending development of a comprehensive biological assessment. Before this order, a complex set of seasonal and area closures was already in place to reduce the interactions of pollock fisheries and sea lions.

Year-Round Closures

Year-round closure areas have been established to protect habitat, reduce bycatch, and reduce competition with marine mammals (Figure 3.6-8). These closure areas may be considered marine protected areas under common usage, in that the habitat is partially protected from trawl gear impacts. However, the National Research Council (NRC) has adopted a narrower definition (NRC 2001), under which a marine protected area is "a spatially defined area in which all populations are free of exploitation." Under that definition, none of these closure areas would entirely qualify.

The nearshore Bristol Bay closure area encompasses 19,000 nm^2 (BSAI Amendment 37) and expanded upon the area 512 closure enacted under BSAI Amendment 10 in 1987. This area meets all HAPC criteria in that it contains rare habitat types (bryozoans and other living substrates); it is important ecologically, that is, the ecosystem for young-of-the-year red king crab survival structure is necessary for young-of-the-year red king crab survival (McMurray *et al.* 1984, Rounds *et al.* 1989, Rodin 1989); and it is a habitat type thought to be vulnerable and highly sensitive to fishing gear damage (Auster and Langton 1999). The closure area also encompasses areas where red king crab pod, a behavior that occurs when the crabs grow and move away from the epifaunal structure (Dew 1990). For a review of how this area was evaluated as a marine protected area, refer to Ackley and Witherell (1999).

The Pribilof Islands Habitat Conservation Area encompasses 7,000 nm^2 (BSAI Amendment 21a). This area meets all HAPC criteria in that it contains rare habitat types (shell hash); it is important ecologically, and it is needed for juvenile blue king crab survival (Armstrong *et al.* 1985); and it is vulnerable to damage from bottom trawls via crushing, burying, and siltation. Other gear types probably do not significantly alter or impact this habitat.

The Red King Crab Savings Area covers 4,000 nm^2 (BSAI Amendment 37). This area does not meet all HAPC criteria, but contains a known concentration of adult red king crab. It contains primarily a sand/silt substrate, which does not appear as sensitive to the impacts of fishing gear as some other substrates.

The red king crab protection zones around Kodiak Island were established under GOA Amendment 26 to reduce crab bycatch and unobserved crab mortality, and, to a lesser extent, provide habitat protection. Trawling is prohibited in some areas year-round, whereas other areas are closed on a seasonal basis. The year-round areas encompass about 1,000 nm^2.

The southeast Alaska no-trawl area covers about 52,600 nm^2. This area contains a vast amount of deep water living substrates, including red tree coral. This prohibition of trawling east of 140° was adopted as part of the license limitation program (GOA Amendment 41).

The Sitka Pinnacles Marine Reserve covers 2.5 nm^2 (GOA Amendment 59). It is an unusually productive area that contains great concentrations of spawning lingcod and a variety of rockfish species, which find shelter in the algae and anemones along the rock walls. The ADF&G and NOAA Fisheries worked together to close the area to commercial fishing for groundfish and halibut, or anchoring by groundfish or halibut vessels. Commercial and recreational salmon fishing remains open.

Amendment 60 prohibits non-pelagic trawling in Cook Inlet. The purpose is to control crab bycatch mortality and protect crab habitat in an area that has depressed king and Tanner crab stocks. The area to be protected covers about 7,000 nm^2, including state waters, where consistent restrictions have been imposed by the Alaska Board of Fisheries.

Year-round closures to pollock trawling extending out to 10 nm have been implemented around 71 Steller sea lion rookeries and haulouts (46 in GOA, and 25 in the BSAI; Figure 3.6-9). It is assumed that one half of the total closed area indicated in the figure is comprised of land, resulting in approximately 22,000 nm^2 of area covered by water being closed to pollock trawling (NMFS 2001b). These closures were implemented by regulatory amendments in 1992: BSAI Amendment 20 and GOA Amendment 25.

The entire Aleutian Islands management area is closed to pollock fishing year-round to reduce interactions of Steller sea lions and trawl fisheries targeting pollock.

Southeast Trawl Closure Areas - the year round closure, adopted as part of the LLP, prohibits all trawling east of 140°W and closes about 53,000 nm^2, of which about 2,000 nm^2 is located on the shelf.

Internal Management Summary

Adequate habitat is essential for maintaining the productivity of fishery resources, and some species or life stages require particular habitats for food, reproduction, and shelter from predators. Numerous fishery closures and/or limitations that protect benthic habitat exist in the BSAI and GOA (see Table 3.6-1 and Figure 3.6-1). The existing management measures protecting habitat include fishing seasons and area quotas, fishing gear restrictions, time and area closures, and prohibited species restrictions. The primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear. Some of the trawl closures are in effect year-round while others are seasonal (see Table 3.6-1). In general, year-round trawl closures have been implemented to protect vulnerable benthic habitat. Seasonal closures are used to reduce bycatch by closing areas where and when bycatch rates had historically been high. Additional measures to protect the declining western stocks of the Steller sea lion began in 1991 with some simple restrictions based on rookery and haulout locations, to specific fishery restrictions 2000 and 2001. Most of the areas listed on Table 3.6-1 allow fishing by gear other than trawl gear; however, ten sites shown on Table 3.6-1 lasting protection for part or all of the natural resources on a year-round basis.

Existing closures include three large areas in the Bering Sea (Red King Crab Savings Area, Nearshore Bristol Bay encompassing Area 512, and Area 516), together encompassing 27,000 nm^2. These areas, along with the Pribilof Islands closure area (7,000 nm^2) and the Opilio/Tanner Crab Bycatch Limitation Zone are closed to groundfish trawling and/or other specified fisheries such as scallop dredging on a seasonal or trigger basis to reduce potential adverse impacts on king crabs and crab habitat. The shallow areas in particular contain complex living and non-living substrates, which are essential for juvenile crab survival and are potentially sensitive to bottom trawling. The Chum and Chinook Salmon Savings Areas, the Herring Savings Area, and the Zones 1 and 2 areas are trigger closures that protect EFH for several species. While not year round, they encompass a total of nearly 125,000 nm^2. The Walrus Islands seasonal closures and the Steller sea lion critical habitat and trawl exclusion zones, and state waters (0-3 nm) are also closed to bottom trawling.

In the GOA, several discrete trawl closure areas (Kodiak No-Trawl Zones) covering about 1,500 nm^2 are set around Kodiak Island to reduce crab bycatch, but also serve to protect crab habitat. In addition, fishing with all gear types has been prohibited in an area around two nearshore pinnacles identified as supporting rare, vulnerable, and ecologically important habitat (Sitka Pinnacles Marine Reserve). The year round southeast trawl areas closure adopted as part of the LLP prohibits all trawling east of 140°W and closes about 53,000 nm^2, of which about 2,000 nm^2 is located on the shelf. Steller sea lion critical habitat and trawl exclusion zones are also identified in the GOA and will continue under Alternative 1. A proposal to close Cook Inlet to bottom trawling was approved by NPFMC in September 2000 to protect that area's crab habitat.

Putting the closure in perspective, the areas closed in the Bering Sea encompass more than twice the size of Georges Bank off the east coast of the U.S. The GOA closures encompass about 47,000 nm^2 (140,200 km^2), but a vast majority (80 percent to 90 percent) of this area is off the continental shelf, in extremely deep water.

3.6.6 Essential Fish Habitat Comparative Baseline

In general, the overall comparative baseline for habitat is generally adversely impacted in many areas, but unknown in others. Physical benthic information is limited to site-specific investigations. Existing information includes recent Bering Sea sampling grid efforts, older Outer Continental Shelf Environmental Assessment Program investigations for a portion for the central GOA, and no specific physical mapping effort for the Aleutian Islands. A complete representation of the physical benthic environment for Alaska does not exist. However some comparative conclusions can be drawn for each of the impacts in the three regions.

Non-Living Habitat Baseline

<u>Physical Characteristics: Bering Sea</u>

- Large, relatively shallow (<100m) plain consisting of mud, sand, sand and mud, and gravels. Boulders and smaller rock are scattered.
- Bedrock and gravel shelf break relatively far offshore, as compared to the Aleutian Islands.
- Non-living shell hash is common.

<u>Aleutian Islands</u>

- Volcanic island system consisting of higher relief and vertical rock wall bedrock ledges with numerous rock and gravel passes, canyons, and trenches.
- Shelf break relatively nearshore.

<u>GOA</u>

- Diverse rock, cobble, gravel, sand, and mud slope extending to bedrock shelf break consisting of canyons, banks, and flats. Non-living habitats have been historically exposed to fishing activity.

Generally, theses habitats can be categorized into hard substrates (bedrock, boulders), coarse substrates (cobble, gravel) and soft substrates (sand, mud). Harder substrates are considered static with some local relocation of smaller boulders. Softer and coarse substrates are thought to be altered in some degree, but the extent of these alterations is not well known.

Living-Habitat Baseline

Bering Sea

- Diverse benthic community consisting of infauna and epifauna such as sponges, soft and hard corals, anemones, and bryozoans.

Aleutian Islands

- Rich, diverse, concentrated benthic bio-structures such as sponges, soft corals, tree corals, and anemones.

GOA

- Diverse benthic community consisting of infauna and epifauna such as sponges, tree corals, soft corals, anemones, and bryozoans.

Benthic habitats have been exposed to fishing in larger areas of the Bering Sea, smaller areas in the GOA, and in more discrete locations in the Aleutian Islands. Benthic community diversity has been altered in these areas. However, the direct association of the fishing intensity and the degree of diversity alteration remains relatively unknown. Information suggests that areas subject to high disturbance notice some change in species diversity, as compared to similar habitats or historical species distribution. For this reason we rate the comparative baseline as conditionally significant adverse.

Habitat impacts modeling indicates that biostrucure has been reduced in these locations. In the Bering Sea, impacts to biostructure range from 1.8 to 9 percent of the fishable EEZ and 8.2 to 41.9 percent of the fished area. In the Aleutian Islands, baseline impacts ranged from 1.1 to 6.8 percent of the fishable EEZ and 5.4 to 32.6 percent of the fished area. In the GOA, baseline effects averaged over the entire fishable EEZ range from 0.9 to 6.9 percent and 3.8 to 29 percent of the fished area.

Long-lived corals and sponges are more prevalent in the Aleutian Islands. These organisms have life history traits that make them very susceptible to fishery-induced mortality. Past fishing practices have likely had lingering effects on these species. Distribution maps of living habitat based on survey data are provided in Heifetz (2001) and Malecha *et al.* (2003).

Distribution of Fishing Effort Baseline

Bering Sea

- Bottom trawl fisheries mainly target shallow and deepwater flatfish, Pacific cod, and rockfish.

- Pelagic fisheries mainly target walleye pollock and Atka mackerel.
- Pot gear fisheries mainly target Pacific cod and sablefish.
- Longline fisheries mainly target sablefish and rockfish.

<u>Aleutian Islands</u>

- Bottom trawl fisheries mainly target Pacific cod, Atka mackerel, and Pacific ocean perch.
- Pelagic fisheries mainly target walleye pollock.
- Pot gear fisheries mainly target Pacific cod, sablefish, and crab.
- Longline fisheries mainly target sablefish and rockfish.

<u>GOA</u>

- Bottom trawl fisheries mainly target Pacific cod, flatfish, and rockfish.
- Pelagic fisheries mainly target walleye pollock and Atka mackerel.
- Pot gear fisheries mainly target Pacific cod, sablefish and crab.
- Longline fisheries mainly target sablefish and rockfish.

FMPs for the BSAI and GOA distribute effort to specific fishery management units with the plan. Areas are seasonally and permanently closed to a particular gear type, during certain times, to afford protection of habitats. In the GOA, there exists a large area permanently closed to a specific gear type and a mixture of seasonal closures. In the Bering Sea there is a mixture of open fishing areas adjacent to areas closed to fishing. In the Aleutian Islands, closure areas exist for a limited number of fishing types and there are no permanent closure areas for all fishing activities.

3.6.7 Essential Fish Habitat Cumulative Effects Analysis Status

Even though at this time it is difficult to state a definitive baseline status for EFH in the BSAI and GOA, the topic will be brought forward for cumulative effects analysis. However, the following external events will not be brought forward since the impacts on EFH have not been directly observed or documented, or are likely to be minimal or have no lingering impacts:

- Vessel groundings.
- Introduction of exotic species.
- Toxic algal blooms.

- Volcanic eruptions.

- Earthquakes/underwater landslides.

All other internal and external events and management actions depicted on Table 3.6-2 will be brought forward for cumulative effects analysis.

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3.7 Seabirds

The purpose of this chapter is to describe the baseline condition of seabirds as they relate to the federally managed groundfish fishery in Alaska. This baseline condition includes a description of the pertinent natural history for each species and an assessment of the various natural and anthropogenic factors that have shaped the status of each species in Alaskan waters. These accounts summarize the human and natural impacts on each species, to the extent that they are known, and thus provide the historical and scientific basis for analyzing the potential impacts of the alternative FMPs in Chapter 4.

The geographical and temporal scope of material presented in this chapter is not consistent between different species because of the wide variety in their distributions and the incompleteness of historical information. For some species, like the short-tailed albatross, the defining events that pertain to their present status in Alaska may be well known but took place many years ago in distant waters. For other species, like many of the auklets, there are few historical records of impacts and basic biological parameters such as population trends and winter distribution are still not known. The intent is to provide as much relevant information as possible for each species. In order to minimize redundancy in the individual species accounts, general information on seabird biology and the types of effects that may impact seabird populations are described below. Information pertinent to only one species or species group will be presented in the individual species accounts.

The USFWS is the lead federal agency for managing and conserving seabirds. Its Ecological Services Program addresses fish and wildlife conservation, endangered species, and contaminants issues through the review of federally permitted, licensed or constructed projects. USFWS biologists evaluate effects of land and water resource development projects and recommend mitigation measures to the developer or responsible federal agency. The USFWS Office of Migratory Bird Management is responsible for monitoring migratory seabird populations, and their distribution and abundance. Its goals are 1) to conserve migratory bird populations and their habitats in sufficient quantities to prevent them from being considered as threatened or endangered and 2) to ensure continued opportunities to enjoy both consumptive and non-consumptive uses of migratory birds and their habitats. Data are collected annually for selected species of marine birds at geographically dispersed breeding sites along the entire coastline of Alaska. Twelve sites, located roughly 300 to 500 km apart, are scheduled for annual monitoring, and a number of other sites are monitored every three years (Figure 3.7-1). Systematic monitoring provides long-term, time series data from which biologically-significant changes may be detected, and has alerted NOAA Fisheries to negative trends in individual seabird populations (USFWS 1999a).

Seabirds spend the majority of their life at sea rather than on land. Species from two Orders account for the vast majority of seabirds discussed in this document. The albatrosses, shearwaters, fulmars, and storm-petrels belong to the Order *Procellariiformes* and are commonly called "tubenoses." The Order *Charadriiformes* has two families of birds that make up another large part of Alaskan seabirds, the gulls (family *Laridae*), and the alcids (family *Alcidae*), which include the puffins, murres, auklets, and murrelets. Other bird groups contain pelagic members, including the loons, grebes, sea ducks, and phalaropes, but only those species that regularly interact with the federally managed groundfish fisheries will be discussed.

Thirty-eight species of seabirds breed in Alaska. More than 1,600 colonies have been documented, ranging in size from a few pairs to 3.5 million birds (Figure 3.7-2). The USFWS has compiled population estimates of seabirds from many researchers at many colonies throughout Alaska (USFWS 1998a). This database is now called the Beringian Seabird Colony Catalog and is updated on the Internet as new information becomes available. Although it is the best source of information that we have on Alaska seabird numbers, many of the estimates are rated as "poor" or "fair" in quality and the resultant population totals cannot be considered reliable for anything but the most generalized discussions. They are certainly not sufficient for documenting anything but the most extreme changes in population-levels. Breeding populations are estimated to contain 36 million individual birds in the BSAI and 12 million in the GOA (Table 3.5-62). Total population size (including subadults and non-breeders) is estimated to be approximately 30 percent higher. Five additional species that do not breed in Alaskan waters but occur in Alaska during the summer months contribute another 30 million birds (Table 3.5-63).

Assessment of Population-Level Effects

In order to monitor population trends, the USFWS has established sample plots for different species in various locations, as described above. Population monitoring has been reasonably good for 5 to 20 years for most seabird species that nest on cliffs, and for some that nest on flat ground or in burrows. Information with which to estimate population trends is lacking for some open- and burrow-nesters and for almost all crevice-nesters. Groups whose populations are not monitored adequately enough to estimate population trends anywhere in Alaska include jaegers, all gulls except for glaucous-winged, terns, auklets, horned puffins, and rhinoceros auklets. Groups for which population trends are known only in a few small areas include storm-petrels, cormorants, and pigeon guillemots. The inability to estimate seabird population trends prevents analysis of past effects of fisheries management or environmental change on the seabird species. Population trends for those species that can be monitored are presented in an annual report entitled, "Breeding Status, Population Trends, and Diets of Seabirds in Alaska," published by the USFWS (Dragoo *et al.* 2001). Trends vary for different species and in different areas of the state and are summarized in the individual species accounts.

There are actually many other sources of seabird abundance and distribution information from various at-sea transect surveys over the years, including many from the Outer Continental Shelf Environmental Assessment Program (OSCEAP) in the 1970s and early 1980s. These data have been essentially unavailable to researchers because of the many different formats and parameters used to record data. A major interagency effort to standardize and compile this data in a searchable database was recently initiated and spearheaded by the USFWS and the U.S. Geological Survey (USGS)/Biological Resource Division. The North Pacific Pelagic Seabird Database is presently under development and will be made available to the public upon completion.

Seabirds are characterized by low reproductive rates, low adult mortality rates, long life span, and delayed sexual maturity—traits that make populations extremely sensitive to changes in adult survival and less sensitive to fluctuations in reproductive effort (Ricklefs 1990, Russell *et al.* 1999, Saether and Bakke 2000, Ricklefs 2000). For this reason, Russell *et al.* (1999) caution against relying on productivity studies to reach conclusions about population dynamics. However, it is much more difficult to obtain long-term demographic data on seabirds to measure survival rates than it is to measure their reproductive success. As a practical matter, reproductive data are often collected in conjunction with population trend data and it is thus tempting to use reproductive data to "explain" population trends. The problem with attributing population changes to specific impacts is that, because seabirds are long-lived animals, it may take years or decades before relatively small changes in survival rates result in observable impacts on the breeding population. One study, which modeled impacts of the loss of juvenile wandering albatross from longline incidental take, estimated it would take 5 to 10 years to detect the decline in breeding populations and 30 to 50 years for the population to stabilize after conservation measures were taken (Moloney *et al.* 1994).

3.7.1 Past and Present Effects on Seabirds

Direct Mortality from Intentional Take

Some seabird species have been hunted by Alaska Natives for thousands of years and continue to be an important source of both meat and eggs in certain communities (Denlinger and Wohl 2001). Seabirds have also been used for clothing and decoration and are important in many cultural contexts. The impacts of subsistence hunts are concentrated during the breeding season and on the colonies most accessible to Native communities.

Commercial harvests of seabirds for meat, eggs, and feathers have not been widespread in Alaska, but there are historical accounts of specific colonies and species that have suffered major impacts (Veniaminov 1840). The commercial harvest of the once abundant short-tailed albatross on its breeding colonies in Japan during the early 1900s nearly wiped out the species, a situation from which it is still recovering (USFWS 1999b). In some cases, seabird nesting sites and breeding adults have been intentionally destroyed in an attempt to displace the birds from military facilities and airport runways, such as the Laysan albatross on Midway Island (NMFS 2001e).

Direct Mortality from Incidental Take in Fisheries

Seabirds are caught incidentally in all types of fishing operations. The risk of seabirds getting caught in fishing gear varies with the density and behavior of the bird species around the fishing vessel, the type of fishing gear used, and the techniques and devices used, if any, to deter or avoid the birds. Many factors contribute to the abundance and distribution of birds at sea, including the availability of natural prey, but many species are attracted to fishing vessels in order to forage on bait, offal, discards, and natural prey disturbed by the fishing operation. The sight and sound of swarming birds can attract other birds from many miles around. For some fishermen, watching the birds is an enjoyable part of their work at sea but mostly fishermen are too preoccupied with fishing to pay them much attention. Even among those who are interested in birds, only some can distinguish one species from another, especially immature birds and very rare species like the short-tailed albatross. Relying on self-reported seabird interactions would therefore underestimate the numbers of birds taken and lead to erroneous conclusions regarding the extent of biological impacts. The first step in getting reliable data is to have trained, dedicated personnel on-board fishing vessels to actually note which species are present and how many are caught. This is not an easy task on a busy commercial fishing vessel.

The definition of "take" in the Migratory Bird Treaty Act of 1918 is "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect" (50 CFR 10.12). In a fishery context, "take" refers to birds killed or injured during commercial fishing operations, whether in fishing gear or by striking some part of a vessel. Under the Migratory Bird Treaty Act of 1918, take of migratory birds is illegal, even if it is accidental or inadvertent, unless permitted through regulations (such as hunting regulations or permit exemptions). Thus far, only certain forms of intentional take have been legalized in these ways. There are currently no regulations to allow unintentional take. The USFWS and Department of Justice are vested with enforcement discretion, which has been used in lieu of a permitting program. Enforcement has focused on those who take birds with disregard for the law and the impact of their actions on the resource, particularly where effective conservation measures are available but have not been applied ("Fact sheet" on Migratory Bird Treaty Act of 1918, K. Laing, USFWS). Executive Order 13186 (66 FR 3853-3856), "Responsibilities of Federal Agencies to Protect Migratory Birds", which was signed by the President on January 10, 2001, directs federal agencies to develop and implement a "Memorandum of Understanding" with the USFWS to promote the conservation of migratory birds affected by their actions, including mitigation of activities that cause unintentional take. NOAA Fisheries and USFWS are currently developing this framework document which will incorporate seabird protection measures designed for specific fisheries (K. Rivera, NOAA Fisheries National Seabird Coordinator, personal communication).

In addition to the Migratory Bird Treaty Act, the Bald Eagle Protection Act (16 U.S.C. 668(a)) specifically prohibits the taking of bald eagles. In February 2001, the USFWS surveyed the pollock shoreside fish processing facilities in Unalaska regarding interactions with bald eagles. Anecdotal information indicated that eagles were attracted to the pollock vessels delivering shoreside, with birds entering the ship holds and becoming caught in the hoppers as fish were being delivered. Occasionally an injured bird would be sent to the Bird Treatment and Learning Center in Anchorage, Alaska for rehabilitation. The Bird Treatment and Learning Center maintains a database recording information about the nature and cause of each bird's injury, but many birds received from Unalaska are not accompanied by information on the cause of the injury. The current database contains no birds reported as injured by groundfish fishing activities (Bird Treatment and Learning Center, personal communication).

The application of the ESA to the case of the endangered short-tailed albatross has had a major impact on the longline sector of the BSAI and GOA groundfish fisheries. The history of these ESA deliberations and management actions is detailed in the species account for short-tailed albatross (Section 3.7.4). On a global level, the Food and Agriculture Organization of the United Nations Committee on Fisheries called for increased research and mitigation of seabird take, among other species taken incidentally in worldwide fisheries, in its *Code of Conduct for Responsible Fisheries* (FAO 1995). NOAA Fisheries developed a national Bycatch Plan that addressed these issues in a document entitled, *Managing the Nation's Bycatch: Programs, Activities, and Recommendations for the National Marine Fisheries Service* (NMFS 1998b). The management actions taken to protect short-tailed albatross in the groundfish fishery have instituted the recommendations in these documents, including monitoring and mitigation, and provide substantial protection for other species as well.

Observer Program and Estimation of Incidental Take

NOAA Fisheries began to collect data on seabird/groundfish fishery interactions in 1992 and expanded those efforts through the existing North Pacific Groundfish Observer Program in 1993, 1999, and 2000 (BSAI FMP Amendments 13, 27, 37 and GOA FMP Amendments 18 and 30). The Observer Program also collects data for a wide variety of fishery management and research purposes (see Section 2.5). A major change in 1993 was to train observers in seabird identification and provide group or species identifications of incidentally caught seabirds. NOAA Fisheries coordinated with the USFWS to update the seabird section of the NOAA Fisheries observer manual and to incorporate a standardized format for reporting sightings of sensitive species. Observers began providing information on seabird avoidance measures being used by hook-and-line vessels in 1997. The information collection was expanded in early 1999 to incorporate more detailed information about the frequency of measures used during a fishing trip and specific characteristics of different avoidance measures. In 2000, observers began to record the type of seabird avoidance measures used by longliners on a haul-by-haul basis. Recently, NOAA Fisheries and USFWS have developed and distributed an improved species identification guide for seabirds that focuses on feet and bills, often the only identifiable body parts remaining when a bird is retrieved onboard.

The seabird incidental take estimation methods and procedures, developed by USFWS in consultation with NOAA Fisheries, are described in a report using 1993-1997 data from the longline fishery (Stehn *et al.* 2000). Standard statistical procedures ("separate ratio estimators" of stratified random sampling; Cochran 1977) for estimating a population total from a sample were used. USFWS and NOAA Fisheries calculated rates and estimates for all seabird species or species groups in each stratum of all fishing gears, statistical fishing areas, regions (BSAI or GOA), vessel types (processors, motherships, and catcher-only vessels), and time periods (annual or each of 13 four-week periods in a year) (Stehn *et al.* 2000). As requested by USFWS, the following eleven groups of seabirds were chosen for analysis: short-tailed albatross, black-footed albatross, Laysan albatross, unidentified albatross, fulmars, gulls, shearwaters, unidentified tubenoses, alcids, other bird species, and unidentified seabirds (those not identified to one of the other ten groups). The Observer Program data actually includes some records of birds that are identified to species but which are included in a species group for statistical and analytical purposes.

Incidental catch estimates were based on the number of seabirds by species in samples from observed hauls and the total commercial fish catch as estimated by the NOAA Fisheries blend program. The NOAA Fisheries method utilized two measures of fishing effort: total tons of groundfish catch per haul or set for the trawl fishery (NOAA Fisheries blend program), and the number of hooks or pots per set for both the longline and pot fisheries (estimated for the unobserved fishery in the NOAA Fisheries blend program using the average number of hooks or pots, respectively, in the observed fishery). The NOAA Fisheries Observer Program data is incorporated into the NORPAC database which records the number and weight of the fishery catch by species in the species composition samples and the estimated weight of the entire catch (all species combined) in the whole haul or set. NORPAC also records the number of hooks or pots in the sample and the estimated number of total hooks or pots in the whole set. The number of observed birds in a species composition sample per effort (tons or hooks or pots) of that sample was used to extrapolate the number of seabirds to the whole haul or set, and similarly upwards to the whole fishery, including the unobserved effort. Both the catch rate of birds (number of birds per weight of fish, or birds per 1,000 hooks) and the catch rate of fish (total weight of all fish species per hook/pot/net) were assumed to be equal for observed and unobserved hauls of the same gear, area, and time period. These assumptions may not hold, not necessarily because the presence of the observer may change the fishing practices of the skipper or crew, but rather because, for some other operational reason, the smaller (unobserved) vessels may have different catch rates than the large or mid-sized vessels. The constant catch rates for birds and/or fish among vessel size categories are untested and critical assumptions. If different catch rates do exist for different vessel size categories, then the average area catch rates and the estimates of the total seabird incidental catch number may be overestimated or underestimated.

In some fisheries around the world, observer data have not accounted for birds that are hooked on longlines as they were deployed but fell off before they were retrieved on board. One study from Australia (Gales *et* *al.* 1998) indicated that 30 percent to 95 percent of the birds coming out of the water fell off or were shaken off the gangions before being hauled aboard and were thus missed by observers. However, that study was based on an observer program that did not actively watch the groundline as it was retrieved. In the North Pacific Groundfish Observer Program, observers actually watch the groundline as it is retrieved and do tally birds that fall off before being retrieved on board. This accounts for some of the "unidentified seabird" data (S. Fitzgerald, NOAA Fisheries, North Pacific Groundfish Observer Program, personal communication).

Direct Mortality from Incidental Take on Longlines

At a global level, concerns about the incidental catch of seabirds on longlines led to the development of the *International Plan of Action for Reducing the Incidental Catch of Seabirds in the Longline Fisheries*, a voluntary plan endorsed by the Food and Agriculture Organization of the United Nations Committee on Fisheries (FAO 1999). The plan applies to countries in whose waters longline fishing is being conducted by domestic or foreign vessels, and countries which conduct longline fishing on the high seas and in the EEZ of other countries. The international plan calls for individual countries to develop distinct national plans of action. Consequently, in addition to the local action taken by NPFMC and the NOAA Fisheries Alaska Regional Office, NOAA Fisheries and the USFWS have developed a *National Plan of Action for Reducing the Incidental Catch of Seabirds in the Longline Fisheries* (NMFS 2001d). The purpose of the plan is to reduce seabird incidental take in those U.S. longline fisheries where incidental take is determined to be a problem by a regional fishery management council. While not prescribing specific mitigation measures, the plan provides a framework of actions that the agencies can use within their area of authority. It is intended to give NPFMCs additional flexibility to incorporate local, fishery-specific measures. The national plan calls for the regional councils to assess the extent of incidental take in their fisheries on a regular basis, mitigate problems quickly, and cooperate with national and international agencies to address more widespread issues. NOAA Fisheries Alaska Region provides an annual assessment of seabird incidental take in all three groundfish gear sectors in the "Ecosystem Considerations" section of the annual Stock Assessment and Fishery Evaluation report (NPFMC 2002c, SAFE, available from the website: http://www.fakr.noaa.gov/npfmc/safes/safe.htm.

Seabirds are hooked on longline gear as they attempt to capture the bait or scavenge fishery wastes, mostly while the line is being deployed but sometimes as it is hauled aboard. With the closure of the international high-seas driftnet fisheries in 1992, longline fishing has grown tremendously and is now considered the most serious global threat faced by albatrosses and other tubenoses (Brothers *et al.* 1999a). The impacts of longline mortality on particular species are discussed in the separate species accounts.

Estimates of the annual seabird incidental take in the groundfish longline fisheries, based on 1993 to 2001 data, indicate that approximately 14,400 seabirds were taken annually in the BSAI at an average rate of 0.09 birds per 1,000 hooks (Table 3.7-1). The species composition of these birds is: 60 percent fulmars, 19 percent gull species, 12 percent unidentified seabirds, 4 percent albatross species, 3 percent shearwater species, and 2 percent all other species (Table 3.7-2, Figure 3.7-3). In the GOA, about 1,030 birds were estimated to be taken annually between 1993-2001 at an average rate of 0.03 birds per 1,000 hooks. The species composition of these birds is: 46 percent fulmars, 35 percent albatrosses, 11 percent gull species, 4 percent unidentified seabirds, 3 percent shearwater species, and less than one percent all other species (Table 3.7-3, Figure 3.7-3).

In the following species accounts, data on the incidental take in the groundfish fisheries are reported for each species or species group. In an effort to evaluate the effectiveness of the seabird protection measures that have been enacted (see below), the average take from 1993-1996 is compared to the average take from 1997-2001. However, these comparisons should be viewed with caution for several reasons. First, many longline fishermen began using a variety of seabird deterrence techniques of their own design before the techniques were required in regulations. In fact, many of the techniques that are included in the regulations came from the longline fleet's initiative in developing effective measures. There are no data on which techniques were used or how many vessels used them, but the data from 1993-1997 are clearly not a "no deterrence" baseline. Second, many variables influence the effectiveness of a given deterrence technique, including the quality of the deployment. One factor not under the control of the fishermen is the behavior of the birds. Many fishermen and observers have reported instances where flocks of birds swarmed the vessel and appeared to be unusually aggressive and persistent in going after bait, ignoring all attempts to deter them. These birds were assumed to be under great nutritional stress due to an area-wide shortage of natural food and the fishing vessel provided the only source of food available. Certain years, like 1997 and 1998, have anomalously high incidental take rates for many species groups which indicates that these years may have had widespread food shortages, at least for certain periods during the longline seasons. Since the data set compares a group of four years (1993-1996) with a group of five years (1997-2001), one or two high years can dominate an average take level. Again, these comparisons should be viewed with these caveats in mind.

It is difficult at this time to make valid comparisons of bird incidental catch rates between regions. It is difficult to discern whether the differences between the BSAI and GOA estimated incidental catch rates are due to vastly different levels of fishing effort in each region, different vessel types used in each region (small catcher vessels in the GOA and large catcher processors in the BSAI), different distribution and abundance of birds, or some other factor. It may be possible to use the Observer Program database to make a statistical comparison of incidental catch rates from different areas but this work would require some new budgetary resources.

As a result of ESA Section 7 consultations with the USFWS and their resulting BiOp on the protection of short-tailed albatross, NOAA Fisheries required the BSAI and GOA groundfish longline fleet to employ specified seabird avoidance measures to reduce incidental take in 1997 (62 FR 23176). Prior to 1997, avoidance measures were not required but observer information indicates that some vessel operators used mitigation measures voluntarily. In order to protect short-tailed albatross in other North Pacific fisheries, NOAA Fisheries required seabird avoidance measures to be used by vessels fishing for Pacific halibut and sablefish in U.S. EEZ waters off Alaska in 1998 (63 FR 11161) and for the Hawaii pelagic longline fleet in 2002 (67 FR 34408). The Alaska longline seabird avoidance regulations have been changed several times to reflect improvements in techniques and the need to evaluate the effectiveness of those techniques in reducing incidental take. The U.S. Coast Guard is responsible for at-sea enforcement of these and other regulations and regularly checks for compliance during at-sea boardings. Reports of these compliance checks are made in the Coast Guard's report to NPFMC at each meeting. NOAA Fisheries Enforcement currently is investigating several cases involving alleged violations of seabird avoidance regulations and other seabird-related issues (T. DuBois, NOAA Fisheries Enforcement, personal communication).

As of the 2002 season, all vessel operators using hook-and-line gear to fish for groundfish and Pacific halibut must conduct fishing operations as follows:

- Use baited hooks that sink as soon as they are put in the water.

- Discharge offal in a manner that distracts seabirds from baited hooks (if discharged at all during the setting or hauling of gear).

- Make every reasonable effort to ensure that birds brought on board alive are released alive.

In addition, all applicable hook-and-line vessels at or more than 26-ft length overall, must employ one or more of the following four measures:

- Set gear at night (during hours specified in regulation);

- Tow a streamer line or lines during deployment of gear to prevent birds from taking hooks.

- Tow a buoy, board, stick, or other device during deployment of gear at a distance appropriate to prevent birds from taking hooks;

- Deploy hooks underwater through a lining tube at a depth sufficient to prevent birds from settling on hooks during the deployment of gear.

Fishermen currently are provided some flexibility to choose the most appropriate and practicable methods for their vessel size, fishery, and fishing operations and conditions.

In September of 1998, two short-tailed albatross were taken by longline vessels that were using required avoidance measures in the BSAI cod fishery. However, at least one of these takes was the result of a poorly deployed avoidance technique. Concerned that the incidental take threshold for short-tailed albatross could be exceeded, the longline fleet petitioned NPFMC to improve the seabird avoidance measures and to specify performance standards for their deployment. In 1999, NPFMC recommended revising the existing regulations to make the most effective avoidance techniques mandatory. They also recommended that NOAA Fisheries undertake for the first time a comprehensive scientific study to experimentally determine the effectiveness of seabird deterrent measures. This research, conducted by the Washington Sea Grant Program in 1999 and 2000 in the IFQ halibut and sablefish fishery and in the BSAI Pacific cod freezer-longliner fishery, was a cooperative effort funded by NOAA Fisheries, USFWS, and the Washington Sea Grant Program, with major support by the North Pacific Groundfish Observer Program and the longline industry. It was the largest study of its kind in the world with over 1.2 million hooks set in the sablefish fishery and over 6.3 million hooks set in the cod fishery.

The results of the study were presented to NPFMC in October 2001 in its final report, "Solutions to Seabird Bycatch in Alaska's Demersal Longline Fisheries" (Melvin *et al.* 2001). The study found that paired streamer lines of specified performance and material standards successfully reduced seabird incidental take in both years, regions, and fleets by 88 to 100 percent relative to controls with no deterrent. Single streamer lines of specified performance and material standards were slightly less effective than paired streamer lines, reducing seabird incidental take by 96 percent and 71 percent relative to controls with no deterrent in the sablefish and cod fisheries, respectively. While the study participants took special precautions when short-tailed albatross were sighted and none of these birds were caught during the study, the dramatic reduction of incidental take of similar-feeding species with the use of paired streamer lines indicates that the risk of incidental take to the endangered species would be greatly reduced if this avoidance measure was widely adopted. However, despite their effectiveness in reducing overall take, single streamer lines were five times more likely to take Laysan albatross compared to paired streamers. The Washington Sea Grant study did not recommend use of single streamers to reduce the potential for taking short-tailed albatross.

Based on the results of their research (Melvin *et al.* 2001), the Washington Sea Grant Program, USFWS, and NOAA Fisheries jointly developed recommended changes to the existing seabird avoidance regulations required in the groundfish and halibut hook-and-line fisheries off Alaska. At its October and December 2001 meetings, NPFMC reviewed these recommendations, made some changes, and requested NOAA Fisheries to implement the necessary regulations. NPFMC's recommendations include the following:

- Vessels over 55 ft (16.8 m) LOA using hook-and-line gear in the EEZ would be required to use paired streamer lines of specified performance and materials standards.

- Vessels over 26 ft (7.9 m) LOA to 55 ft (16.8 m) LOA using hook-and-line gear would be required to use less stringent measures such as a buoy bag line or single streamer line—each with its own specified performance and materials standards. The requirement would depend upon fishing location ['Inside' or EEZ, where 'Inside' is PWS (NOAA Fisheries Area 649), southeast inside district (NOAA Fisheries Area 659), and state waters of Cook Inlet], vessel type (if masts, poles, or rigging are on vessel), and gear type (if snap gear is used).

- The performance and material standards for measures required on smaller vessels would be guidelines for an interim one-year period, at which time they would become required.

- Directed discharge (through chutes, pipes, or other similar devices suited for purpose of offal discharge) of residual bait or offal from the stern of the vessel while setting gear would be prohibited.

- Prior to offal discharge, embedded hooks would be removed from offal.

- A Seabird Avoidance Plan would be required onboard the vessel.

- Vessels less than or equal to 32 ft (9.8 m) LOA fishing for halibut in IPHC Area 4E within 0 to 3 miles of shore would be exempt from seabird avoidance measures.

- Vessels less than or equal to 26 ft (7.9 m) LOA would continue to be exempt from seabird avoidance measures.

The proposed seabird avoidance measures would apply to the operators of vessels using hook-and-line gear for:

- Pacific halibut in the IFQ and CDQ management programs (0 to 200 nm).

- IFQ sablefish in EEZ waters (3 to 200 nm) and waters of the State of Alaska (0 to 3 nm), except waters of PWS and areas in which sablefish fishing is managed under a State of Alaska limited entry program (Clarence Strait, Chatham Strait).

- Groundfish (except IFQ sablefish) with hook-and-line gear in the U.S. EEZ waters off Alaska (3-200 nm).

The longline fleet has been proactive in adopting these techniques and most vessels may already be in compliance in advance of the forthcoming regulations. At its March 2002 meeting, the Alaska Board of Fisheries approved a proposal that will change state groundfish regulations to parallel federal regulations governing seabird avoidance measure requirements for operators in hook-and-line fisheries.

NOAA Fisheries published the proposed regulations in February 2003 (68 FR 6386) and final regulations on January 13, 2004 (69 FR 1930). These regulations are in effect as of February 2004 and vary by length of vessel, area fished, type of gear, and other factors. They are available at NOAA Fisheries website http://www.fakr.noaa.gov/protectedresources/seabirds.html.

NOAA Fisheries attempted to incorporate the most current information as possible into this Final Programmatic SEIS document. Seabird avoidance measures are discussed throughout the following species accounts in Chapter 3 and in the analysis of alternatives in Chapter 4. Due to the timing of the publication of the Final Programmatic SEIS document and the newest regulations published in January 2004, only the Preferred Alternative analysis specifically references the new seabirds BiOps. However, the analyses of seabird impacts under Alternatives 1 through 4 in the Final Programmatic SEIS were written anticipating the adoption of these new regulations and therefore, no changes to significance ratings were necessary. The interested reader is directed to NOAA Fisheries website for the most recent fishing regulations that concern seabirds.

Direct Mortality from Incidental Take in Trawls

On trawl vessels only, observers may use any one of three different sample sizes of groundfish catch to monitor incidental take of birds in a haul. Observers are currently advised to use the largest of the three sample sizes whenever possible. However, observers do not record the sample size choice for monitored hauls which have no observable seabird take. Thus, it has been necessary to calculate two alternative sets of estimates for incidental take in trawls based on the smallest and largest sizes of sampling effort recorded. In each of these two alternative calculation methods, a "separate ratio estimator" was used to bind the results of the catch ratios and variances of data from the three different sample sizes into arbitrary equal samples which were then extrapolated to the total catch effort of the NOAA Fisheries blend program. Although, it is not known with certainty which of the two sets of estimates is more accurate, the level of seabird bycatch on trawl vessels during the 1990s probably lies somewhere between the two sets of estimates. Observer Program data on the numbers and species composition of incidental take in the combined BSAI and GOA trawl fisheries is currently available for 1997 through 2001 (Table 3.7-4). During this time period, an estimated average of between 961 to 9,687 seabirds were taken in trawls each year. Based on the means of the high and low estimates for each species group, the species composition of these birds is approximately: 58 percent fulmars, 15 percent shearwaters, 8 percent unidentified seabirds, 5 percent gulls, 5 percent alcids, 5 percent other species, 2 percent unidentified tubenoses, and 2 percent Laysan albatross.

Diving species, including some alcids, are taken more frequently in trawls than they are on longlines. However, trawls actually take many more individuals of the surface-feeding and shallow-diving species than they do of deep-diving species. Many of these birds are probably caught in trawls as they attempt to scavenge processing wastes or capture escaping fish as the net is being retrieved, rather than while it is actively fishing at depth. NOAA Fisheries analysis of 1997 to 2001 observer data indicates that trawl gear accounted for 6 to 35 percent of the total average annual incidental take of seabirds in the BSAI and GOA groundfish fisheries, depending on the trawl sampling methodology used (Figure 3.7-4).

Direct Mortality from Incidental Take in Pot Gear

Pot gear is the cleanest type of fishing as far as seabird incidental take is concerned. It accounts for only a small fraction of the total numbers of seabirds taken in the BSAI and GOA groundfish fisheries (Figure 3.7-4). Observer Program data on the numbers and species composition of incidental take in the combined BSAI and GOA pot fisheries are currently available for 1993 through 2001 (Table 3.7-5). During this time period, an estimated 48 birds were taken in pot gear per year, about 70 percent of which were northern fulmars. Many of these birds may have been killed by collisions with pot gear as it sat on deck, rather than as it was fishing.

Direct Mortality from Vessel Strikes

Seabirds sometimes strike vessels and fishing gear in flight. Some birds fly away without injury but others are injured or killed. The Observer Program records of bird-strikes from 1993-2000 have been entered into the Observer Notes Database (USFWS, Anchorage). Statistical analysis of the bird-strike data has not been completed but some preliminary summaries can be made (NPFMC 2002c). There are 120 definitive records of birds striking the vessel (n = 101) or the rigging (n = 19). The main species involved in vessel strikes were northern fulmars (564 birds in 38 incidents), Laysan albatross (21 birds in 15 incidents), storm-petrels (631 birds in 19 incidents), crested auklets (1,305 birds in seven incidents), and sooty shearwater (526 birds in six incidents), with almost half of the birds being killed or injured. As the last two records indicate, collisions of large numbers of birds occasionally occur. In one historical account, approximately 6,000 crested auklets were attracted to lights and collided with a fishing vessel near Kodiak Island during the winter of 1977 (Dick and Donaldson 1978). Bird strikes are probably most numerous during the night and during storms or foggy conditions when bright deck lights are on, which can cause the birds to become disoriented. From the limited number of observer records that included weather observations (n = 53), most of the bird-vessel interactions occurred when it was snowing (83 percent), with some occurring during rain (10 percent) or fog (seven percent). The proximity of the vessels to seabird colonies during the breeding season is also a factor (V. Byrd, USFWS, personal communication).

Many trawl vessels deploy a cable ("third wire") from the vessel to the trawl net monitoring device (sonar transducers). There are 16 records of birds striking the "third wire" in the Observer Notes Database. These incidents involved 79 birds, mainly fulmars and Laysan albatross, with approximately 90 percent mortality. However, these cables are not typically monitored by groundfish observers and any birds killed by such collisions would not be likely to make their way into the trawl net and would therefore not be recorded in observers' haul samples. The distribution and extent of seabird mortalities or injuries by species are therefore unknown. NOAA Fisheries' AFSC is currently pursuing the possibility of using video technology to evaluate this issue. NOAA Fisheries and USFWS are presently trying to determine if this impact poses a threat to short-tailed albatross (USFWS 2000c). Solutions may be as simple as hanging streamers from the third wire (G. Balogh, USFWS, Anchorage – personal communication).

Indirect Mortality or Reduced Fitness

The following effects are classified as indirect because the impacts are removed in time and/or space from the initial incident. In some cases, individual birds may be killed outright by the effect. In other cases, individuals are affected in ways that may decrease their chances of surviving natural phenomenon or reproducing successfully. These sub-lethal impacts may thus decrease their overall "fitness" as individuals and may have population-level implications if enough birds are impacted.

Indirect Effects Through Changes in Prey Availability

Seabird species differ greatly from one another in their prey requirements and feeding behaviors, leading to substantial differences in their responses to changes in the environment. Diets consist largely of fish or squid less than 15 cm long and large zooplankton. Although they may take a wide variety of prey species during the year, most seabirds in a given area and time depend on one or a few prey species (Springer 1991b). Diets and foraging ranges are most restricted during the breeding season, when high-energy food must be delivered efficiently to nestlings, and are somewhat more flexible at other times of the year. Winter foraging ecology is not known for most species (Hunt *et al.* 1999b). Seabird diets have been summarized in Tables 3.5-62 and 3.5-63 and specific research results are cited in the following species accounts.

A major constraint on seabird breeding is the distance between the breeding grounds on land and the feeding zones at sea (Weimerskirch and Cherel 1998). Breeding success in most species varies among years, but in stable populations, poor success is compensated for by occasional good years (Boersma 1998, Russell *et al.* 1999). Adult non-breeding seabird survival is unlikely to be affected by the common interannual variability of prey stock because adults can shift to alternative prey or migrate to seek prey in other regions. In contrast, breeding birds are tied to their colonies and local fluctuations in fish availability can have a dramatic effect on seabird reproduction. If food supplies are reduced below the amount needed to generate and incubate eggs, or if the specific species and size of prey needed to feed chicks are unavailable, local reproduction by seabirds will fail (Hunt *et al.* 1996a). The natural factor most often associated with lower breeding success is food scarcity (Kuletz 1983, Murphy *et al.* 1984, Murphy *et al.* 1987, Springer 1991b, Furness and Monaghan 1987, Croxall and Rothery 1991, Cairns 1992). Reproductive success, therefore, is usually limited by food availability (Furness 1982, Croxall and Rothery 1991).

Some authors believe that food is more limited in winter than summer for many species (Croxall 1987). Outside the breeding season, diets, feeding habitats, energy requirements, and distribution have been studied only minimally for most seabird species. Limited information suggests that in winter months many seabirds consume a greater variety of fish as well as higher proportions of zooplankton and invertebrates (DeGange and Sanger 1986, Sanger 1987).

The availability of prey to seabirds depends on a large number of factors and differs among species and seasons. All seabird species depend on one or more oceanographic processes that concentrate their prey at the necessary time and place; these include upwellings, stratification, ice edges, fronts, gyres, and tidal currents (Schneider *et al.* 1987, Coyle *et al.* 1992, Elphick and Hunt 1993, Hunt and Harrison 1990, Hunt

1997, Hunt *et al.* 1999b, Springer *et al.* 1999). Oceanographic phenomena that influence seabird foraging habitat primarily are on the scale of hundreds of meters to hundreds of kilometers (Hunt and Schneider 1987). Favorable foraging conditions are likely to last for a relatively short time (hours to weeks) at one spot and for many seabirds foraging in shelf waters, small-scale physical processes that concentrate prey are very important for successful foraging (Hunt *et al.* 1999b). Prey availability may also depend on the ecology of food species, including productivity, other predators, food-web relationships of the prey, and prey behavior, such as migration of fish and zooplankton. Many factors that influence prey availability are completely unknown. Most critical is the lack of information on how events beyond a seabird's foraging range may influence the prey availability. Such factors may include environmental changes, fluctuations in regionwide stocks of forage and non-forage species, and commercial harvests.

Reductions in the availability of forage fish to seabirds have been attributed to both climatic cycles and commercial fisheries but a NRC study (1996) concluded that both factors probably are significant. Regime shifts are major changes in atmospheric conditions and ocean climate that take place on multi-decade time scales and trigger community-level reorganizations of the marine biota (Anderson and Piatt 1999). Two cycles of warm and cold regimes have been documented in the GOA in the past 100 years, with the latest shift being from a cold regime to a warm regime in 1977. The consequences of this shift on fish and crustacean populations have been documented, including major improvements in groundfish recruitment and the collapse of some high-value forage species such as capelin and Pacific sand lance (Anderson and Piatt 1999). Unfortunately, that is around the time that data on most Alaskan seabird populations began to be collected so the effects of regime shifts on seabird populations can only be surmised on general principles. Declines in the breeding success and populations of piscivorous (fish-eating) species in several areas of Alaska have been attributed to the general decline in certain forage fish species (Springer 1992, NRC 1996, Piatt and Anderson 1996, Kuletz *et al.* 1997, Francis *et al.* 1998, McGowan *et al.* 1998, Anderson and Piatt 1999, Agler *et al.* 1999). However, directed fisheries on forage fish can deepen and prolong their natural low population cycles (Duffy 1983, Steele 1991). In nations with directed forage fish fisheries, some stocks have been decimated due to a combination of climatic and fishery pressures, which led to local population declines in seabirds (Duffy 1983, Anker-Nilssen and Barrett 1991, Crawford and Shelton 1978).

Competition and predation may also influence seabird prey availability. Links between seabirds and other species could be direct or they could be extremely diffuse and indirect. Possible links include competition between seabird species (Mehlum *et al.* 1998, Hunt *et al.* 1999b); competition of piscivorous seabirds with other large marine predators such as marine mammals and fish (Harrison 1979, Hunt 1990, Obst and Hunt 1990); cannibalism by large pollock on the smaller pollock preyed on by some seabirds; competition for food among forage species, such as small pollock, capelin, Pacific sand lance, herring, myctophids, and squid; competition between planktivorous seabirds with whales or planktivorous fish (including forage fish of other seabird species); and even ecosystem links with groups such as jellyfish. Little information is available on the magnitude or direction of these potential links.

The fraction of total exploitable stocks in the EBS that are consumed by seabirds has been estimated at 3 percent for pollock and less than one percent for herring (Livingston 1993), which is similar to an estimate of 4 percent for Pacific sand lance in the North Sea (Furness and Tasker 1997). Seabirds, therefore, may account for a very minor proportion of forage fish mortality, even for the young age classes that they consume (Livingston 1993). Seabirds may have greater impacts on fish stocks within foraging range of seabird colonies, however, because the birds are concentrated there during summer (Springer *et al.* 1986, Roseneau *et al.* 1998, Birt *et al.* 1987). About 15 to 80 percent of the biomass of juvenile forage fish may be removed by birds near breeding colonies each year (Wiens and Scott 1975, Furness 1978, Springer *et al.* 1986, Logerwell and Hargreaves 1997). This suggests that food availability to birds may be limited, at least in a given season, by the size of the local component of fish stocks. Seabirds may, therefore, be vulnerable to factors that reduce forage fish stocks in the vicinity of colonies (Monaghan *et al.* 1994).

In April 1997, NPFMC adopted Amendment 36 to the BSAI FMP and Amendment 39 to the GOA FMP to prevent the development of commercial fisheries for forage fish. NOAA Fisheries published the final rule implementing the regulations on March 17, 1998 (63 FR 13009). Amendments 36/39 defined a forage fish species category and prevented the development of a commercial directed fishery for forage fish. The amendment established a 2 percent maximum retainable bycatch (MRB) amount in other directed fisheries and prohibited the selling, bartering, trading, or receiving any remuneration for forage fish species. However, within the 2 percent limit, forage fish could be reduced to fish meal and sold. Forage fish identified under this action include: capelin, smelt, lanternfish, deep-sea smelts, sand lance, bristlemouths, pricklebacks, gunnels, Pacific sandfish, and euphausiids. These amendments are presumed to have had beneficial impacts on the availability of prey to seabirds but no quantitative benefits have been demonstrated to date.

Indirect Effects Through Ingestion of Processing Wastes and Discards

Scavenging of fishery wastes can influence population trends in either direction. About 30 percent of the total food consumed by seabirds in the North Sea is estimated to be offal and discards (Tasker and Furness 1996). These foods are, therefore, of direct importance in sustaining populations of some seabirds. Processing wastes may not be adequate foods for successfully rearing chicks (Murphy *et al.* 1984, Baird and Gould 1986, Irons *et al.* 1986, DeGange and Sanger 1986), but abundant scavenging during winter may increase populations because survival of immature birds is enhanced (Patten and Patten 1982). On the other hand, if populations of the larger gull species increase, local populations of other species may be reduced through increased competition for nest sites and predation pressure on their young (Spaans and Blokpoel 1991, Furness 1999). Sudden withdrawal of discards might cause the predatory species to increase pressure on other species long before the predator populations decline to previous levels (Furness 1999). In the North Sea, numerous instances are cited showing potential relationships between discards in diets and changes in breeding populations of different species, some of which were beneficial and some adverse (Garthe *et al.* 1999). No data are available on these effects in Alaska.

The seabird species whose normal foraging behavior includes scavenging on dead material, including the tubenoses and gulls (Patten and Patten 1982, Furness and Ainley 1984, Gould *et al.*1997), are strongly attracted to the food provided by fishing vessels. While this may benefit individual birds, it also places them in danger from entanglement and incidental take in fishing gear. As discussed above, incidental take may have population-level impacts on some seabird species and is a continuing fishery management concern. The timing and method of disposing of fishery wastes is an important element in efforts to reduce incidental take. The net impact of fishery wastes on particular seabird species, whether beneficial or adverse, has not been demonstrated in Alaska.

Indirect Effects Through Disturbance by Fishing Vessels

Fishing vessels can affect seabird populations whether or not the vessels are engaged in fishing or processing activities. Many surface-feeding birds are attracted to vessels (Furness 1999), but others, such as marbled murrelets, may be displaced from forage areas by vessel activity (Kuletz 1996). The magnitude of the impact on such species depends on the location, timing, and frequency of vessel traffic and on how closely those factors coincide with important seabird foraging areas. While avoidance behavior has been observed in many areas, measurable impacts of vessel traffic on seabird survival or reproduction have not been demonstrated in Alaska.

There is some concern that fishing activity, especially trawling, may have detrimental impacts on seabirds by disrupting the schooling behavior of their prey and therefore decreasing their foraging success. Although the intensity and longevity of trawling impacts on the structure and distribution of forage fish schools are not known, improvements in hydroacoustic methods may allow such research to be conducted in the future. However, given the large number of variables that influence foraging success for different species and the ability of birds to search for prey over large distances, it is unlikely that any localized disruptions of the prey field could be demonstrated to have specific adverse effects on seabirds. On the other hand, there is evidence that some forms of trawling may make fish vulnerable to diving birds by disturbing or injuring the fish. Black guillemots (Ewins 1987) and great cormorants (*Phalacrocorax carbo sinensis*) in the North Atlantic Ocean (Camphuysen 1999) are two species that may have learned to take advantage of such disruptions.

Indirect Effects Through Contamination by Oil Spills

The threat of oil spills to seabirds is well-known. All types of oil and fuel are dangerous, and only a few drops of oil are enough, under some situations, to kill a seabird. Oil kills birds because it damages the feathers, which are necessary to insulate the bird from cold water, and also because the bird ingests toxic oil as it tries to clean its plumage and suffers damage to various internal organs and its immune system (Burger and Fry 1993). Oiled feathers also affect the bird's buoyancy and ability to dive and fly. Since the insulation value of the feather is reduced, energy demands increase, requiring the birds to feed more when they are least able to do so (Wiens 1995). Reproductive success can also be decreased through effects to the endocrine system, transferring oil to eggs which affects hatching success, and through the loss of mates (Fry *et al.* 1987). In addition to the direct pathways of exposure listed above, birds may be indirectly affected by oil through habitat loss (e.g., vegetation mortality), habitat degradation, and diminished food populations (Huguenin *et al.* 1996).

A dramatic accident like the *Exxon Valdez* oil spill may kill hundreds of thousands of seabirds and reduce local populations of vulnerable species for several years (Piatt *et al.* 1990, Piatt and Ford 1996). The types of oil spills most commonly associated with fishing vessels are the chronic small spills of refined oil products (less than 100 gallons) caused by accidents during routine activities such as fuel transfer operations and bilge cleaning. For instance, in Dutch Harbor between November 1997 and June 1998, 13 oil or fuel spills were reported. The largest spill was 47,000 gallons from the *M/V Kuroshima*; the remainder of the spills were 1 to 15 gallons each. In the winter of 1996, the freighter *M/V Citrus* collided with a crab processing vessel off St. Paul Island, spilling an unknown quantity of bunker oil, which killed over 1,700 birds (Flint *et al.* 1998). The overall risk of these threats also depends on the number and condition of all vessels in the area, many of which are not associated with the fishing industry. Due to the great number of variables, including spill type and volume, wind and ocean currents, and season, the overall risk of oil contamination has not been quantified for particular species or in specific ocean areas. A report of data from 1995-2001 from the Alaska Department of Environmental Conservation (ADEC) indicates that the number of spills and volume from all sources in the BSAI and GOA is greatest during the summer months (ADEC 2001).

Many field and laboratory studies have demonstrated the differences in the effects of oil on various groups of birds. The three most important factors affecting sensitivity are behavior, distribution, and reproductive rate (Huguenin *et al.* 1996). The species at most risk are diving seabirds, which spend more time resting on the water than do surface-feeders (King and Sanger 1979). More specifically, of all bird groups alcids are considered to be the most vulnerable to oil, followed by diving ducks. Surface feeding and plunge feeding pelagic seabirds (albatrosses, petrels, fulmars, shearwaters, skuas, and jaegers) are moderately sensitive to oil effects given their extreme reliance on open-water marine habitats for feeding and roosting, making them susceptible to incidents in these settings. Gulls and terns are usually oiled in low proportion to the exposed populations because they are readily able to avoid oil (Huguenin *et al.* 1996).

Indirect Effects by Introducing Mammalian Predators to Nesting Islands

Seabird colonies on nesting islands are extremely sensitive to introductions of exotic predators. Seabirds nest on inaccessible islands and steep cliffs because these habitats provide protection against predators such as arctic fox (*Vulpes fulva*), red fox (*Alopex lagopus*), and rats (*Rattus norvegicus*). These mammals attack eggs, chicks, and even adult birds. When Vitus Bering first discovered Alaska in 1741, most islands in the Aleutian chain, along the south coast of the Alaska Peninsula, and in the GOA were not inhabited by foxes (Bailey and Kaiser 1993). In contrast, arctic foxes and, on a few nearshore islands, red foxes were indigenous to the islands in the Bering Sea. Apparently, foxes did not occur on any of the central or western Aleutians. Starting in 1750 and continuing into the 1930s, it was the policy of the Russian and, later, U.S. governments to facilitate the introduction of foxes for commercial fur farming purposes. The intent was for the foxes to feed on the seabirds, which they did most efficiently. In some cases, rats and voles were introduced to serve as alternative prey for foxes, but they preyed on seabirds and their eggs. Burrow and cliff-nesting species as well as Aleutian Canada geese were especially hard hit. Concern for the seabirds (and crash of the fox market) finally put an end to the practice. The USFWS has actively exterminated foxes on many islands since then, except where they occur naturally (Bailey 1993), and the foxes have died out on many other islands after eliminating the birds. Auklets and other species have begun to recolonize some of those islands after the removal of the foxes but populations are probably still depressed from pre-fox levels (Bailey and Kaiser 1993).

Rats are not native to Alaska, but they have become established on 22 Alaskan islands, including Kodiak and some of the Aleutian Islands. Fishing vessels and other ships inadvertently transport rats to previously uninvaded islands when the rats jump ship at docks or after wrecks (Brechbill 1977, Jones and Byrd 1979, Bailey 1993). At present, rats pose the greatest introduced predator threat to seabirds breeding in Alaska. Rats are voracious predators and can burrow, enter crevices, and climb cliffs with great agility (Jones and Byrd 1979). They can also kill small adult birds (Bailey 1993). Rats are a major management concern and the USFWS in Alaska has an extensive program to reduce the threat of new rat invasions. Efforts include maintaining networks of poison-bait boxes at ports on rat-free islands; training local communities to monitor and counteract rats aboard ships and on land; conducting public outreach programs to encourage operation of rat-free vessels in Alaskan waters; and training emergency-response teams to attack rats when they are found at remote shipwrecks. These efforts are in early stages, however, and the threat of rat invasions from vessels remains very serious. It is not known what proportion of fishing vessels carry rats. The effects of rat invasions on local seabird populations are not known in Alaska, because no islands have been monitored before and after their arrival. However, for most islands in other parts of the world where rats have invaded, seabird populations have declined or gone extinct (Jones and Byrd 1979, Moors *et al.* 1992, Burger and Gochfeld 1994).

Indirect Effects Through Plastics Ingestion

The presence of plastic pollution in marine birds was first recorded in 1962, coinciding with the increase in production of plastic resin (Robards *et al.* 1997). Ingestion of plastic pollutants has been recorded in 80 species of marine birds from around the world (Sievert and Sileo 1993). Species feeding primarily by surface-seizing or pursuit-diving have the highest frequencies of plastic ingestion, including the tubenoses and the parakeet auklet, whereas gulls and most alcids ingest little or no plastic. Species feeding primarily on crustaceans or cephalopods have the highest frequencies of plastic ingestion, probably because certain sizes and colors of plastic resemble their natural prey. Subadult seabirds, because they are less experienced in discriminating food items, ingest more pieces of plastic than do adult seabirds (Day *et al.* 1985). Adult seabirds may pass plastics on to chicks by regurgitation (Robards *et al.* 1997).

Two classes of plastic are commonly found in seabirds; pellets and fragments. Pellets are the raw product of the plastic industry and most probably enter the marine ecosystem during transportation or via drainage systems. Plastic fragments or "user" plastics are small, weathered pieces of larger manufactured items that are discarded or lost at sea, particularly from fishing boats and marine shipping vessels (Robards *et al.* 1997). Ocean currents, winds, and the location of disposal influence the abundance and distribution of plastic in the North Pacific Ocean (Auman *et al.* 1997). The highest incidence of ingested particles in the subarctic North Pacific was in the Aleutian coastal waters. Densities of small plastic particles in the subarctic North Pacific and Bering Sea are 26 to 400 times lower, respectively, than in subtropical waters. Of small oceanic plastic particles found in the central North Pacific, 3.7 percent were pellets and 96.3 percent were user fragments (Robards *et al.* 1997). In contrast, seabirds in the subarctic North Pacific ingested mostly pellets (76 percent pellets, 22 percent user plastic, 2 percent unrecognizable plastic particles) (Robards *et al.* 1997). Some of the recognizable plastic objects are consistent with debris originating from dumping as opposed to fishing activities.

Available evidence suggests that plastics are damaging to seabirds when they are consumed in sufficient quantity to obstruct the passage of food or cause stomach ulcers. Other effects may include bioaccumulation of polychlorinated biphenyls, toxic effects of hydrocarbons, diminished feeding stimulus, reduced fat deposition, lowered steroid hormone levels, and delayed reproduction. However, at present, acute effects of plastic ingestion are rarely observed, and chronic effects on body condition are generally equivocal (Robards *et al.* 1997). It may not be possible to demonstrate direct cause-and-effect relationships between plastic ingestion and body condition in wild seabirds because of natural variability in the environment and the fact that affected birds may quickly disappear from sampled populations (Robards *et al.* 1997).

The Marine Plastic Pollution Research and Control Act of 1987 (33 USC §§ 1901 *et seq.*) implements the provisions relating to garbage and plastics of the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). These regulations apply to all vessels, regardless of flag, on the navigable waters of the U.S. and in the Exclusive Economic Zone of the U.S. It applies to U.S. flag vessels wherever they are located. The discharge of plastics into the water is prohibited, including synthetic ropes, fishing nets, plastic bags, and biodegradable plastics. In 1995, as part of their BiOp on the status of short-tailed albatross (USFWS 1995a), the USFWS recommended that NOAA Fisheries begin an education program to help fishers be aware of and comply with the laws against discarding plastic at sea, an effort that continues to the present time.

3.7.2 Black-Footed Albatross (*Phoebastria nigripes)*

Life History and Distribution

The black-footed albatross is a large, dark-plumaged seabird with a wingspan of up to 80 inches. Nearly the entire world population nests on the Hawaiian Islands National Wildlife Refuge, principally Laysan and Midway Islands. Breeding begins in early November. One egg is laid and both parents share incubation which lasts about 65 days. Chicks begin to hatch in mid-January and are fed by regurgitation from both adults. This high calorie, nutrient-rich regurgitate consists primarily of squid and stomach oil and can sustain a chick for a number of days while the parents forage for food at sea. Fledging occurs in June and July. Sub-adults return to their natal colony when they are three years of age but do not mate and nest until they are between 5 and 8 years old. USFWS banding studies on Midway Island indicate that individuals may live 40 years or more in the wild.

The historic range of the species is from the coasts of China, Japan, and Russia east to continental North America; and from the Sea of Okhotsk and the Bering Sea south to about 18°N in the central Pacific (Shuntov 1972). Although the central Pacific is considered to be the preferred wintering area for non-breeding adults, low numbers of black-footed albatross are found in the eastern temperate North Pacific Ocean throughout the entire winter, as far north as 55°N (McDermond and Morgan 1993). Black-footed albatross are more abundant over the outer continental shelf, especially at the shelf break, than elsewhere. Areas with strong, persistent upwelling and the boundaries of different water masses are also favored. Their concentration over the continental slope may in part be a result of the distribution of fishing vessels in these areas, to which they are strongly attracted by fish wastes and bait (McDermond and Morgan 1993). Black-footed albatross spend the summer (approximately May through September) in Alaskan waters, although some non-breeding birds may be encountered at any time. In Alaska, black-footed albatross are most abundant in the GOA.

The USFWS conducts census counts annually at the Hawaiian breeding colonies. The census data suggest that during the last decade the estimated numbers of breeding pairs of black-footed albatross in nesting colonies in the Northwest Hawaiian Islands have fluctuated between approximately 53,000 and 41,000, with the high estimate in 1993 and the low in 2000. The estimate increased in 2001 to approximately 45,000 pairs. However, the overall breeding population of black-footed albatross appears to be decreasing by as much as 1.3 percent annually (NMFS 2001e). Individual nesting colonies such as French Frigate Shoals and Midway Atoll have shown dramatic inter-annual fluctuations (NMFS 2001e). The reasons for these fluctuations are not clear. Breeding adults do not typically nest every year and may skip a year for various reasons, including for molting or possibly if they are nutritionally stressed. Mortality of adults and subadults at sea is also a factor in determining how many birds return to nest.

The most recent estimate for the number of black-footed albatross breeding pairs is 54,548 (NMFS 2001e). Since the number of sub-adult (i.e., non-breeding) albatross may be five to six times the number of breeding pairs (Pradel 1996), the total world population of black-footed albatross is approximately 300,000 (Cousins and Cooper 2000).

Trophic Interactions

Cephalopods play a major role in the diet of black-footed albatross (Cherel and Klages 1998). Squid from the families Ommastrephidae and Onychoteuthidae are the most important food items although the species eaten by black-footed albatross are poorly known. Few observations have been published of black-footed albatross feeding in the wild, other than by scavenging near fishing vessels. They take food in the upper 1 m of the ocean's surface by seizing and dipping while sitting on the water (Gould *et al.* 1998). In addition to squid, other food items include myctophids (lanternfish), other invertebrates, and fish. In one study prior to the cessation of the high-seas driftnet fisheries in 1992, squids were more important than fishes in the diets of non-breeding black-footed albatross (review in Gould *et al.* 1998). A study in Hawaii found that fish eggs were the main component of the diet of black-footed chicks (Harrison *et al.* 1983). Black-footed albatross, with their short, stocky bills, are better adapted to scavenging naturally occurring large carrion or refuse from ships than they are at retrieving small prey from surface waters (Gould *et al.* 1998). Because of this attraction to fish waste and bait, black-footed albatross are drawn to fishing vessels and are vulnerable to being caught by longlines. One recent study incorporated the use of immersion monitors to study the foraging behavior of Laysan and black-footed albatross (Fernandez and Anderson 2000). The data suggested that individuals split their time between nocturnal and diurnal foraging.

In 1998 and 1999, satellite telemetry studies indicated that black-footed albatross nesting in the northwestern Hawaiian Islands mixed short foraging trips near their nesting island with much longer trips that typically extended to the California, Oregon, and Washington State coasts but did not include the colder waters of the GOA (Hyrenbach *et al.* 2002).

Management Overview

Wildlife management responsibility for the black-footed albatross, established by the Migratory Bird Treaty Act (16 U.S.C. 703 *et.seq.*), falls under the jurisdiction of the USFWS. Most research on the species has taken place in their northwest Hawaiian breeding colonies (where 96 percent of the world population resides) which are predominately on National Wildlife Refuge lands. Black-footed albatross were recently assigned "vulnerable" status on the World Conservation Union's *Red List of Threatened Species* (IUCN 2000) because of reported declines in numbers on their breeding colonies. This criterion is used for species that are deemed to have a high risk of extinction in the wild in the medium-term future (60 years).

Past and Present Effects and Management Actions

<u>Direct Mortality: Harvest and Other Intentional Take</u>

Within historic time, black-footed albatross have experienced periods of heavy mortality at their breeding colonies from various human activities, including mass harvesting of adults for feathers at the beginning of the 20th century, warfare, intentional destruction of nest sites and breeding birds for airport runway construction, collisions with aircraft and communication towers, and contamination with lead paint and other toxic wastes left from 50 years of military use (NMFS 2001e). The impact of these mortality factors on the population has not been quantified.

Direct Mortality from Incidental Take in External Fisheries

Human impacts on albatross at sea are also substantial. High-seas driftnet fisheries for tuna, squid, and salmon have been identified as a major source of mortality for albatrosses in the past. The Japanese large-mesh driftnet fishery for tuna and swordfish dates back to 1905. This fishery peaked in 1982 with over 700 vessels but declined to only 70 vessels by 1991. There are no data on the incidental take of seabirds for most of this fishery except for the 1990-1991 season when over 3500 seabirds were estimated to be taken, including a large number of black-footed albatross (DeGange *et al.* 1993). Driftnet fisheries targeting *Ommastrephes* squid, one of the preferred prey of black-footed albatross, were started in the late 1970s by Japan, Korea, and Taiwan. At their peak in the late 1980s, these fisheries deployed millions of kilometers of driftnet. Rough estimates of the total number of seabirds killed by the squid driftnet fisheries were between 875,000 and 1,660,000 seabirds annually, including 2,000-5,000 black-footed albatross per year (DeGange *et al.* 1993). Due to the tremendous amount of waste and ecosystem damage associated with the high-seas driftnet fisheries, they were outlawed by international agreement through United Nations Resolution (46/215) in December of 1992 (Paul 1994). Because black-footed albatross are such a long-lived and slowly maturing species, high rates of mortality from the driftnet fisheries may have a lingering impact on the population growth rate at present.

Longline fishing is considered the most recent and potentially most serious global threat faced by albatrosses (Brothers *et al.* 1999a). Longlines catch surface-feeding seabirds when they attempt to capture the bait as the line is being set. Mortality of black-footed albatross occurs in Alaskan and Hawaiian longline fisheries as well as in North Pacific longline fisheries conducted by Japan, Taiwan, Korea, Russia, and China (Brothers *et al.* 1999). Estimates of incidental take in some of these fisheries may underestimate actual mortality because they are based on samples of birds brought on-board and do not account for birds that are hooked as the line is being deployed but fall from the hook before the lines are retrieved. When observers do not watch the groundline as it is retrieved, underestimates of incidental take may be as high as 30 to 95 percent (Gales 1998). However, observers in the North Pacific Groundfish Observer Program actually watch the groundline as it is retrieved and tally birds that fall off before being retrieved on board.

Based on 1994 through 1999 data, the estimated average annual total catch of black-footed albatross in the Hawaiian pelagic longline fishery is 1,743 birds (NMFS 2001e). Preliminary estimates of the number of both black-footed and Laysan albatross taken in non-U.S. fisheries in the north and central Pacific pelagic longline fisheries (swordfish and tuna) are about 34,700 birds per year (Cousins *et al.* 2001). It is not known what portion of these are black-footed albatross. An estimate of this mortality may be made if one assumes that the percentages of Laysan and black-footed albatross are about the same in foreign fishing waters as they are in the U.S. Black-footed albatross make up about 57 percent of the total albatross taken in the Hawaiian longline fishery (NMFS 2001e) and 60 percent in the GOA longline fishery (Table 3.7-3). Based on the assumption that the U.S. data are comparable to the foreign fisheries situation, where there are no data, the numbers of black-footed albatross taken in the foreign longline fisheries could be over 20,000 birds per year.

State-managed longline fisheries and IPHC halibut fisheries may contribute only relatively small amounts to the overall incidental take of albatross. The larger hooks used in the halibut fisheries presumably result in lower incidental catch rates although there is little data to support this. In 1998, incidental takes of 32 unidentified albatrosses were documented in the IPHC halibut fishery through interviews with fishermen (Trumble and Geernaert 1999). However, since the halibut and state-managed fisheries are not subject to the NOAA Fisheries Observer Program, there is no way to independently verify or quantify the numbers of particular species taken by these vessels. NOAA Fisheries and NPFMC are working with the IPHC to find new ways to provide oversight and monitoring of the bycatch from these fisheries, which set millions of hooks each year.

Direct Mortality from Incidental Take on Groundfish Longlines

Tables 3.7-2 and 3.7-3 list the estimated incidental take of various species of seabirds by longline fisheries in the BSAI and GOA for the period 1993-2001 (Observer Program data). In the BSAI, the estimated number of black-footed albatross killed by longlines varied between 4 and 66 birds per year with an average of 21 per year (95 percent confidence interval is 14-29 birds per year). There were also an average of 63 unidentified albatross caught each year in the BSAI. If we assume that the unidentified albatross occurred in the same proportion as the identified numbers of black-footed and Laysan albatross, the average number of unidentified albatross would translate into 2 more black-footed albatross caught in the BSAI every year. This gives an estimated average of 23 black-footed albatross taken in the BSAI groundfish longline fishery every year between 1993-2001. In the GOA, between 7 and 658 black-footed albatross were caught each year with an average of 190 per year (95 percent confidence interval is 144-236 birds). An average of 56 unidentified albatross were also taken each year. Black-footed albatross make up a higher proportion of the identified albatross caught in the GOA, so this translates into an additional 34 black-footed albatross caught. This gives an estimated average of 224 black-footed albatross incidentally taken in the GOA groundfish longline fishery every year between 1993-2001. In this time period, the estimated total take of black-footed albatross in the BSAI and GOA longline fishery was thus an average of 247 birds per year. No black-footed albatross were observed to be taken in the trawl or pot fisheries during this period (Tables 3.7-4 and 3.7-5).

Several factors are likely to affect the risk of seabird incidental catch, including: fishing effort (number of hooks per year), the distribution of effort by sub-area and season, the abundance and distribution of seabirds in the vicinity of fishing vessels, seabird nutritional condition (i.e., starvation), and the use of seabird deterrents in longline fisheries. The relative importance of these factors has not been fully studied. NOAA Fisheries analyzed the relationship between fishing effort and numbers of birds hooked in the BSAI and GOA and found that the relationship varies for different species groups (Figures 3.7-5 and 3.7-6, respectively). The data suggest that fishing effort (number of hooks set) does not play a strong role in determining how many albatross are caught.

NPFMC and NOAA Fisheries have addressed the issue of seabird bycatch in numerous ways over the years, including scientific research and regulations that require changes in fishing techniques. Although these efforts have been pursued largely to protect the endangered short-tailed albatross, the take reduction measures that have been enacted since 1997 should decrease take of all seabird species that are susceptible to capture by longlines, including black-footed albatross. (See Section 3.7.4 on short-tailed albatross for a discussion of research and regulatory measures taken to protect seabirds from longline take). Observer Program data (Tables 3.7-2 and 3.7-3) show an estimated average of 33 black-footed albatross taken every year in the BSAI from 1993-1996. From 1997-2001, this estimated yearly take decreased to 11 birds. In the GOA, estimated annual take of black-footed albatross averaged 233 birds between 1993-1996. From 1997-2001, that average dropped to an estimated 156 birds taken per year. In the recently completed Washington Sea Grant Project study, new avoidance techniques resulted in a reduction of 70-95 percent of all species caught and were especially effective for black-footed albatross and other species that do not dive deeply on baited lines (Melvin *et al.* 2001).

Assessment of Population-Level Effects

Recent evidence from population studies and modeling exercises suggests that the combination of domestic and foreign longline fisheries in the North and Central Pacific has had a negative impact on the black-footed albatross population (Cousins and Cooper 2000). One finding of the modeling exercises indicates that the sustained growth rate of an albatross population (without any fishing-related mortality) is in the range of zero to four percent. The model concluded that a total loss of 10,000 birds per year (natural and anthropogenic mortality sources combined) is about the maximum a population of 300,000 black-footed albatross could sustain and still remain stable (Cousins and Cooper 2000). The modeling also showed that the growth rate of the population may be reduced by an equivalent percentage of the total number of birds killed in the fisheries each year. Thus, if fisheries mortality is one percent of the total population (3,000 birds), then the population growth rate will be reduced by more than one percent (Cousins 2001). This estimated reduction in population growth is a robust estimate in that it is not sensitive to the ratio of juveniles to adults lost and thus includes the potentially greater impact of taking nesting adults.

Other Past and Present Effects

The following issues have been identified as having potential impacts on black-footed albatross, but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects is outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** Abundance and distribution of squid and other prey are greatly influenced by climatic and oceanic fluctuations. High-seas squid drift fisheries by several Asian countries may have impacted prey availability but these fisheries were outlawed in 1992 (Paul 1994). Impacts of groundfish and other fisheries on availability of squid and small fish to albatross are unknown. Ability of albatross to forage over huge areas is presumed to lessen the potential impact of localized depletion of prey.

- **Indirect effects through consumption of fishery discards.** Albatross are attracted to fishing vessels and processors to eat discards and offal. Benefits of the food source are countered by increased risk of incidental take on longlines. The net benefit or adverse impact of this effect has not been studied.

- **Indirect effects through plastics ingestion.** There are many sources of plastic pollution on land and at sea. Albatross are particularly attracted to small consumer products that resemble floating prey. Adults may suffer from swallowing sharp objects and excessive amounts of non-digestible material (Sievert and Sileo 1993, McDermond and Morgan 1993). Chicks fed regurgitated plastics are subject to physiological stress as a result of satiation and mechanical blockages which may affect chick survival when the volume of plastic ingested is high (Sievert and Sileo 1993, Auman *et al.* 1997).

Comparative Baseline

There are an estimated 300,000 black-footed albatross in the world as of 2001, but their breeding numbers have declined over the past ten years (NMFS 2001e). They are not listed under the ESA, but are listed as "vulnerable" according to international conservation criteria. The great majority of nesting occurs in Hawaii and is protected under the National Wildlife Refuge System. The species faces serious threats from incidental take in longline fisheries throughout its range, especially by foreign tuna and swordfish pelagic longline fisheries in the Central and North Pacific. The numbers of black-footed albatross taken in the BSAI and GOA groundfish longline fisheries are relatively small compared to the estimated take in foreign fisheries. Seabird avoidance measures instituted for the BSAI and GOA longline fleet in 1997 have reduced the numbers of black-footed albatross taken. The past and present effects on black-footed albatross are summarized in Table 3.7-6.

Status for Cumulative Effects Analysis

Incidental take of black-footed albatross is expected to continue under all alternatives and warrants consideration in the cumulative effects analysis. Because of the similarity of their fishery interactions and responses to management measures, black-footed albatross will be discussed in conjunction with Laysan albatross in the analysis of FMP Alternatives.

3.7.3 Laysan Albatross (*Phoebastria immutabilis)*

Life History and Distribution

The Laysan albatross, also known as "gooney bird," is a large white and black seabird with a wingspan that reaches 85 inches. More than 99 percent of Laysan albatross nest in the northwest Hawaiian Islands. They are monogamous and if one of the mates should die it may be several years before the survivor can make a new pair bond. Only one egg is laid per year beginning around mid-November, and incubation lasts about 65 days. Both parents share in incubation duties although females usually leave for a few weeks after egg-laying. Chicks hatch during late January to mid-February. Both parents will feed the chick by regurgitation and will often leave them for several days while they obtain food out at sea. Fledging occurs 5 to 6 months after hatching (mid-June through late July). Parents will often leave before the chicks have reached their full juvenile plumage. Sub-adults return to their natal nesting colony after spending 3 to 5 years at sea. Mating and first nesting usually occurs by age 6 to 8.

Laysan albatross occur throughout the North Pacific from the southern Bering Sea to the Hawaiian Islands (Shuntov 1972). Laysan albatross spend the summer (approximately May through September) in Alaskan waters, although some non-breeding birds may be encountered at any time. In 1989 and 1999, satellite telemetry studies indicated that Laysan albatross nesting in the northwestern Hawaiian Islands mixed short foraging trips near their nesting island with much longer trips primarily to the north, frequently reaching the Aleutian Islands and GOA. Thus, based on satellite telemetry data, breeding Laysan albatross are known to forage in waters off Alaska (Anderson *et al.* 2000, Hyrenbach *et al.* 2002). Since the 1970s, the Laysan albatross has greatly expanded its presence in the southeastern Bering Sea. At present, Laysan albatross are most abundant in the western Aleutian Islands but are increasingly encountered in and north of the passes through the Aleutian Islands, over the shelf north of the Alaska Peninsula, and along the shelf break as far as the Pribilof Islands; hence, these birds are likely to attend even more vessels than may have previously been the case (G. L. Hunt, Jr., University of California, Irvine, personal communication).

Laysan albatrosses are the most numerous of the North Pacific albatrosses, but the species was probably even more abundant before feather hunters decimated breeding colonies in the early 1900s. No systematic population estimates were made until the USFWS began to make population estimates in 1992. The current world estimate of the number of breeding pairs of Laysan albatross is 488,852 (NMFS 2001e). Since the number of sub-adult (i.e., non-breeding) albatross may be five to six times the number of breeding pairs (Pradel 1996), the total world population of Laysan albatross is approximately 2.4 million birds (Cousins *et al.* 2000). Given the relative abundance of this species compared to other albatross species, its status is generally considered to be relatively secure. However, the number of breeding pairs at the largest nesting site, Midway Atoll, has decreased substantially in the past decade, from approximately 429,300 pairs in 1992 to 285,600 pairs in 2001 (NMFS 2001e). At the second largest nesting site, Laysan Island, the number of breeding pairs decreased from approximately 200,000 pairs in 1997 to about 55,000 pairs in 2000. This downward trend changed in 2001 when the number of breeding pairs increased on Laysan Island to approximately 118,000 pairs (NMFS 2001e). It is not clear why these fluctuations have been so dramatic. Albatross tend to return to their same nest sites over the years so it seems unlikely that breeding pairs are moving to different islands. Breeding adults do not typically nest every year and may skip a year for various reasons, including for molting or possibly if they are nutritionally stressed. Of course, adult and juvenile mortality at sea is also a factor in determining how many birds return to nest.

Trophic Interactions

Cephalopods play a major role in the diet of Laysan albatross (Cherel and Klages 1998). Squid from the families Ommastrephidae and Onychoteuthidae are the most important food items although which species are eaten by Laysan albatross is poorly known. Few observations have been published of Laysan albatross feeding in the wild, other than of those birds scavenging near fishing vessels. They take food in the upper 1 m of the ocean's surface by seizing and dipping while sitting on the water (Gould *et al.* 1998). In addition to squid, other food items include myctophids (lanternfish), other invertebrates, and fish. In one study prior to the cessation of the high-seas driftnet fisheries in 1992, fishes were more numerous than squid in the diets of non-breeding Laysan albatross (review in Gould *et al.* 1998). A study in Hawaii found that squid was the main component of the diet fed to Laysan chicks (Harrison *et al.* 1983). Numerous studies have noted that Laysan albatrosses are more frequently observed seaward of the continental slope, over areas of strong, persistent upwelling, and at the boundaries between different water masses, presumably because of the natural concentration of their prey in those situations (review in McDermond and Morgan 1993). Laysan albatross have better night vision than black-footed albatross and may be more capable of rapid retrieval of small prey that are active in surface waters at night. (Gould *et al.* 1998). One recent study incorporated the use of immersion monitors to study the foraging behavior of Laysan and black-footed albatross (Fernandez and Anderson 2000). The data suggested that individuals split their time between nocturnal and diurnal foraging. Laysan albatross are also strongly attracted to fishing vessels where the birds may aggressively pursue bait and fish processing waste.

Management Overview

Wildlife management responsibility for Laysan albatross falls under the jurisdiction of the USFWS. The species is protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*). Most research on the species has taken place on their nesting grounds which are predominantly on National Wildlife Refuge lands.

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Early Aleut and Eskimo hunters apparently preferred albatross for their meals, because archeologists find hundreds of albatross bones in the remains of old houses and villages along the Bering Sea coast (Smithsonian's Arctic Studies Center 2002). Although these remains have not been identified to species, it may be an indication that albatross were once more abundant and widespread in the Bering Sea. No albatross were identified in recent Alaska Native subsistence hunts (Denlinger and Wohl 2001).

Within historic time, Laysan albatross have experienced periods of heavy mortality at their breeding colonies in the northwest Hawaiian Islands from various human activities, especially mass harvesting of adults for feathers at the beginning of the 20th century. At only one of the many breeding colonies that were subjected to massive hunts, Laysan Island, feather hunters killed at least 300,000 birds in 1909 alone (Dill and Bryan 1912). The species has also suffered from intentional destruction of nest sites and breeding birds for military airport runways, collisions with aircraft and communication towers, and contamination with lead paint and other toxic wastes left from 50 years of military use (NMFS 2001e). Since systematic population estimates were only begun in 1992 by USFWS, the impact of these past mortality factors on the population have not been quantified.

Direct Mortality from Incidental Take in External Fisheries

High-seas driftnet fisheries for tuna, squid, and salmon have been identified as a major source of mortality for albatross in the past. The Japanese large-mesh driftnet fishery for tuna and swordfish dates back to 1905. This fishery peaked in 1982 with over 700 vessels but declined to only 70 vessels by 1991. There are no data on the incidental take of seabirds for most of this fishery except for the 1990-1991 season when over 3500 seabirds were estimated to have been taken, including a "large number" of Laysan albatross (DeGange *et al.* 1993). The land-based Japanese salmon gillnet fishery was responsible for millions of seabird deaths between 1952-1987, including an estimated 921 Laysan albatross in 1977. By 1987, fishing effort had been reduced and an estimated 231 Laysan albatross were caught (DeGange and Day 1991). Between 1981-1984, the Japanese salmon driftnet mothership fleet killed an estimated average of 86 Laysan albatross each year (Jones and DeGange 1988). Driftnet fisheries targeting *Ommastrephes* squid, one of the preferred prey of Laysan albatross, were started in the late 1970s by Japan, Korea, and Taiwan. At their peak in the late 1980s, these fisheries deployed millions of kilometers of driftnet. Rough estimates suggest that the total number of seabirds killed by the squid driftnet fisheries ranged between 875,000 and 1,660,000 seabirds annually, including 50,000-108,000 Laysan albatross per year (DeGange *et al.* 1993). Due to the tremendous amount of associated waste and ecosystem damage, the high-seas driftnet fisheries were outlawed by international agreement through United Nations Resolution (46/215) in December of 1992 (Paul 1994). Because Laysan albatross are such a long-lived and slowly maturing species, high rates of mortality from the driftnet fisheries may have a lingering impact on the population growth rate at present.

Longline fishing is considered the most recent and potentially most serious global threat faced by albatrosses (Brothers *et al.* 1999a). Mortality of Laysan albatross occurs in both Alaskan and Hawaiian longline fisheries as well as in other North and Central Pacific longline fisheries conducted by Japan, Taiwan, Korea, Russia, and China (Brothers *et al.* 1999). Preliminary estimates suggest that the number of both black-footed and Laysan albatross taken in non-U.S. pelagic longline fisheries in the North and Central Pacific (swordfish and tuna) is about 34,700 birds per year (Cousins *et al* 2001). It is not known what portion of these are Laysan albatross. An estimate of this mortality may be made if one assumes that the percentages of Laysan and black-footed albatross are about the same in foreign fishing waters as they are in the U.S. Laysan albatross make up about 43 percent of the total albatross taken in the Hawaiian longline fishery (NMFS 2001e) and 39 percent in the GOA longline fishery (Table 3.7-3). Based on the assumption that the U.S. data are comparable to the foreign fisheries situation, where there are no data, the numbers of Laysan albatross taken in the foreign longline fisheries could be close to 15,000 birds per year.

Based on 1994 through 1999 data, the estimated average annual take of Laysan albatross in the Hawaiian pelagic longline fishery is 1,330 birds (NMFS 2001e). NOAA Fisheries established mandatory seabird protection measures for this Hawaiian fishery in 2002 (67 FR 34408).

State-managed longline fisheries, which are typically near-shore operations, and halibut fisheries may contribute only a small amount to the overall incidental take of albatrosses. The larger hooks used in the halibut fisheries presumably result in lower incidental catch rates but there is little data to support this claim. In 1998, incidental takes of 32 unidentified albatrosses were documented in the halibut fishery through interviews with fishermen (Trumble and Geernaert 1999). However, since the halibut and state-managed fisheries are not subject to the NOAA Fisheries Observer Program, there is no way to independently verify or quantify the numbers of particular species taken by these vessels. NOAA Fisheries and NPFMC are working with the IPHC to find new ways to provide oversight and monitoring of the bycatch from these fisheries which set millions of hooks each year.

Direct Mortality from Incidental Take on Groundfish Longlines

Tables 3.7-2 and 3.7-3 list the estimated incidental take of Laysan albatross in the BSAI and GOA longline fisheries between 1993-2001 (Observer Program data). In the BSAI, the estimated number of Laysan albatross killed by longlines varied between 234 and 1,431 birds per year with an average of 538 per year (95 percent confidence interval is 481-595 birds). There was also an average of 63 unidentified albatross caught each year in the BSAI. If we assume that the unidentified albatrosses occurred in the same proportion as the identified numbers of black-footed and Laysan albatross, the average number of unidentified albatross would translate into 61 more Laysan caught in the BSAI every year. This gives an estimated average of 599 Laysan albatross taken in the BSAI groundfish longline fishery every year between 1993-2001. In the GOA, between 40 and 217 Laysan albatross were caught each year with an average of 126 per year (95 percent confidence interval is 98-154 birds). An additional 45 unidentified albatross were also taken each year. Laysan albatross make up a smaller proportion of the identified albatross caught in the GOA so this translates into an additional 18 Laysan caught. This gives an estimated average take of 144 Laysan albatross in the

GOA groundfish longline fishery every year between 1993-2001. In this time period, the estimated total take of Laysan albatross in the BSAI and GOA longline fishery was thus an average of 773 birds per year.

In an effort to reduce the incidental take of seabirds on longlines, NOAA Fisheries instituted mandatory seabird avoidance measures for the groundfish fleet in 1997 (62 FR 23176). Prior to 1997, the average estimated number of Laysan albatross taken in the BSAI was 406 birds per year. Between 1997 and 2001, the estimated annual average take in the BSAI increased to 643 Laysan albatross per year. Most of this increased average take was due to an unusually high number of birds taken in 1998 (1,431 albatross). The reason this one year was so different than the others is not known but it may be related to nutritional stress. Starving birds appear to be much more aggressive in pursuit of food around fishing vessels and the numbers of fulmars, gulls, and shearwaters taken on longlines were also well above average in 1998, indicating a possible region-wide food shortage. In the GOA, the average take before and after the seabird avoidance measures were enacted remained essentially the same (129 albatross per year in 1993-1996 versus 124 birds per year in 1997-2001).

Direct Mortality from Incidental Take in Groundfish Trawls

According to 1993-2001 Observer Program data, the amount of estimated incidental take of Laysan albatross in BSAI and GOA groundfish trawls varied substantially between years (Table 3.7-4). From 1997-2001, the estimated average number of Laysan albatross taken every year was estimated to be between 46 birds (average low estimate) and 133 birds (average high estimate).

Direct Mortality from Vessel Strikes

According to the Observer Program records of bird-strikes from 1993-2000, Laysan albatross have been documented to strike vessels and rigging. Of the 120 recorded collisions, 21 Laysan albatross were involved in 15 incidents. Laysan's were also observed to collide with trawl "third wires". Monitoring these types of collisions is not part of the observer's normal duties so the true extent of this impact is not known. NOAA Fisheries is currently investigating the issue, especially as it relates to "third wires". During 2002, NOAA Fisheries evaluated the use of video as a tool to monitor "third wire" seabird interactions, and the report is in process. (NPFMC 2002c) NOAA Fisheries is investigating mitigation efforts for this problem, which may be as simple as hanging streamers from the wire (G. Balogh, USFWS, Anchorage, personal communication).

Assessment of Population-Level Effects

Recent evidence from population studies and modeling exercises suggest that the combination of domestic and foreign longline fisheries in the North and Central Pacific have had a negative impact on albatross populations (Cousins and Cooper 2000). Although the emphasis to date has been on the impacts of longline fishing operations on the black-footed albatross population, the modeling exercises can be applied to the Laysan albatross population and to all sources of anthropogenic mortality as well. One finding of the modeling exercises indicates that the sustained growth rate of an albatross population (without any fishing-related mortality) is in the range of zero to four percent. The modeling also showed that the growth rate of the population may be reduced by an equivalent percentage of the total number of birds killed in fisheries each year. Thus, if fisheries mortality is one percent of the total population (24,000 birds), then the population growth rate will be reduced by more than one percent (Cousins 2001). This estimated reduction in population growth is a robust estimate in that it is not sensitive to the ratio of juveniles to adults lost and thus includes the potentially greater impact of taking nesting adults.

Other Past and Present Effects

The following issues have been identified as having potential impacts on Laysan albatross but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impacts of groundfish and other fisheries on the availability of prey to Laysan albatross are unknown. The ability of albatross to forage over huge areas is presumed to lessen the potential impact of localized depletion of prey.

- **Indirect effects through consumption of fishery discards.** Laysan albatross are attracted to fishing vessels and processors to eat discards and offal. Benefits of the food source are countered by increased risk of incidental take on longlines.

- **Indirect effects through plastics ingestion.** Species feeding primarily by surface-seizing or pursuit-diving, including Laysan albatross, have the highest frequencies of plastic ingestion (Sievert and Sileo 1993). Studies on Midway Island found that ingested plastic probably does not cause significant direct mortality in Laysan albatross chicks, but likely causes physiological stress as a result of satiation and mechanical blockages (Auman *et al.* 1997) and may affect chick survival when the volume of plastic ingested is high (Sievert and Sileo 1993).

- **Indirect effects through contamination by oil spills.** Surface-feeding pelagic seabirds, including Laysan albatross, are moderately sensitive to oil effects given their extreme reliance on open-water marine habitats for feeding and roosting, making them susceptible to incidents in these settings (King and Sanger 1979).

Comparative Baseline

The Laysan albatross is the most numerous albatross species in the BSAI and is also common in the GOA with a total population estimated to be about 2.4 million birds. However, the recent decline in breeding pairs at their largest nesting colony in Hawaii is cause for concern. According to population modeling exercises, the impact of mortality from incidental take in fisheries, especially longlines, may be contributing to recent declines at nesting colonies. The amount of incidental take from the BSAI and GOA groundfish fishery is relatively small compared to the estimated mortality from foreign fisheries. Seabird avoidance measures instituted for the BSAI and GOA longline fleet in 1997 have not reduced the numbers of Laysan albatross taken. The past and present effect on Laysan albatross are summarized in Table 3.7-7.

Status for Cumulative Effects Analysis

Incidental take of Laysan albatross is expected to continue under all alternatives and warrants consideration in the cumulative effects analysis. Because of the similarity of their fishery interactions and responses to management measures, Laysan albatross will be discussed in conjunction with black-footed albatross in the analysis of FMP Alternatives.

3.7.4 Short-Tailed Albatross (*Phoebastria albatrus)*

Life History and Distribution

The short-tailed albatross is a very large seabird with narrow, seven-foot-long wings adapted for soaring low over the ocean. Young birds are chocolate brown, gradually turning white as they grow older. Adult short-tailed albatross have an entirely white back, white or pale yellow head and back of neck, and black and white wings. Their large pink bill is hooked at the end with a blue tip. Short-tailed albatross mate for life, returning to the same nest sites in the breeding colony for many years. Presently, these birds nest only on two islands in Japan, Torishima and Minami-kojima. Single eggs are laid in October or November, chicks hatch in December through February, and the young fledge from May to July. Immature birds wander across the North Pacific until they begin breeding at 6 to 9 years old (ADF&G 1994).

Relatively little is known about seasonal movements or factors determining marine distribution of the short-tailed albatross (McDermond and Morgan 1993). It is believed that the species was formerly common off China, in the Sea of Japan, the Sea of Okhotsk, the Bering Sea north to the Bering Strait, and throughout the entire temperate North Pacific Ocean, from Alaska to Baja California (McDermond and Morgan 1993, USFWS 1998b). Areas of high food productivity, such as along the Pacific coast of North America, in the Aleutian Islands, and in the Bering Sea, were favored (Hasegawa and DeGange 1982). Over 90 percent of records are sightings of one or two birds (mostly single birds) and these sightings have been reported in all months of the year. For those sightings that recorded age(s), four times more non-adults (juvenile, immature, and subadult) than adults were sighted. Past observations indicate that as with other albatross, older short-tailed albatross are present in Alaska primarily during the summer and fall months along the shelf break from the Alaska Peninsula to the GOA. Recent satellite telemetry studies indicate that, following the breeding season, the tagged short-tailed albatross moved north along the coast of Japan to the southern tip of the Kamchatka Peninsula and then east to the western Aleutians. Records of sightings from the Observer Program and fishing vessels have been compiled to indicate their present distribution in Alaskan waters (Figure 3.7-7) (NPFMC 2002c).

The North Pacific Ocean and Bering Sea once supported millions of short-tailed albatross but they were decimated by commercial hunters in the early 1900s. Volcanic eruptions also destroyed significant amounts of nesting habitat. By 1949, there were no short-tailed albatross breeding at any of the 15 historically known breeding sites, including Torishima Island, and the species was reported to be extinct. Fortunately, this report was premature and several birds returned from the sea in 1950 to nest on Torishima. By 1954 there were 6 breeding pairs and 25 total birds seen on the island. Japan designated the albatross a protected species in 1958, prohibiting hunting and limiting access to the breeding colonies. These protection measures and extensive habitat enhancement work on Torishima has allowed the species to increase steadily (Fadely, 1999). In addition, Japan has been working to reestablish breeding colonies in areas that are not so susceptible to volcanic eruptions and mudslides. Small numbers of short-tailed albatross have also been observed on a regular basis at Midway Atoll in the Hawaiian Islands and this may become a future colony site (Fadely, 1999). Based on egg counts from 1980 to 1998, the population on Torishima is increasing at an annual rate of 7 to 8 percent, a level that appears to be near its maximum biological potential (J. Cochrane, USFWS, Grand Marais, personal communication). Based on data from site visits to the two known breeding colonies in 2001 and estimates of the fraction of adult and sub-adult birds that do not visit the breeding colonies, the current world population of short-tailed albatross is estimated at 1600 to 1700 individuals (NPFMC 2002c). No confidence intervals for this estimate are available at this time. The great majority of nesting occurs on Torishima Island with small numbers at Minami-kojima Island (H. Hasegawa, personal communication, 2001).

Trophic Interactions

Albatross seize small fish (e.g., larval and juvenile pollock and sablefish), squid, and zooplankton from the surface of the water or just below it. Short-tailed albatross forage along the edge of the continental shelf and on the outer shelf where upwellings bring their prey to the surface. They may forage at night as well as in daylight (Sherburne 1993). Since they range widely over the ocean and are opportunistic feeders, their diet varies with local availability. Albatross are attracted to fishery wastes released from fishing vessels and processors and are thus vulnerable to being caught in fishing gear, especially on baited hooks in the longline fisheries.

Management Overview

Wildlife management responsibility for the short-tailed albatross is under the jurisdiction of the USFWS. The short-tailed albatross was originally designated as "endangered" under the Endangered Species Conservation Act of 1969 as a foreign-listed species (because they do not nest in U.S. territory). In 1973, when the ESA replaced the 1969 Act, the short-tailed albatross was included as a foreign species but not as a native species. This created an administrative error by listing its status as endangered elsewhere except in the U.S. The USFWS corrected this administrative error by extending the species endangered status to include its range within the U.S. (USFWS 2000c). The proposed and final rules contain extensive information on the species life history, demographics, and population status (USFWS 1998a, 2000c). Despite the listing oversight, the short-tailed albatross has been treated as an endangered species in the EEZ since 1970.

At the time a species is proposed for listing under the ESA, critical habitat can also be proposed. Habitats outside of the U.S. are not eligible for critical habitat designation. Because the North Pacific Ocean and Bering Sea once supported millions of short-tailed albatross, USFWS scientists believe that this species is nowhere near its habitat carrying capacity, and that it would be some time before any feature of its marine habitat becomes a critical limiting factor to population growth. Further, because the species' precarious situation derives entirely from historical harvest of the birds themselves, not from actions that caused habitat degradation, and because marine habitat loss does not appear to be a factor limiting current population growth rate, NOAA Fisheries determined that designation of critical habitat within the U.S. would not be beneficial to the short-tailed albatross (USFWS 1998a, 2000c).

Under the requirements of the ESA Section 7, the USFWS is responsible for determining whether proposed federal actions are likely to jeopardize the recovery of the species. The resulting BiOps may contain mandatory and/or recommended mitigation procedures and may set limits on the number of birds that can be taken incidental to the proposed action. In 1989, NOAA Fisheries had its first consultation with USFWS concerning the effects of the BSAI and GOA groundfish fisheries on the endangered short-tailed albatross. Although the 1989 BiOp identified several possible adverse effects of fishing activities, it concluded that the

BSAI and GOA FMPs were not likely to jeopardize the continued existence of the short-tailed albatross (USFWS 1998a and 1998b). It did, however, establish a threshold number of incidental takes (two birds per year) that would be allowed in the fishery based on historical take estimates. If this threshold number was exceeded, USFWS would immediately initiate a review of the fishery and possibly require mitigation measures under Section 7 of the ESA. The 1989 BiOp also required NOAA Fisheries to begin monitoring incidental takes more closely and reduce them as much as possible. There are two interrelated challenges to this issue which are discussed below. The first is how to measure the number of birds actually caught in the fisheries and the second is to develop effective fishing techniques that avoid catching seabirds. Working in collaboration with NOAA Fisheries, NPFMC has addressed both aspects of this issue with amendments to the BSAI and GOA FMPs, specifically BSAI Amendments 13, 27, 37 and GOA Amendments 18 and 30 (see Appendix C and D). NOAA Fisheries continued to consult with the USFWS on both a formal Section 7 basis and informal basis during TAC-setting deliberations and amendments to the FMPs. The history of these consultations and NOAA Fisheries regulatory responses as of June 2003 are summarized in Table 3.7-8.

The mandatory and recommended measures established in the 1998 BiOp (USFWS 1998c) are listed in Tables 3.7-9 and 3.7-10. In the 1998 BiOp, the USFWS required NOAA Fisheries to actively monitor the numbers of seabirds taken incidentally in the groundfish fisheries, which it does through the Observer Program, educate fishers on the identification of short-tailed albatross and the applicable laws, report any takings of short-tailed albatross immediately, institute mandatory protective measures on the longline fleet, and research the effectiveness of those protective measures. The incidental take threshold for the groundfish fisheries was set at four birds taken in a two year period (USFWS 1999b).

After the Draft Programmatic SEIS was published (August 2003), the USFWS issued two new BiOps (September 2003) as part of their ESA Section 7 consultations on the federal groundfish fisheries. These documents are available on NOAA Fisheries' website: http://www.fakr.noaa.gov/protectedresources/seabirds.html. One BiOp takes a programmatic look at the impacts of the BSAI/GOA groundfish FMPs and associated fisheries on the endangered short-tailed albatross and the threatened Steller's eider (NPFMC 2003) while the other BiOp concerns the TAC-setting process for these fisheries (NPFMC 2003). These documents conclude that the fisheries would not likely jeopardize the continued existence or recovery of either the short-tailed albatross or Steller's eider and would not adversely modify Steller's eider critical habitat (no critical habitat has been designated for short-tailed albatross in U.S. waters). The TAC-setting BiOp included updated Incidental Take Statements for these species. For short-tailed albatross, incidental take on longline gear is anticipated to be the same as previous years, with up to four birds taken every two years. In addition, for the first time the USFWS included an anticipated take for short-tailed albatross through collisions with trawl gear. Unlike the situation with the longline fleet where there are over ten years of Observer Program data on take of albatross, the USFWS and NOAA Fisheries have only recently begun investigating how frequently albatross may be colliding with trawl gear. Because of this uncertainty, the Incidental Take Statement anticipates that up to two birds could be taken by the trawl fleet but the time period was left open until the BiOp is superceded by a new one. This open-ended period allows USFWS and NOAA Fisheries to continue gathering data on the potential risk of trawl gear before a new Section 7 consultation is initiated.

The TAC-setting BiOp also includes mandatory terms and conditions that NOAA Fisheries must follow in order to be in compliance with the ESA. The first of these is the implementation of seabird deterrent measures for the longline fisheries as proposed by NOAA Fisheries in February 2003 (68 FR 6386) and adopted as final regulations on January 13, 2004 (69 FR 1930). These regulations are in effect as of February 2004 and vary by length of vessel, area fished, type of gear, and other factors. They are available at NOAA Fisheries website: http://www.fakr.noaa.gov/protectedresources/seabirds.html. Other provisions include continued outreach and training of fishing crews as to proper deterrence techniques, continued training of observers in seabird identification, retention of all seabird carcasses until observers can identify and record takes, continued analysis and publication of estimated incidental take in the fisheries, collection of information regarding the efficacy of seabird protection measures, cooperation in reporting sightings of short-tailed albatross, and continued research and reporting on the incidental take of short-tailed albatross in trawl gear.

Past and Present Effects and Management Actions

Direct Mortality: Natural Events

Toroshima Island in Japan, the main breeding site of short-tailed albatross, is an active volcano and has erupted as recently as August 2002. While a volcanic eruption is a natural event, it could have a devastating impact on the population if it occurred while the birds were nesting. Monsoon rains have also caused mud slides and erosion that have destroyed nesting sites. Japanese biologists and technicians have worked very hard in the past thirty years to reclaim and protect nest sites on Torishima from these natural threats. Although diseases and parasitic infestations do not appear to be significant at present, the fact that the species is so restricted in its nesting locations makes it more susceptible to these natural mortality factors.

Because of the critically small population size of this endangered species, fishery-related mortality is a conservation concern. In consideration of this, USFWS recently noted that in the event of a major population decline resulting from a natural environmental catastrophe (such as a volcanic eruption on Torishima Island) or an oil spill, the effects of longline fisheries on short-tailed albatrosses could be significant under ESA (USFWS 2000c). If such a catastrophic event were to occur, it would constitute new information requiring the reinitiation of a Section 7 consultation under the ESA (USFWS 1999b).

Direct Mortality: Harvest and Other Intentional Take

Early Aleut and Eskimo hunters apparently preferred albatross for their meals because archeologists find hundreds of albatross bones in the remains of old houses and villages along the Bering Sea coast (Smithsonian's Arctic Studies Center 2002). Although these remains have not been identified to species, some of these birds may have been short-tailed albatross given the fact that the species was once much more abundant and widespread in the Bering Sea. No albatross were identified in recent Alaska Native subsistence hunts (Denlinger and Wohl 2001).

The most important factor affecting the short-tailed albatross population was their near extermination by commercial harvesting almost 100 years ago. From the late 1800s to the 1930s, hunters killed millions of short-tailed albatross in their breeding colonies for feathers, meat, and eggs (Hasegawa and DeGange 1982). Between 1885 and 1903, an estimated 5 million birds were killed on Torishima Island alone. As stated above, even though they are now protected from harvest, they are still extremely rare and this magnifies the importance of other potential impacts.

Direct Mortality from Incidental Take in External Fisheries

In general, seabirds are vulnerable to becoming entangled in derelict fishing gear. The magnitude of the impact on short-tailed albatross is unknown. Hasegawa (personal communication 1997) reports that three to four birds per year on Torishima come ashore entangled in derelict fishing gear, some of which die as a result. He also stated that some take by Japanese fishermen (handliners) may occur near the nesting colonies, although no such take has been reported. There is no additional information on the potential effects of fisheries near Torishima on the species. Lost or abandoned fishing gear could be a threat to the species throughout its range and is not restricted to the breeding colony around Torishima.

The issue that has received the most attention is the incidental take of short-tailed albatross on the baited hooks of longline fisheries throughout their range. Although short-tailed albatross are likely taken in several international fisheries, there is no quantitative information available on the numbers of birds taken. This situation is the result of several factors; relatively few fishermen can identify rare species of seabirds (especially subadult plumages), there is no international reporting center, and very few fishing vessels have trained observers on board to monitor seabird incidental take. The lack of reliable data is problematic for effective mitigation management.

The Pacific halibut fishery, managed by the IPHC and regulated by NOAA Fisheries, sets millions of hooks each year but does not have an observer program. Under the authority of the ESA, USFWS has required NOAA Fisheries to investigate all options for monitoring the incidental take of short-tailed albatross in the Pacific halibut fishery in waters off Alaska and to institute appropriate changes to the fishery as a result of its investigation. NOAA Fisheries has contracted with the IPHC to carry out this research and make recommendations for management actions. IPHC is evaluating the use of video as a monitoring tool, with cost comparison to deploying observers.

Direct Mortality from Incidental Take on Groundfish Longlines

Seven short-tailed albatross have been reported to be taken incidentally in Alaska fisheries since 1983 (Table 3.7-11), six from vessels using hook-and-line gear. For most seabird species, NOAA Fisheries uses sampling statistics to extrapolate the numbers of seabirds incidentally caught in the entire fishery from the portion of the fleet covered by the Observer Program. However, since they are so scarce, the situation for short-tailed albatross is more difficult and uncertain. Until 1995, no short-tailed albatross had even been taken within an observer sample. At the February 1999 NPFMC meeting, the SSC stated in its minutes that ". . . Because incidental catch is so small, estimation of the total take of short-tailed albatross is problematic. Uncertainty exists on how the known take of albatross should be expanded to the unobserved portion of the fishery."

In the NOAA Fisheries analysis of the 1993-2001 observer data, only three of the albatross taken were identified as short-tailed albatross and all were from the BSAI region (Tables 3.7-2 and 3.7-3). Of the albatross taken, not all were identified. This analysis of 1993-2001 data resulted in an estimated average of one short-tailed albatross being taken annually in the BSAI groundfish longline fishery and zero short-tailed albatross taken annually in the GOA longline fishery. The incidental take threshold, as established by USFWS, is based on the actual reported takes of short-tailed albatross and not on extrapolated takes.

The uncertainty in estimating actual numbers of short-tailed albatross taken, combined with their endangered species status, places a great deal of importance on the issue of avoiding seabird bycatch in general, especially for longliners. Fishermen have a natural interest in reducing or eliminating the ability of seabirds to get at their bait since any hook that has caught a seabird or had its bait stolen is not available to catch fish. However, no one technique can be applied to all fishing vessels and gear types and whatever technique is used has to meet basic safety standards and not hinder the deployment or retrieval of fishing gear. In conjunction with USFWS, NOAA Fisheries recommended a series of seabird protection measures to NPFMC In 1997, NPFMC reviewed these measures and requested NOAA Fisheries to enact regulations that required longliners to use at least one of several different options to avoid incidental seabird takes. Within a range of criteria, fishermen were allowed to experiment with different techniques to see what worked best for their fishing style (see Section 3.7.1). NOAA Fisheries then began to measure the effectiveness of various seabird avoidance measures through changes in the Observer Program which required observers to gather data on the techniques used and their effectiveness in avoiding seabird take. Data collection was expanded in 1999 and 2000 to incorporate more detailed information about the frequency of measures used during a fishing trip and specific characteristics of different avoidance measures.

The seabird avoidance measures implemented in 1997 did not prevent additional takes of the short-tailed albatross. Two short-tailed albatross were taken in late September 1998 in the BSAI Pacific cod fishery and both vessels that hooked these birds were using the required seabird avoidance devices. However, the regulations do not include performance standards and, even though they were technically in compliance, reports from observers on these vessels indicated that the avoidance gear was set in a very ineffective configuration. There was a great deal of concern within the fishing industry at that point because they were close to reaching the incidental take threshold of four birds within a two year period established by USFWS. Under the regulations and authority of the ESA, exceeding this threshold would have required an immediate Section 7 consultation with USFWS to review the seabird protection measures. One possible, yet remote, outcome was that the fishery would have to close until new measures were in place, regardless of the economic impact. This concern prompted the longline industry to petition NPFMC to revise the existing seabird protection measures for the longline fisheries in the BSAI and GOA. At its April 1999 meeting, NPFMC recommended revising the existing regulations to make the most effective techniques mandatory. They also recommended that NOAA Fisheries undertake a comprehensive scientific study to test the effectiveness of these different techniques. This study was conducted by the Washington Sea Grant Program in 1999 and 2000 in the IFQ halibut and sablefish fishery and in the BSAI Pacific cod freezer-longliner fishery, with funding by NOAA Fisheries and USFWS and substantial support from the Observer Program and the longline industry. This research was carried out with the active cooperation and participation of the fishing industry to make sure that the techniques developed would meet with safety and "fishability" requirements.

The final report from the Washington Sea Grant study (Melvin *et.al.* 2001) indicates that use of paired streamer lines (with specified parameters) effectively eliminated all bycatch of Laysan albatross and northern fulmar without impacting catch rates of target species. While the study participants took special precautions when short-tailed albatross were sighted and none of these birds were caught during the study, the dramatic reduction of incidental take of similar-feeding species with the use of paired streamer lines indicates that the risk of incidental take to the endangered species would be greatly reduced if this avoidance measure was widely adopted. The use of single streamer lines was almost as effective as the paired streamer lines for overall seabird bycatch avoidance but Laysan albatross were caught five times as frequently with single versus paired streamer lines. The study concluded that the risk of hooking albatrosses, including short-tailed albatross, remains when only single streamer lines are used. Based on the results of their research (Melvin *et al.* 2001), the Washington Sea Grant Program, USFWS, and NOAA Fisheries jointly developed recommended changes to the existing seabird avoidance regulations required in the groundfish and halibut hook-and-line fisheries off Alaska. At its October and December 2001 meetings, NPFMC reviewed these recommendations, made some changes, and requested NOAA Fisheries to implement the necessary regulations. (See Section 3.7.1) The longline fleet has been very proactive in adopting these techniques and most vessels may already be in compliance in advance of the new regulations becoming legalized.

<u>Direct Mortality from Vessel Strikes</u>

Many trawl vessels deploy a cable ("third wire") from the vessel to the trawl net monitoring device (sonar transducers). There are 16 records of birds striking the "third wire" in the Observer Notes Database. These incidents involved 79 birds, mainly fulmars and Laysan albatross, with approximately 90 percent mortality (NPFMC 2002c). However, these cables are not typically monitored by groundfish observers and any birds killed by such collisions would not be likely to make their way into the trawl net and would therefore not be recorded in observers' haul samples. The distribution and extent of seabird mortalities or injuries by species is therefore unknown. NOAA Fisheries' AFSC is currently pursuing the possibility of using video technology to evaluate this issue. NOAA Fisheries and USFWS are presently trying to determine if this impact poses a threat to short-tailed albatross (USFWS 2000c). Solutions may be as simple as hanging streamers from the third wire (G. Balogh, USFWS, Anchorage, personal communication).

Other Past and Present Effects

In addition to potentially catastrophic natural events, the USFWS has identified several other human-induced impacts as potential threats to the species conservation and recovery (USFWS 2000c). Not enough information is available to assess the extent of these impacts quantitatively. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Direct mortality from incidental take in groundfish trawls.** No short-tailed albatross have been recorded as being taken in the groundfish trawl fishery but the similar Laysan albatross have been taken in trawls. The first recorded short-tailed albatross taken in Alaska fisheries was caught in a brown crab net (Table 3.7-11).

- **Indirect effects through changes in prey availability.** The impacts of groundfish and other fisheries on the availability of prey to short-tailed albatross are unknown. The ability of albatross to forage over huge areas is presumed to lessen the potential impact of localized depletion of prey. The fact that the short-tailed albatross population is growing at or near its theoretical maximum rate and that the environment used to support millions of them, it is thought that food availability is not limited at present (USFWS 2000c).

- **Indirect effects through consumption of fishery discards.** Short-tailed albatross are attracted to fishing vessels and processors to eat discards and offal. Benefits of the food source are countered by an increased risk of incidental take on longlines.

- **Indirect effects through plastics ingestion.** Species feeding primarily by surface-seizing, including short-tailed albatross, have the highest frequencies of plastic ingestion (Sievert and Sileo 1993). Dr. Hiroshi Hasegawa (personal communication 1997) reports that short-tailed albatross on Torishima commonly regurgitate large amounts of plastic debris. Hasegawa has observed a large increase in the occurrence of plastics in birds on Torishima over the last 10 years. His impression is that the vast majority of regurgitated plastics have been washed out to sea from land-based activities (USFWS 1998b). Plastic ingestion may cause physiological stress as a result of satiation and mechanical blockages (Auman *et al.* 1997) and may affect chick survival when the volume of plastic ingested is high (Sievert and Sileo 1993).

- **Indirect effects through contamination by oil spills.** Surface-feeding pelagic seabirds, including short-tailed albatross, are moderately sensitive to oil effects given their extreme reliance on open-water marine habitats for feeding and roosting, making them susceptible to incidents in these settings (King and Sanger 1979). Dr. Hiroshi Hasegawa (personal communication 1997) has observed some birds on Torishima with oil spots on their plumage. An oil spill in an area where a large number of individuals were rafting, such as near breeding colonies, could affect the population significantly.

Comparative Baseline

Short-tailed albatross were nearly exterminated by commercial hunting about 100 years ago but are making a comeback. The population appears to be increasing at a near-maximum rate. They are still one of the rarest species on earth with an estimated population of only 1600 to 1700 birds and are listed as "endangered" under the ESA. The need to protect this species from all sources of human-induced mortality has driven a great deal of research and regulation of seabird/fisheries interactions in the BSAI and GOA area. The institution of mandatory seabird protection measures for longliners in 1997 did not eliminate incidental take of this species but no incidental takes have been reported since September 1998. Recent scientific research indicates that new seabird avoidance techniques can greatly reduce the incidental take of species with similar feeding behavior as short-tailed albatross. NPFMC has recommended that these techniques be made mandatory for the groundfish longline fleet. NOAA Fisheries is currently in the process of implementing new seabird avoidance regulations for the longline fleet. The past and present effects on short-tailed albatross are summarized in Table 3.7-12.

Status for Cumulative Effects Analysis

Incidental take of short-tailed albatross remains a concern under all alternatives. The species' endangered status under the ESA requires that it receive consideration in the cumulative effects analysis. Because of its special status, it will not be grouped with any other species in the analysis of FMP Alternatives.

3.7.5 Northern Fulmar (*Fulmarus glacialis*)

Life History and Distribution

The northern fulmar has a wide range of color variations and looks similar to gulls but is actually related to the albatross. Fulmars are one of the few species in the tubenose family that breeds in Alaska. Nesting on remote, steep-sided island cliffs, both sexes share parental duties. The single egg is incubated for about eight weeks and the young fledge about seven weeks after they hatch.

The foraging range during nesting season is potentially large: the parents alternately depart from the colony every four to five days on foraging trips and are known to forage out to 100 km or more (Hatch and Nettleship 1998). They disperse throughout ice-free Alaskan waters and in the North Pacific Ocean in winter (Gould *et al.* 1982, Shuntov 1993). Fulmars do not reach breeding age until at least six years old and can live up to 50 years or longer.

Northern fulmars inhabit the northern oceans of the world, with separate populations in the Pacific and Atlantic (Harrison 1983). The estimated worldwide population of this species is 10 to 12 million individuals with an estimated population of 4 to 5 million individuals in the North Pacific (Hatch and Nettleship 1998). Ninety-nine percent of the Alaskan population nests in four colonies: Semidi Islands (GOA), Chagulak Island (Aleutian Islands), the Pribilof Islands (Bering Sea), and St. Matthew/Hall Islands (Bering Sea) (Hatch and Nettleship 1998). The estimated population is 1,500,000 fulmars in the BSAI area and 600,000 in the GOA area (Table 3.5-62).

Population trend data has been collected from permanent sample plots in several areas. The population of fulmars on the Pribilof Islands (St. George and St. Paul) was estimated at about 70,000 individuals in the 1970s (S. Hatch, personal communication, USGS, Alaska Biological Science Center). Permanent study plots for fulmars were established on St. George Island in 1976. The census for these plots was relatively consistent for the next twelve years but then rose dramatically from about 970 birds in 1988 to a high count of 1979 birds in 1992. The census for these plots then declined even more dramatically to 475 birds in 1999 (Dragoo *et al.* 2001). On nearby St. Paul Island, a much smaller colony, census plots showed a similar pattern of stability and then major increase to a high in 1992 and then a decline in subsequent years.

On Chowiet Island, the main fulmar colony in the Semidi Islands in the GOA, census numbers for permanent study plots show a similar pattern to that in the Pribilofs. After relatively stable counts from 1976 to 1991, numbers increased substantially to a maximum in 1993 and then declined by more than half that number in 1998 (Dragoo *et al.* 2001). There are no regularly censussed sample plots on the St. Matthew/Hall or Chagulak Island colonies.

Trophic Interactions

Northern fulmars forage on a variety of surface species including squid, jellyfish, crustaceans, other invertebrates, and small fish (including juvenile pollock in the Pribilof Islands) (Ainley and Sanger 1979, Hunt *et al.* 1981a, DeGange and Sanger 1986, Sanger 1987, Schneider *et al.* 1986, Baird 1990, Hatch 1993, Gould *et al.* 1997). Food is taken from the water surface or just beneath it, including at night when pelagic prey migrate close to the surface (Schneider *et al.* 1986, Hatch 1993). Fulmars probably do much of their foraging at night, and may use olfactory cues in locating food because their sense of smell is highly developed (Hatch and Nettleship 1998). Fulmars obtain food by dipping, surface-seizing, surface-plunging, pursuit-diving, and scavenging. They are apparently unable to pick up prey while on the wing.

Ranging over large areas of ocean, fulmars forage from the continental shelf to beyond the continental shelf break (Hunt *et al.* 1981c, Gould *et al.* 1982, Schneider and Hunt 1984, DeGange and Sanger 1986, Schneider *et al.* 1986, Hatch 1993). The outer front and shelf edge, where water from the continental slope is upwelled, is important to several surface-feeding seabird species, including fulmars. Availability of prey to these seabirds may vary with strength of the upwelling (Schneider *et al.* 1987).

Although the location of breeding sites influences seabird feeding distribution, fisheries also have a strong influence on the distribution of seabirds at sea (Garthe and Huppop 1994). Fulmars are common scavengers of discarded fish thrown overboard by commercial fishing boats, sometimes forming vast chattering groups of thousands of birds.

Management Overview

Wildlife management responsibility for the northern fulmar is under the jurisdiction of the USFWS. The species is protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*).

Past and Present Effects and Management Actions

Direct Mortality from Incidental Take in External Fisheries

Past fisheries in the North Pacific, both foreign and domestic, have taken fulmars in the course of their operations. For most of these fisheries, the numbers of individual species taken were not recorded. One exception is the Japanese salmon mothership fishery where an average of 2,352 fulmars were taken every year between 1981-1984 (Jones and DeGange 1988). In 1977, the land-based Japanese salmon gillnet fishery killed an estimated 1,536 fulmars. In 1987, after substantial reductions in the fishing effort, an estimated 694 fulmars were taken (DeGange and Day 1991). The incidental take of fulmars in other current foreign gillnet fisheries is unknown. Since they usually forage at-sea, they are unlikely to be taken in coastal gillnet fisheries.

State-managed longline fisheries (cod, sablefish, rockfish) and halibut fisheries may contribute only a small amount to the overall incidental take of fulmars. The larger hooks used in the halibut fisheries presumably result in lower incidental catch rates than in the groundfish fisheries. In 1998, incidental takes of 57 fulmars were documented in the halibut fishery through interviews with fishermen (Trumble and Geernaert 1999). However, since the halibut and state-managed fisheries are not subject to the NOAA Fisheries Observer Program, there is no way to independently verify or quantify the numbers of particular species taken by these vessels.

Direct Mortality from Incidental Take on Groundfish Longlines

The numbers of fulmars that were caught in the BSAI and GOA groundfish longline fisheries between 1993-2001 were estimated from Observer Program data (Tables 3.7-2 and 3.7-3). Fulmars are taken incidentally on longlines far more frequently than any other species. In the BSAI, fulmars constitute an average of 60 percent of all birds taken and in the GOA, 46 percent are fulmars. Between 1993 and 2001, the estimated number of fulmars killed by longlines in the BSAI varied between 4,251 and 15,533 birds per year with an estimated average of 8,644 fulmars per every year (95 percent confidence interval is 8,252 - 9,036 birds). In the GOA, an estimated average of 479 fulmars were taken every year (95 percent confidence interval is 388 - 569 birds).

In an effort to reduce the incidental take of seabirds on longlines, NOAA Fisheries instituted mandatory seabird avoidance measures for the groundfish fleet in 1997 (62 FR 23176). These measures included some flexibility for captains to decide which options to use in order to accommodate their particular fishing vessels and techniques. Based on the observation that most seabirds fed during daylight hours, one of these options was to fish at night. Unfortunately, fulmars are an exception to that general rule and often feed at night. Prior to 1997, the average estimated numbers of fulmars taken in the BSAI were 6,087 birds per year. Between 1997and 2001, the estimated annual average take in the BSAI increased to 10,689 fulmars per year, with the two largest takes in 1997 and 1998. In contrast, the GOA 1993-1996 average was 569 fulmars per year and the 1997-2001 average decreased to 406 birds per year. It is not known what proportion of fishing effort was conducted at night as a seabird avoidance measure and whether the different responses in the BSAI and GOA were the result of different fishing strategies or other factors. During the Washington Sea Grant Program experimental tests of the efficacy of the various seabird avoidance measures, night sets of longline fishing gear showed significant increases of fulmar incidental catch over daytime sets (Melvin *et al.* 2001). This study also indicated that use of paired streamer lines (with specified parameters) effectively eliminated all bycatch of northern fulmars without impacting catch rates of target species. In response to the Washington Sea Grant results, NOAA Fisheries' pending new regulations eliminate night fishing as an optional seabird deterrent technique and require that paired or single streamer lines be used on all groundfish longline vessels longer than 26 ft LOA.

Several factors are likely to affect the risk of seabird incidental catch, including fishing effort (number of hooks per year), the distribution of effort by sub-area and season, the abundance and distribution of seabirds in the vicinity of fishing vessels, the nutritional condition of the birds (i.e. starving or not), and the use of seabird deterrents. The relative importance of these factors has not been fully studied. NOAA Fisheries analyzed the relationship between fishing effort and numbers of birds hooked in the BSAI and GOA longline fisheries and found that the relationship varies for different species groups (Figures 3.7-5 and 3.7-6, respectively). The data suggest that fishing effort in longline fisheries (number of hooks set) does play a strong role in determining how many fulmars are caught. This was not the case for the other major groups of seabirds that are taken.

Direct Mortality from Incidental Take in Groundfish Trawls

The combined BSAI and GOA trawl fishery took an estimated average of between 274 fulmars (low estimate) and 5,891 fulmars per year (high estimate) from 1997-2001 (Table 3.7-4).

Direct Mortality from Incidental Take in Groundfish Pot Gear

Fulmars are one of the few species that are caught in the pot fisheries and actually make up a large majority of birds caught (Table 3.7-5). Still, pot fisheries account for relatively few incidental takes. Between 1993 and 2001, an average of 33 fulmars were taken in the combined BSAI and GOA pot fisheries. Many of these birds may actually have been killed by collisions with the pot gear while it was on deck, rather than as it was fishing, with dead birds being caught in the gear before it was deployed.

Direct Mortality from Vessel Strikes

According to the Observer Program records of bird-strikes from 1993-2000, fulmars are the species most frequently observed to strike the vessel, rigging, or trawl “third wires”. Of the 120 recorded collisions, 564 fulmars were involved in 38 incidents. Monitoring these types of collisions is not part of the observer’s normal duties so the true extent of this impact is not known. NOAA Fisheries is currently investigating the issue, especially as it relates to “third wires” (NPFMC 2002c).

Assessment of Population-Level Effects

One major question for resource managers is whether a given level of incidental take is significant at the population-level. The Observer Program data has been combined from many different areas to give a broad, regional average for incidental take. Taken as a percentage of a regional population estimate, a given average level of incidental take may not appear to be a significant impact. However, if a majority of the fulmars taken annually in the groundfish fishery originate from one colony (such as St. George), and if a substantial proportion of the catch consists of adult birds, then it is possible that fishery incidental take could be contributing to population declines at specific colonies. As noted above, fulmar sample plots on St. George, St. Paul, and Chowiet islands all showed a similar pattern of stability in the 1970s and 1980s followed by a major increase in the early 1990s and an even larger decline thereafter (Dragoo *et al.* 2001). This pattern was especially dramatic on St. George. There is some question regarding the accuracy of the sample plots in reflecting actual population-level fluctuations. For instance, due to their conservative life history strategy, fulmars would not be expected to double their population over 4 years as did the sample plot numbers between 1988 and 1992 at St. George. If the count on St. George in 1992 was anomalously high (for some unexplained reason), the apparent subsequent ‘decline’ may be less meaningful in terms of actual population impacts. In order to address this uncertainty, the USGS/Biological Resource Division has recently begun to collect data on the at-sea foraging distribution of northern fulmars as well as identifying the colony of provenance of a sample of incidentally taken fulmars. Results will be used in the development of population models that may elucidate the potential for incidental take in groundfish fisheries to have colony-level population impacts. There are, of course, other factors besides fishing impacts that may cause population-levels to fluctuate, including variable environmental conditions, and these will be investigated as well.

Other Past and Present Effects

The following issues have been identified as having potential impacts on northern fulmars but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impacts of groundfish and other fisheries on the availability of prey to fulmars are unknown. The ability of fulmars to forage over huge areas is presumed to lessen the potential impact of localized depletion of prey.

- **Indirect effects through consumption of fishery discards.** Fulmars are attracted to fishing vessels and processors to eat discards and offal. Benefits of the food source are countered by increased risk of incidental take on longlines.

- **Indirect effects through plastics ingestion.** Species feeding primarily by surface-seizing, including northern fulmar, have the highest frequencies of plastic ingestion (Sievert and Sileo 1993).

- **Indirect effects through contamination by oil spills.** Surface-feeding pelagic seabirds, including fulmars, are moderately sensitive to oil effects given their extreme reliance on open-water marine habitats for feeding and roosting, making them susceptible to incidents in these settings (King and Sanger 1979).

Comparative Baseline

Northern fulmars are abundant breeders and residents in the BSAI and GOA area with an estimated population of 2 million birds in the BSAI and GOA. They are strongly attracted to fishing vessels where they scavenge for fish processing waste and bait. Their numbers and behavior have contributed to their status as the bird species most frequently taken incidental to the groundfish fisheries. The institution of mandatory seabird protection measures for longliners in 1997 actually led to an increase of fulmars taken in the BSAI even though incidental take in the GOA decreased. Fulmars make up the majority of birds taken in the trawl fisheries with annual take in the thousands. Investigations into possible colony-level population impacts are currently underway. The past and present effects on northern fulmar are summarized in Table 3.7-13.

Status for Cumulative Effects Analysis

Incidental take of northern fulmars is expected to continue under all alternatives and warrants consideration in the cumulative effects analysis. Because of their status as the most frequently taken seabird species in all sectors of the groundfish fisheries, they will be discussed as a separate species in the analysis of FMP Alternatives.

3.7.6 Shearwaters

- Short-tailed shearwater (*Puffinus tenuirostris*)
- Sooty shearwater (*Puffinus griseus*)

Life History and Distribution

Shearwaters belong to the order Procellariiformes, the tubenoses, along with albatross, fulmars, and storm-petrels. Both species common to the BSAI and GOA, the short-tailed and sooty shearwaters, are dark gray with long, narrow wings and are difficult to distinguish from each other. Shearwaters breed in the Southern Hemisphere: short-tailed shearwaters in southeastern Australia and Tasmania, sooty shearwaters in New Zealand and in Chile along the South American coast. Both short-tailed and sooty shearwaters visit Alaskan waters from May through September. Short-tailed shearwaters are found in the Bering and Chukchi Seas as well as the GOA while sooty shearwaters range primarily south of the Aleutian Islands and in the GOA (Hunt *et al.* 1981b, Gould *et al.* 1982).

The total world population of short-tailed shearwaters, almost all of which spend the austral winter in the North Pacific, has been estimated at 23 million (Everett and Pitman 1993). The population of sooty shearwaters may exceed 30 million (Springer *et al.* 1999). The populations of these two species account for over 50 percent of all seabirds in Alaskan waters in summer (Sanger and Ainley 1988).

Three different time-series of pelagic bird abundance collected in disparate portions of the California Current revealed a 90 percent decline in sooty shearwater abundance between 1987 and 1994. The decline was negatively correlated with a concurrent rise in sea-surface temperatures (Veit *et al.* 1996 and 1997). The widely separated surveys suggest that this abundance change may be more than just a local change in distribution. An overall decreasing trend in sooty and short-tailed shearwater abundance at breeding colonies has occurred over the past 20 to 30 years. (Baduini, University of California, Irvine, personal communication 2000). The extent and mechanism(s) for these potential declines have not yet been established.

Trophic Interactions

Both short-tailed and sooty shearwaters forage on the surface or can dive to at least 60 m (Weimerskirch and Sagar 1996, Weimerskirch and Cherel 1998). Shearwaters depend on areas where prey are concentrated by upwellings, convergences, or bottom terrain features, especially along the inner front (boundary between wind-mixed and stratified water on the Bering Sea shelf) (Hunt *et al.* 1981b, Schneider *et al.* 1986, Hunt *et al.*1996c). The short-tailed shearwater eats primarily large euphausiids and some jellyfish and small schooling fish (Marchant and Higgins 1990). Diets of short-tailed shearwaters in spring varied by region in the western subarctic (Springer *et al.* 1999). This apparently reflects the availability of prey species rather than dietary preferences since elsewhere (e.g., Sea of Okhotsk and Bering Sea) other prey predominate (Ogi *et al.* 1980). Sooty shearwaters eat primarily small schooling fish, such as Pacific saury and myctophids, and their movements are believed to coincide with the movements of the sauries (Ogi 1984). Sooty shearwaters forage on squid on the outer shelf and shelf break (DeGange and Sanger 1986) and with increasing prominence at higher latitudes (Ogi 1984).

Shearwaters in the southeastern Bering Sea have, in the past, consumed a large biomass of euphausiids. Recent evidence (Baduini *et al.* 2000) suggests that, since 1997, short-tailed shearwaters over the southeastern Bering Sea shelf have been taking increasing amounts of fish. Inshore of the inner front, Pacific sand lance is taken, whereas most foraging flocks offshore of the inner front were focused on age-0 gadids, most likely pollock. This apparent dependence on age-0 pollock may occur when euphasiids are scarce over the middle domain (Hunt *et al.* 1998).

Short-tailed shearwaters occasionally die-off in large numbers during late summer, apparently due to widespread scarcity of prey during anomalous oceanographic conditions. Major die-offs were recorded in Alaska in 1983, 1986, and 1997 (Nysewander and Trapp 1984, Irons *et al.* 1986, Hatch 1987, Baduini *et al.* 1998, Mendenhall *et al.* 1998). In 1997, a die-off of short-tailed shearwaters, apparently from starvation, was estimated at 11 percent of the population surveyed (Baduini *et al.* 2000). This estimate was based on a count of floating carcasses in the southeast Bering Sea as a percent of the population surveyed. In 1998, anomalous climate conditions were repeated for a second consecutive year, with elevated water temperature, cross-shelf advection of zooplankton and larval fish, major changes in the structure of the zooplankton community, and an unprecedented second observation of a large-scale coccolithophorid phytoplankton bloom (Hunt *et al.* 1999a). Although no unusual mortality of short-tailed shearwaters was seen, birds were underweight. In both years, shearwater diets were broader than in previous years, with fish becoming a dominant prey in 1998.

The recent large-scale die-off of short-tailed shearwaters suggests that these birds are vulnerable to changes in the abundance or availability of their preferred foods in the southeastern Bering Sea (Vance *et al.* 1998). Changes in water temperature or productivity may influence the abundance of euphausiids either directly, through bottom-up effects, or indirectly through changes in the distribution of predators that compete with shearwaters for euphausiids. When euphausiids are scarce, shearwaters can use age 0 pollock, if they are present in high concentrations. Shearwater use of age 0 pollock may need to be considered in future management decisions (G.L. Hunt, Jr., University of California, Irvine, personal communication). Major changes in the zooplankton community will be likely to affect other higher trophic level species, including fish and whales (Hunt *et al.* 1999a).

Management Overview

Wildlife management responsibility for shearwaters is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*).

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Shearwater chicks, called "muttonbirds" because of their high fat content, have been heavily harvested by subsistence and commercial hunters in the South Pacific for many years. In Australia alone, an estimated 700,000 short-tailed shearwater chicks are harvested every year (Everett and Pitman 1993).

Direct Mortality from Incidental Take in External Fisheries

Short-tailed and sooty shearwaters are attracted to fishing vessels throughout their range and have been taken incidentally in many different fisheries. The fact that they migrate between subarctic and subantarctic waters exposes them to a great variety of fisheries. High-seas driftnet fisheries for tuna, squid, and salmon have been identified as a major source of mortality for shearwaters in the past. The Japanese large-mesh driftnet fishery for tuna and swordfish dates back to 1905. This fishery peaked in 1982 with over 700 vessels but declined to only 70 vessels by 1991. There is no data on the incidental take of seabirds for most of this period except for the 1990-1991 season when over 3500 seabirds were estimated to be taken, including a large number of sooty shearwaters (DeGange *et al.* 1993). Between 1981 and 1984, the Japanese salmon mothership fishery took an average of 95,500 shearwaters each year, mostly short-tailed (Jones and DeGange 1988). In the Japanese land-based drift gillnet fishery, an estimated 80,000 shearwaters (again, mostly short-tailed) were killed in 1977. By 1987, fishing effort had been reduced and an estimated 27,500 shearwaters were killed (DeGange and Day 1991). These estimates do not include birds that fell out of the nets before being retrieved or birds that were released alive. Driftnet fisheries targeting flying squid were started in the late 1970s by Japan, Korea, and Taiwan. At their peak in the late 1980s, these fisheries deployed millions of kilometers of driftnet. Rough estimates of the total number of seabirds killed by the squid driftnet fisheries ranged between 875,000 and 1,660,000 seabirds annually. Up to 70 percent of these birds consisted of sooty shearwaters and over 100,000 birds were identified as short-tailed shearwaters (DeGange *et al.* 1993). Due to the tremendous amount of waste and ecosystem damage associated with the high-seas driftnet fisheries, they were outlawed by international agreement through United Nations Resolution (46/215) in December of 1992 (Paul 1994). Because shearwaters are such long-lived and slowly maturing species, high rates of mortality from the driftnet fisheries may have a lingering impact on the populations at present.

State-managed longline fisheries and halibut fisheries may contribute only a relatively small amount to the overall incidental take of shearwaters. In 1998, incidental take of 3 unidentified shearwaters were documented in the halibut fishery through interviews with fishermen (Trumble and Geernaert 1999).

Direct Mortality from Incidental Take on Groundfish Longlines

The estimated numbers of seabirds caught in the BSAI and GOA groundfish longline fisheries are listed in Tables 3.7-2 and 3.7-3. The two species are combined into one "shearwater" category and are probably also included to some extent in the "unidentified tubenoses" category. The combination of these categories averaged 674 birds per year between 1993 and 2001 in the BSAI and about 30 birds per year in the GOA.

In an effort to reduce the incidental take of seabirds on longlines, NOAA Fisheries instituted mandatory seabird avoidance measures for the groundfish fleet in 1997 (62 FR 23176). Prior to 1997, the average estimated number of identifiable shearwaters taken in the BSAI was 389 birds per year (not including "unidentified tubenoses"). Between 1997 and 2001, the estimated average take in the BSAI increased to 578 shearwaters per year. Much of this increased average take was due to an unusually high number of birds taken in 1998 (1,131 shearwaters). The reason this one year was so different than the others is not known but may be related to nutritional stress of the birds. In the GOA, the average take before and after the seabird avoidance measures were enacted declined from 35 shearwaters per year in 1993-1996 to 18 shearwaters per year in 1997-2001. Although the Washington Sea Grant Program results indicate that new seabird avoidance techniques could reduce overall incidental take of seabirds by 70-95 percent, incidental take of species such as shearwaters that can dive deep in pursuit of baited hooks were not reduced when single or paired streamer lines were employed (Melvin *et al.* 2001).

Direct Mortality from Incidental Take in Groundfish Trawls

The estimated number of shearwaters caught in the combined BSAI and GOA groundfish trawl fisheries varied considerably between years (Table 3.7-4). The average estimated number of shearwaters taken was between 271 birds per year (low estimate) and 1,327 birds per year (high estimate) in 1997-2001.

Direct Mortality from Vessel Strikes

According to preliminary analysis of the Observer Program records of bird-strikes from 1993-2000, sooty shearwaters were observed to strike the vessel or rigging on 6 occasions but these involved 526 birds. Collisions of large numbers of birds typically occur during the night or during storms or foggy conditions when bright deck lights are on, which can cause the birds to be disoriented (NPFMC 2002c).

Other Past and Present Effects

The following issues have been identified as having potential impacts on short-tailed and sooty shearwaters but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impacts of groundfish and other fisheries on the availability of prey to short-tailed and sooty shearwaters are unknown. The ability of short-tailed and sooty shearwaters to forage over huge areas is presumed to lessen the potential impact of localized depletion of prey.

- **Indirect effects through consumption of fishery discards.** Shearwaters are attracted to fishing vessels and processors to eat discards and offal. Benefits of the food source are countered by increased risk of incidental take on longlines and trawls.

- **Indirect effects through plastics ingestion.** Species feeding primarily by surface-seizing or pursuit-diving, including shearwaters, have the highest frequencies of plastic ingestion (Sievert and Sileo 1993).

- **Indirect effects through contamination by oil spills.** Diving pelagic seabirds, including shearwaters, are moderately sensitive to oil effects given their extreme reliance on open-water marine habitats for feeding and roosting, making them susceptible to incidents in these settings (King and Sanger 1979).

Comparative Baseline

Short-tailed and sooty shearwaters are by far the most abundant seabirds in Alaska, even though they do not breed here. They have been hunted in huge numbers on their breeding grounds and taken incidentally in various fisheries throughout their range. Increasing ocean water temperatures and changing ocean currents have apparently altered their prey availability and caused periodic massive die-offs due to starvation. Both species may have experienced population declines in the past twenty years but they continue to be very abundant. The numbers of shearwaters taken in the BSAI and GOA groundfish fisheries is relatively small. The past and present effects on shearwaters are summarized in Table 3.7-14.

Status for Cumulative Effects Analysis

Incidental take of shearwaters is expected to continue under all alternatives and warrants consideration in the cumulative effects analysis. Because of the similarity of their fishery interactions and responses to management measures, sooty and short-tailed shearwaters will be discussed together in the "shearwater" group in Chapter 4.

3.7.7 Storm-Petrels

- Leach's storm-petrel (*Oceanodroma leucorhoa*)
- Fork-tailed storm-petrel (*Oceanodroma. furcata*)

Life History and Distribution

Storm-petrels are tubenoses and are thus related to albatross, fulmars, and shearwaters. Two species breed in Alaska: Leach's storm-petrel and fork-tailed storm-petrel. Both are robin-sized birds with forked tails. Leach's is dark gray with a white rump and the fork-tailed is mostly whitish-gray with darker wings. Both species nest on islands in burrows that they dig or in crevices in the rocks. They lay one egg in June, incubate it for about 40 days, and fledge chicks about 70 days later. These species are active at the colony only at night, and often stay at sea during the day or on moonlit nights (Boersma and Groom 1993).

Both the Leach's and fork-tailed storm-petrels breed on islands from the western Aleutians through the GOA, but not farther north (USFWS 1998a). These species winter over the deep ocean, including the Bering Sea Basin (Shuntov 1993). Populations of most seabirds that nest in burrows and crevices, including these two storm-petrels, have not been adequately counted at any season. Population estimates are extremely crude and may only indicate their numbers within an order of magnitude (Boersma and Groom 1993). Although difficult to count, these species appear to be quite abundant in the BSAI and GOA. USFWS (1998a) estimates that there are 4.5 million Leach's storm-petrels in the BSAI and 1.5 million in the GOA. Fork-tailed storm-petrels are thought to number 4.5 million in the BSAI and 1.2 million in the GOA (Table 3.5-62).

USFWS conducts annual surveys of the populations of storm-petrels on three islands in Alaska: St. Lazaria (southeast), Aiktak (eastern Aleutians), and Buldir (western Aleutian Islands) (Figure 3.7-1). Breeding populations are indexed by counting burrow holes on permanent plots. Since they cannot be distinguished reliably, burrows made by Leach's and fork-tailed storm-petrels are combined for a total storm-petrel population index. On all three islands, the density of burrow holes has generally increased since counts were begun in the early 1990s (Dragoo *et al.* 2001).

Trophic Interactions

Storm-petrels seize prey from the water's surface and forage at night. They have well-developed olfactory senses and find their food and perhaps nest sites by scent (Boersma and Groom 1993). Storm-petrels feed on small fishes, particularly juvenile lantern fish, squid, and euphausiids (Springer *et al.* 1999), but in some areas, fork-tailed storm-petrels may depend on capelin (Ainley and Sanger 1979, Baird and Gould 1986, DeGange and Sanger 1986).

Storm-petrels forage at distances of more than 100 km from breeding colonies and typically forage over the shelf edge and deep water (Springer *et al.* 1999). Leach's storm-petrels forage from the shelf-break seaward (Ainley and Sanger 1979, Hunt *et al.* 1981b, Gould *et al.* 1982, Schneider *et al.* 1986). Fork-tailed storm-petrels most typically forage over the outer shelf and adjacent ocean. This species has also been observed feeding on the southeast Bering Sea shelf near the Slime Bank area and in large groups in Resurrection Bay coming out of Seward (C. Baduini, University of California, Irvine, personal communication).

Management Overview

Wildlife management responsibility for storm-petrels is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*).

Past and Present Effects and Management Actions

Direct Mortality from Incidental Take in External Fisheries

Storm-petrels are attracted to fishing vessels throughout their range and have been taken incidentally in many different fisheries. Between 1981 and 1984, the Japanese salmon mothership fishery took an estimated annual average of 94 Leach's storm-petrels and 954 fork-tailed storm-petrels (Jones and DeGange 1988). In the Japanese land-based drift gillnet fishery, an estimated 1,843 fork-tails were killed in 1977 and 578 were killed in 1987 (DeGange and Day 1991). No estimates of incidental take are available for the high seas squid gillnet fisheries of Japan, Korea, and Taiwan.

Direct Mortality from Incidental Take in the Groundfish Fisheries

Storm-petrels are not identified by species in the Observer Program data (Tables 3.7-2 through 3.7-5) but are presumably included in the "unidentified tubenoses", "other", and "unidentified seabird" categories. Storm-petrels account for an unknown fraction of these totals.

Direct Mortality from Vessel Strikes

According to the Observer Program records of bird-strikes from 1993-2000, storm-petrels strike the vessel or rigging on a regular basis. Of the 120 recorded collisions, 631 storm-petrels were involved in 19 incidents. It is not known what proportion of these birds were killed or injured (NPFMC 2002c).

Other Past and Present Effects

The following issues have been identified as having potential impacts on storm-petrels but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impacts of groundfish and other fisheries on the availability of prey to storm-petrels are unknown. The ability of storm-petrels to forage over large areas is presumed to lessen the potential impact of localized depletion of prey.

- **Indirect effects through contamination by oil spills.** Storm-petrels are moderately sensitive to oil effects given their extreme reliance on open-water marine habitats for feeding and roosting, making them susceptible to incidents in these settings (King and Sanger 1979).

- **Indirect effects by introducing mammalian predators to nesting islands.** Burrowing seabirds, including storm-petrels, were decimated or seriously reduced on many islands in the Aleutian chain and GOA after the introduction of arctic and red foxes by fox farmers. Storm-petrels have begun to re-colonize some of those islands after the removal of the foxes but populations are probably still depressed from pre-fox levels. (Bailey and Kaiser 1993). At present, rats pose the greatest predator threat to seabirds breeding in Alaska, especially for burrow and crevice nesters such as storm-petrels. It is not known what proportion of fishing vessels carry rats. The USFWS in Alaska has an extensive program to reduce the threat of new rat invasions.

Comparative Baseline

Leach's and fork-tailed storm-petrels are abundant in the BSAI and GOA area. Reliable population estimates and trends are not available for these species. These species are probably taken occasionally by groundfish vessels, at least through vessel strikes. They are not gregarious at sea and can forage long distances from their breeding colonies and are thus not likely to be impacted by potential local depletion of forage species. The past and present effects on storm-petrels are summarized in Table 3.7-15.

Status for Cumulative Effects Analysis

The frequency of interaction between storm-petrels and the groundfish fleet warrants further consideration in the cumulative effects analysis. Due to the lack of quantitative information on fishing impacts on these species, they will be included in the "other planktivorous species" group in the following analysis of FMP Alternatives.

3.7.8 Cormorants

- Pelagic cormorant (*Phalacrocorax pelagicus*)
- Red-faced cormorant (*Phalacrocorax urile*)
- Double-crested cormorant (*Phalacrocorax auritus*)

Life History and Distribution

Cormorants are large, dark, heavy-bodied birds with long necks and tails. There are four species that breed in Alaska. The pelagic cormorant breeds throughout the BSAI and GOA, the red-faced cormorant breeds in the BSAI north to the Pribilofs and the GOA west of PWS, and the double-crested cormorant breeds in the Aleutian Islands and GOA. Brandt's cormorant (*P. penicillatus*) primarily breeds south of Alaska but has two small colonies in southeastern Alaska and one near the entrance to PWS (USFWS 1998a). It does not regularly interact with the groundfish fisheries and is not described further here. The other three species nest on rocky island ledges in relatively small colonies and lay 3-5 eggs. Both sexes share parental duties. Eggs hatch in 20-25 days and young fledge in 45-60 days.

Cormorants usually range within 20 km of shore (Schneider and Hunt 1984). Winter distributions are similar to their breeding distribution except that birds will move to ice-free coasts and protected waters. Rough estimates of cormorant numbers indicate that they are not nearly as numerous as many other seabird species. In the BSAI, there are an estimated 80,000 pelagics, 90,000 red-faced, and 9,000 double-crested. In the GOA, there are an estimated 70,000 pelagics, 40,000 red-faced, and 8,000 double-crested (Table 3.5-62). Population trends are difficult to ascertain for cormorants because they are known to shift nesting locations between years. Variation in nest counts on survey plots may reflect this tendency to nest in different places rather than indicate changes in population-level. Given this caveat about interpreting the limited sample plot data, pelagic cormorant colonies in the BSAI appear to be relatively stable or decreasing over the past 20 years, decreasing in the GOA, and increasing in southeast Alaska. Red-faced cormorants are surveyed separately in only one location, Chiniak Bay (GOA), and appear to be decreasing. No trend data are available for double-crested cormorants (Dragoo *et al.* 2001).

Trophic Interactions

Cormorants are basically small fish eaters that will also take some crustaceans and other invertebrates. Cormorant species in Alaska are known to take capelin, herring, sandlance, pollock, and other small fish (Siegel-Causey and Litvinenko 1993). Cormorants forage by diving as deep as 40 m (DeGange and Sanger 1986).

Management Overview

Wildlife management responsibility for cormorants is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*).

Past and Present Effects and Management Actions

Direct Mortality from Incidental Take in Fisheries

The incidental take of cormorants in worldwide fisheries is unknown. Given their preference for nearshore waters, cormorants are more likely to be taken in coastal gillnet fisheries than offshore groundfish fisheries. Cormorants are not distinguished by species in the Observer Program data of incidental take in the groundfish fisheries. It is not known how many cormorants might be included in the "unknown" or "other" categories in the various sectors (Tables 3.7-2 through 3.7-5).

Direct and Indirect Effects through Contamination by Oil Spills

A great deal of research has been conducted on the impacts of *Exxon Valdez* oil spill in 1989 on affected species, including cormorants. Carcasses of 838 cormorants were recovered following the oil spill, including 418 pelagic, 161 red-faced, 38 double-crested, and 221 unidentified cormorants. Many more cormorants probably died as a result of the spill, but their carcasses were not found. Counts on the outer Kenai Peninsula coast suggested that the direct mortality of cormorants due to oil resulted in fewer birds in this area in 1989 compared to 1986. In addition, there were statistically-significant declines in the estimated numbers of cormorants (all three species combined) in the oiled portion of PWS based on pre- and post-spill boat surveys in July 1972-1973 compared to 1989-1991. More recent surveys (through 1998) have not shown an increasing population trend since the oil spill, and for that reason these species are considered to be not recovered in the spill area. (EVOS Trustee Council 2002).

Comparative Baseline

Cormorants are widely distributed in the BSAI and GOA but are not abundant anywhere. These species have not been studied in great detail so there are many unknowns regarding their ecosystem and anthropogenic interactions. No quantitative data is available on their interaction with the groundfish fisheries. The past and present effects on cormorants are summarized in Table 3.7-16.

Status for Cumulative Effects Analysis

Since these species do not interact very often with the groundfish fisheries and there is no quantitative data on either their population trends or impacts of the fisheries, these species will not be carried forward for cumulative effects analysis except in the general category of fish-eating (piscivorous) birds.

3.7.9 Spectacled Eider (*Somateria fischeri*)

Life History and Distribution

Spectacled eiders are large diving sea ducks that spend most of the year in marine waters and nest in coastal tundra. Like the other eider species, spectacled eiders are dimorphic; males are mostly white and black while females are mottled brown, making them very difficult to see as they tend the nest. In contrast to the conservative reproductive strategy of alcids and other seabird species, spectacled eiders can lay up to 8 eggs per year and reach sexual maturity in their second year, but may live for only 10 years (Terres 1980). After breeding, the adults travel to protected marine waters where they undergo a complete molt of their flight feathers. Two principal molting and staging areas have been identified off coastal Alaska (Ledyard Bay and eastern Norton Sound) and two off coastal Russia (Petersen *et al.* 1999).

Spectacled eiders congregate during the winter in exceedingly large and dense flocks in polynyas in the pack ice in the central Bering Sea between St. Lawrence and St. Matthew Islands. Spectacled eiders from all three known breeding areas (in Alaska, Canada, and Russia) use this wintering area. Because nearly all individuals of this species may spend each winter occupying an area of ocean less than 50 km (31 miles) in diameter, they may be particularly vulnerable to chance events during this time (USFWS 2000a).

The North American Waterfowl Breeding Pairs Survey indicates that the numbers of spectacled eiders breeding on the Yukon-Kuskokwim Delta dropped from about 48,000 pairs in the 1970s to less than 2,500 pairs by 1992, a 95 percent decline (Ely *et al.* 1994, Stehn *et al.* 1993). Recent surveys suggest the Yukon-Kuskokwim Delta population has stabilized or increased and now stands at about 4,000 pairs (Bowman *et al.* 1999, Eldridge and Dau 1999, USFWS 2000a). Biologists estimate that about 9,000 pairs currently nest on Alaska's arctic coastal plain and at least 40,000 pairs nest in arctic Russia. The current worldwide population estimate is 360,000 birds, which is derived from winter surveys in the Bering Sea and includes non-breeding birds (USFWS 1999c).

Trophic Interactions

While at sea, spectacled eiders appear to be primarily bottom feeders, eating mollusks and crustaceans at depths of up to 70 m in the wintering area (Dau and Kitchinski 1977, USFWS 1999a). They may also forage on pelagic amphipods that are concentrated along the seawater-pack ice interface (Kessel 1989). On their nesting grounds, insect larva and aquatic vegetation dominates the diet (Kistchinski and Flint 1974). Spectacled eiders nest in arctic tundra areas where they are susceptible to predation by arctic fox and several predatory birds. Predation at sea is unknown.

Management Overview

Spectacled eiders, similar to other sea ducks, are co-managed by the USFWS and the ADF&G under the Migratory Bird Treaty Act. Bag limits for sport hunting are set by the USFWS. The ADF&G, Division of Subsistence, monitors subsistence harvest of eiders along with other species of sea ducks.

Spectacled eiders have also been listed as "threatened" under the ESA (May 10, 1993, 58 FR 27474), primarily due to a rapid decline in their breeding population on the Yukon-Kuskokwim Delta. Under the requirements of the ESA Section 7, the USFWS is responsible for determining whether proposed federal actions are likely to jeopardize the recovery of the species. In 1992, while it was a candidate species for the ESA, NOAA Fisheries had its first consultation with the USFWS concerning the effects of the BSAI and GOA groundfish fisheries on spectacled eiders (USFWS 1992). The resulting BiOp concluded that the groundfish fishery would not adversely affect spectacled eiders, based primarily on the lack of spatial/temporal overlap between the marine ranges of the eiders and the groundfish harvest. The USFWS made the same determination (not likely to adversely affect) for the 1993 and 1994 groundfish TAC specifications (USFWS 1993b, USFWS 1994) and decided that it would restrict further consultations on the fishery to the endangered short-tailed albatross.

At the time the species was listed under the ESA, the USFWS determined that it would not be prudent to designate critical habitat for spectacled eiders (USFWS 1993a). After a series of legal challenges, the USFWS reversed its decision and designated critical habitat for spectacled eiders on Feb. 6, 2001, including parts of the Yukon-Kuskokwim Delta and nearby marine waters, Norton Sound, Ledyard Bay, and an area of marine water between St. Lawrence Island and St. Matthew Island (66 FR 9146) (Figure 3.7-8).

Past and Present Effects and Management Actions

Direct Mortality from Harvest and Other Intentional Take

Spectacled eiders have been used for subsistence hunting and egging purposes by local Native residents for centuries. The USFWS estimated that at least 3.75 percent of the breeding adult spectacled eiders on the Yukon-Kuskokwim Delta are taken by subsistence hunters each year, but it is not known what effect this level of harvest has on the population. Take of spectacled eiders on the North Slope are not currently known (Larned *et al.* 2001).

Direct Mortality from Incidental Take in Fisheries

The Observer Program does not distinguish sea ducks by group or by species so there is no data on incidental take of spectacled eiders. However, spectacled eiders are not likely to be directly affected by the BSAI groundfish fisheries because the winter distribution of spectacled eiders occurs within the ice pack in the northern Bering Sea and at other times they are either in nearshore waters for molting or inland to nest.

Indirect Effects through Changes in Prey Availability

Disturbance of marine benthic feeding areas by commercial bottom-trawl fisheries as well as bottom-feeding walruses and gray whales have been identified as possible reasons for the decline of spectacled eider populations (USFWS 1993a, USFWS 1999c). Although there is no direct evidence for adverse impacts of bottom-trawling, the USFWS has recommended that the fisheries avoid disturbing or harvesting benthic communities in eider molting and wintering areas during any time of year (USFWS 1999c).

Indirect Effects through Contamination by Oil Spills and Other Toxic Compounds

Consumption of lead shot in the Yukon-Kuskokwim Delta breeding grounds was identified as a likely contributing factor in the decline of this species (Flint *et al.* 1997). The use of lead shot for hunting was made illegal but lead shot already present on the breeding grounds remains available to birds and poses a continuing risk of toxic contamination.

The tendency of spectacled eiders to congregate in dense flocks on the water makes them particularly susceptible to localized oil spills. The USFWS has recommended several measures to minimize the chances of such spills occurring in eider critical habitat (USFWS 1999c).

Comparative Baseline

Spectacled eiders were listed as threatened under the ESA in 1993 due to major declines in their Alaska breeding populations. Although there appears to be almost no spatial/temporal overlap with the groundfish fisheries and marine waters used by spectacled eiders, the potential effects of BSAI groundfish bottom-trawling on the benthic habitat of eider prey has been cited as one of several possible reasons for the declining population. Specific evidence of adverse impacts from the fishery have not been demonstrated. The breeding population of spectacled eiders on the Yukon-Kuskokwim Delta appears to be increasing in recent years. The current worldwide population estimate is 360,000 birds, including non-breeding birds. The past and present effects on spectacled eiders are summarized in Table 3.7-17.

Status for Cumulative Effects Analysis

The impact of the groundfish fisheries on the feeding ecology and survival of spectacled eiders at sea is largely unknown but remains a concern under all FMP Alternatives. The status of spectacled eiders as threatened under the ESA warrants further consideration in the cumulative effects analysis. Because of the similarities in their conservation concerns and status under the ESA, spectacled eiders will be considered in conjunction with Steller's eiders in the analysis of FMP Alternatives.

3.7.10 Steller's Eider (*Polysticta stelleri*)

Life History and Distribution

Steller's eiders are the smallest species of eider. Like the other eider species, Steller's eiders are dimorphic; males are mostly white and black while females are mottled brown. Females can lay up to 10 eggs per year (Terres 1980). After the nesting season, Steller's eiders return to protected marine waters where they undergo a complete molt of their flight feathers. Concentrations of molting Steller's eiders have been noted in Russia, near St. Lawrence Island in the Bering Sea, and along the northern shore of the Alaska Peninsula.

There are two geographical populations of Steller's eiders, one that winters in the North Atlantic Ocean and one in the Pacific. Most of the Pacific population inhabits the maritime tundra of northeast Siberia (Solovieva 1997), and a smaller population nests in Alaska on the Yukon-Kuskokwim Delta (Flint and Herzog 1999) and the arctic coastal plain (USFWS 1999a). The Pacific population winters primarily along the Alaska Peninsula, from the eastern Aleutian Islands to southern Cook Inlet, in shallow nearshore waters (Palmer 1976). In spring, large numbers concentrate in Bristol Bay before migration. Along open coastline, Steller's eiders usually remain within about 400 m of shore in water less than 10 m deep but they can also be found in waters well offshore in shallow bays and lagoons or near reefs (USFWS 1997, USFWS 2000b).

Population data for Steller's eiders is sketchy due to several reasons; they nest predominately in remote areas of Russia, they do not appear to have many consistent concentration areas, and they have never received much wildlife management attention because they are not an important duck hunting species. Historical accounts of "enormous flocks" of Steller's eiders in the early 1900s were noticeably reduced by the 1950s (USFWS 1997). While recent aerial surveys indicate that the Russian-nesting Pacific population still contains 100,000 to 150,000 birds (USFWS 1999a), the Alaska-nesting population has decreased substantially since the1920s. On the Yukon-Kuskokwim Delta, where they were once described as being widespread and "common" nesters, they currently number only in the tens or hundreds (USFWS 1997, Flint and Herzog 1999). On the arctic coastal plain, Steller's once nested all the way from Wainwright east to the Canadian border but their nesting range has been greatly reduced (Kertell 1991). Aerial surveys of the arctic coastal plain during breeding season averaged 4,800 pairs from 1990 to 1998 (USFWS 1999a). There is evidence that molting and wintering populations of Steller's eiders along the Alaska Peninsula have declined since the 1960s, indicating that the Russian-nesting population is also in decline (Jones 1965, Kertell 1991, USFWS 1999a).

Trophic Interactions

Steller's eiders spend the majority of the year in shallow, near-shore marine waters where they feed by diving and dabbling for clams, polychaete worms, snails and amphipods (Petersen 1980, USFWS 1997). They are opportunistic feeders and will modify their diet according to what is available. A diet study of Steller's eiders conducted in Nelson Lagoon from April to October in 1977 and 1979 indicated that bivalves and amphipods were the primary food items, specifically blue mussels (*Mytilus edulis*), clams (*Macoma balthica*), and gammarid amphipods (Petersen 1981). In freshwater, they commonly feed on insect larvae (Cottom 1939).

Management Overview

Steller's eiders, like other sea ducks, are co-managed by the USFWS and the ADF&G under the Migratory Bird Treaty Act. Bag limits for sport hunting are set by the USFWS. The ADF&G, Division of Subsistence, monitors subsistence harvest of eiders along with other species of sea ducks.

Steller's eiders were listed as "threatened" under the ESA on June 11, 1997 (62 FR 31748) due to a substantial decrease in its nesting range in Alaska. Under the requirements of the ESA Section 7, the USFWS is responsible for determining whether proposed federal actions are likely to jeopardize the recovery of the species. In 1992, while it was a candidate species for the ESA, NOAA Fisheries had its first consultation with the USFWS concerning the effects of the BSAI and GOA groundfish fisheries on Steller's eiders (USFWS 1992). The resulting BiOp concluded that the groundfish fishery would not adversely affect Steller's eiders, based primarily on the lack of spatial/temporal overlap between the marine habitats of the eiders and the groundfish harvest. The USFWS made the same determination (not likely to adversely affect) for the 1993 and 1994 groundfish TAC specifications (USFWS 1993b, USFWS 1994). In the most recent BiOps (USFWS 2003), the USFWS concluded that the fisheries would not likely jeoparidze the continued existence or recovery of Steller's eider and would not adversely modify Steller's eider critical habitat.

At the time the species was listed under the ESA, the USFWS determined that it would not be prudent to designate critical habitat for Steller's eiders (USFWS 1993a). After a series of legal challenges, the USFWS reversed its decision and designated critical habitat for Steller's eiders on Feb. 2, 2001 (66 FR 8849), including breeding habitat on the Yukon-Kuskokwim Delta , and marine waters in northern Kuskokwim Bay, Seal Islands, Nelson Lagoon, and Izembek Lagoon on the north side of the Alaska Peninsula (Figure 3.7-9).

Past and Present Effects and Management Actions

Direct Mortality from Harvest and Other Intentional Take

Steller's eiders have probably been taken in small numbers for subsistence and sport hunting for many years. An average of 31 Steller's eiders were taken every year for subsistence purposes between 1987 and 1997 (Paige and Wolfe 1999).

Direct Mortality from Incidental Take in Groundfish Fisheries

The Observer Program does have a species code for Steller's eiders but none have been recorded to be taken in the groundfish fisheries. Steller's eiders are not likely to be taken by the BSAI and GOA groundfish fisheries because they are not attracted to fishing vessels and prefer to forage in nearshore waters. The one area where there is regular overlap of the fishery and the eiders involves the yellowfin sole bottom trawl fishery in the northern portion of Kuskokwim Bay and this fishery only involved two vessels in 2001.

Indirect Effects through Changes in Prey Availability

There is no direct competition by eiders for species targeted by the groundfish fisheries so any potential impact would have to be through ecosystem-level mechanisms. Non-specific changes in the marine ecosystem have been cited as a possible cause of the population decline but whether those changes were brought about by natural or anthropogenic factors is not known (USFWS 1997). No studies have been made to determine if the yellowfin sole fishery in Kuskokwim Bay or any other area directly affects prey availability or habitat used by the eiders.

Indirect Effects through Contamination by Oil Spills and Other Toxic Compounds

Consumption of lead shot in the Yukon-Kuskokwim Delta breeding grounds is a potential contributing factor in the decline of this species (USFWS 1997). The use of lead shot for hunting is now illegal but lead shot already present on the breeding grounds remains available to birds and poses a continuing risk of toxic contamination.

The concentration of Steller's eiders during molting and migration makes them particularly susceptible to localized oil spills in those situations. The USFWS has recommended several measures to minimize the chances of such spills occurring in eider critical habitat (USFWS 1999a).

Comparative Baseline

No reliable overall population estimates are available but there appear to be over 100,000 Steller's eiders nesting in Russia. Steller's eiders were listed as threatened under the ESA in 1997 due to major declines in their Alaska breeding populations. Although there appears to be no direct competition for prey and very little spatial/temporal overlap with the groundfish fisheries and marine waters used by Steller's eiders, the contribution of the fishery to changes in the marine environment has been cited as one of several possible reasons for the declining population. Specific evidence of adverse impacts from the fishery has not been demonstrated. The past and present effects on Steller's eider are summarized in Table 3.7-18.

Status for Cumulative Effects Analysis

The impact of the groundfish fisheries on the feeding ecology and survival of Steller's eiders at sea is largely unknown but remains a concern under all FMP Alternatives. The status of Steller's eiders as threatened under the ESA warrants further consideration in the cumulative effects analysis. Because of the similarities in their conservation concerns and status under the ESA, Steller's eiders will be considered in conjunction with spectacled eiders in the analysis of FMP Alternatives.

3.7.11 Jaegers

- Long-tailed jaeger (*Stercorarius longicaudus*)
- Parasitic jaeger (*Stercorarius parasiticus*)
- Pomarine jaeger (*Stercorarius pomarinus*)

Life History and Distribution

Jaegers are dark, gull-like birds that spend most of the year at sea, coming ashore only to nest on arctic islands, coasts, and tundra areas throughout the northern hemisphere. They spend their winters on the oceans of the southern hemisphere. They traverse the waters of the BSAI and GOA during their spring and fall migrations. All three species of jaegers have similar life-history strategies. All three species nest on tundra or wet grasslands, lay 2 to 3 eggs, and share parental duties. Jaegers are very fast and agile fliers and often chase gulls and terns until they drop food items.

Population trends for jaegers are unknown. All three species are considered "uncommon" or "rare" during migration in the BSAI and GOA area, with estimated relative abundance in the 10,000 to less than 1000 range (Table 3.5-62).

Trophic Interactions

The principal marine foods for jaegers are small schooling fish such as capelin and Pacific sand lance, either caught by themselves or taken from other seabirds (Gabrielson and Lincoln 1959, DeGange and Sanger

1986). While nesting they usually forage over land and are efficient predators on small birds, mammals, and insects.

Management Overview

Wildlife management responsibility for jaegers is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*).

Past and Present Effects and Management Actions

Direct Mortality from Incidental Take in Fisheries

The incidental take of jaegers in worldwide fisheries is unknown. Jaegers are not distinguished by species or as a group in the Observer Program data on incidental take by the groundfish fisheries. It is not known how many jaegers might be included in the "unknown seabird" categories in the various sectors (Tables 3.7-2 through 3.7-5).

Other Past and Present Effects

The following issues have been identified as having potential impacts on jaegers but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impacts of groundfish and other fisheries on the availability of prey to jaegers are unknown. The ability of jaegers to forage over huge areas, as well as their ability to force other seabirds to disgorge their food, is presumed to lessen the potential impact of localized depletion of prey.

Comparative Baseline

Jaegers migrate through the BSAI and GOA area in relatively small numbers. There is essentially no data on the interactions of these species with the groundfish fleet or their ecology in Alaska waters. The past and present effects on jaegers are summarized in Table 3.7-19.

Status for Cumulative Effects Analysis

Since these species do not interact very often with the groundfish fisheries and there is no quantitative data on either their population trends or impacts of the fisheries, these species will not be carried forward for cumulative effects analysis except in the general category of fish-eating (piscivorous) birds.

3.7.12 Gulls

- Glaucous-winged gull (*Larus glaucescens*)
- Glaucous gull (*Larus hyperboreus*)
- Herring gull (*Larus argentatus*)
- Mew gull (*Larus canus*)
- Bonaparte's gull (*Larus philadelphia*)
- Sabine's gull (*Xema sabini*)

Life History and Distribution

These six species, plus the two kittiwake species considered separately, are the commonly encountered gulls in the BSAI and GOA area. Adults are mostly gray and white while immatures are various shades of brown. The three largest species, glaucous-winged, glaucous, and herring gulls, all take four years to reach adult plumage. Mew gulls take three years and the two smallest species, Bonaparte's and Sabine's, are two-year gulls (Harrison 1983). The large number of immature plumages plus the fact that many of these species regularly hybridize with other gulls means that there is a great deal of plumage variability in these birds. It requires extensive training and practice to distinguish the different species in the field, especially for non-adult plumages. For this reason, observations and data on the interactions of these species with fisheries are usually lumped together under a common "gull" category.

Glaucous-winged gulls breed from the central Bering Sea southeastward through the GOA. Glaucous gulls breed from Bristol Bay northward. Herring gulls are widespread in North America and breed along the Alaska coast as well as inland. Mew gulls also breed along the Alaska coast and inland. Bonaparte's and Sabine's gulls breed from the Alaska Peninsula northward (Sibley 2000). At sea, gulls forage both near shore and at the shelf edge during the summer. In winter, most gulls disperse across the shelf from the ice edge to the deep ocean (Gould *et al.* 1982, DeGange and Sanger 1986, Schneider *et al.* 1986, Shuntov 1993). The edge of the ice pack and polynyas within it provide important winter and spring habitat for large gulls that forage on zooplankton and fish of the ice-edge system (Hunt 1991, Hunt *et al.* 1996b).

The USFWS has made no effort to systematically census gull populations in Alaska. In the BSAI and GOA area, very rough abundance estimates have been made at seabird colonies for some gull species (USFWS 1998a). These data only provide an "order of magnitude" approximation of breeding numbers and should not be used to assess population-level effects. These estimates do not include birds that nest and reside over the mainland rather than in marine areas of the BSAI and GOA (Table 3.5-62). The number of glaucous-winged gulls is estimated to be 150,000 in the BSAI and 300,000 in the GOA. Glaucous gulls are less numerous with an estimated 30,000 in the BSAI and 2,000 in the GOA. Herring gulls rarely nest on the islands and coasts of the BSAI and GOA area and are barely represented in the population estimates. Mew gulls are rare in the BSAI colonies, with only an estimated 700 birds, but have 40,000 in the GOA. Bonaparte's are listed as "rare" (less than 1000 birds) in the BSAI and "uncommon" (1,000 to 10,000 birds) in the GOA. Sabine's are listed as "uncommon" in both the BSAI and GOA.

Population trend data are available for only one species, glaucous-winged gulls, which are censussed on permanent USFWS sample plots on an annual or semi-annual basis. On Buldir Island (western Aleutians), the numbers have declined steadily since the plot was established in 1992. At Middleton Island (GOA), nesting glaucous-winged gulls have increased dramatically since counts were begun in 1974. On four other islands in the BSAI and GOA, numbers have fluctuated but show no consistent pattern of increase or decrease. (Dragoo *et al.* 2001).

Trophic Interactions

Most gulls are highly opportunistic and omnivorous feeders, taking a wide variety of prey from near the surface of the water, including small schooling fish such as capelin, Pacific sand lance, and herring. They will also eat invertebrates and carrion wherever they find them, often while scavenging among floating debris and on beaches. Large gulls also prey on the eggs and young of waterfowl and seabirds (Swartz 1966, Baird and Gould 1986, Bowman *et al.* 1997). They are strongly attracted to bait and discards behind fishing vessels, which exposes them to the risk of incidental take. Gulls can switch to invertebrate prey or scavenging when schooling fish decline during the breeding season, but reproductive success suffers (Murphy *et al.* 1984).

Management Overview

Wildlife management responsibility for gulls is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*).

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Breeding colonies of gulls have been used for subsistence purposes by Native peoples of the BSAI and GOA for thousands of years. Harvest of adult birds from breeding colonies continues to the present time in some coastal communities, most commonly by means of shotguns and motorized boats (Denlinger and Wohl 2001). Egg collection is a widespread activity that provides a significant source of high quality food in early summer and is an important cultural tradition for many coastal communities (Lowenstein 1986). Historical catch data were not recorded but recent community surveys by the ADF&G, USFWS, and tribal governments have provided some indication of the scope of seabird harvests (Denlinger and Wohl 2001). In 1996, communities in the BSAI and GOA area reported takes of 1,571 unspecified gulls, mostly from the St. Lawrence Island/Diomede Islands, Yukon-Kuskokwim Delta, and Bristol Bay areas. In 1995, about 115,000 seabird eggs were collected in the BSAI and GOA area, including a large proportion of unspecified gull eggs. Gull eggs were the most commonly collected eggs in Bristol Bay and the northern Alaska Peninsula regions (Paige and Wolfe 1997). These estimates are considered to be minimal given the nature of post-harvest user surveys. They do not include any estimates of the numbers of eggs that may have been lost during collection activities, either by falling off the cliffs when adults were disturbed or to predatory gulls and ravens when left unprotected.

Direct Mortality from Incidental Take in External Fisheries

Gulls are attracted to fishing and processing vessels to scavenge on fishery wastes. Data on incidental take of gulls has not been recorded for most fisheries or has been included in “unidentified” categories. Although they are likely taken in many types of longline and net gear, in both nearshore and offshore fisheries, the frequency of take appears to be relatively infrequent or rare.

Direct Mortality from Incidental Take on Groundfish Longlines

The numbers of gulls taken in the BSAI and GOA groundfish longline fisheries in 1993- 2001 are estimated in Tables 3.7-2 and 3.7-3. Observers have individual species codes for the large gulls and kittiwakes plus an "unidentified gull" category but for analysis and reporting purposes, all species are combined in one "gull" category. An unknown number of them are also included in the "unidentified seabird" category. For just the gull category, the estimated average take was 2,707 birds per year in the BSAI and 114 birds per year in the GOA between 1993-2001.

In an effort to reduce the incidental take of seabirds on longlines, NOAA Fisheries instituted mandatory seabird avoidance measures for the groundfish longline fleet in 1997 (62 FR 23176). Prior to 1997, the average estimated take of gulls (not including "unidentified seabirds") in the BSAI was 2,007 birds per year. Between 1997 and 2001, the estimated average take in the BSAI increased to 3,268 gulls per year. Much of that increase was derived from high takes in 1998 and 2000 which may have been related to a general shortage of natural food in those years. In the GOA, the number of gulls taken from 1993-1996 was 74 birds per year but that average increased to 147 gulls per year from 1997-2001. It is not clear whether the increase in average takes after 1997 was due to ineffective deployment of seabird deterrent techniques, at least on some vessels, or whether the nutritional state of the birds (i.e., starvation) may have changed the behavior of the birds so that the deterrence was less effective.

Direct Mortality from Incidental Take in Groundfish Trawls

The estimated number of gulls caught in the combined BSAI and GOA groundfish trawl fisheries varied considerably between years, with two years showing zero take (Table 3.7-4). The average estimated number of gulls taken was between 150 birds per year (low estimate) and 398 birds per year (high estimate) in 1997-2001.

Indirect Effects through Consumption of Fishery Discards

Scavenging of fishing discards and processing wastes can have population-level effects for gulls. Scavenged processing wastes and other artificial foods may not be adequate foods for rearing chicks successfully (Murphy *et al.* 1984, Baird and Gould 1986, Irons *et al.* 1986, DeGange and Sanger 1986). On the other hand, abundant scavenging during winter may increase gull populations because survival of immature birds is enhanced (Patten and Patten 1982). Larger gull numbers can reduce local populations of other birds through increased competition for nest sites and predation pressure on their young, although scientists disagree about the magnitude of this problem (Spaans and Blokpoel 1991). Hunt (1972) found that herring gulls on the coast of Maine that used discarded waste had increased breeding success. Studies on two gull species in Spain indicate that a dependence on discards from commercial fishing activities may be a limiting factor in the breeding success of these species (Oro *et al.*1995, Oro 1996). Fishery wastes may have lower caloric density than the best of the forage fishes, but when good-quality forage fish are scarce, food from discards, offal, and garbage may be important for successful reproduction (G. L. Hunt, Jr., University of California, Irvine, personal communication). In the Atlantic Ocean, about 30 percent of total food consumed by seabirds in the North Sea is estimated to be discards (including offal) (Tasker and Furness 1996). Numerous instances are cited showing potential relationships between discards in diets and changes in breeding populations (Garthe *et al.* 1999) but no data are available on these effects in Alaska.

In many areas of the world, fishery discards appear to have benefitted large, aggressive, and predatory seabird species. For example, in the North Sea, populations of great skuas (*Catharacta skua*) and black-backed gulls (*Larus marinus*) have increased due to use of fishery discards, and these birds prey on other seabird species. Sudden withdrawal of discards might cause the predatory species to increase pressure on kittiwakes, puffins, sea ducks, and guillemots long before the skuas and gulls decline to previous levels (Furness 1999).

Other Past and Present Effects

The following issues have been identified as having potential impacts on gulls but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impact of groundfish fisheries on the availability of prey to gulls is likely to only be a factor if it leads to localized depletion of prey around breeding colonies. The extent of this potential impact on gulls is unknown. NPFMC has prohibited directed fisheries on forage fish to minimize any indirect impact on seabirds (BSAI FMP Amendment 36 and GOA Amendment 39).

Comparative Baseline

The Alaska populations of the different species of gulls are not surveyed on a regular basis so it is essentially impossible to assess population-level impacts of natural or anthropogenic phenomena. Highly variable plumages makes identification of the different gull species difficult so they are often lumped together in Observer Program data. Average incidental take of gulls on longlines has increased in the BSAI and GOA since seabird avoidance regulations were enacted in 1997. The past and present effects on gulls are summarized in Table 3.7-20.

Status for Cumulative Effects Analysis

Incidental take of gulls is expected to continue under all alternatives and warrants consideration in the cumulative effects analysis. Because there is no species specific quantitative data on either their population trends or impacts of the fisheries, these species will be discussed in conjunction with the fish-eating (piscivorous) birds in Chapter 4.

3.7.13 Kittiwakes

- Black-legged kittiwake (*Rissa tridactyla*)
- Red-legged kittiwake (*Rissa brevirostris*)

Life History and Distribution

Kittiwakes are small gray and white gulls with black wing tips. Their names tip off their leg color. Kittiwakes are gregarious at all times and nest in dense colonies on steep-sided cliffs. They build nests of mud and vegetation and typically lay 1-2 eggs. Both sexes look alike and share parental duties. Eggs incubate for about a month and chicks fledge in about 45 days. Black-legged kittiwakes take three years to reach adult plumage while red-leggeds take only two years (National Geographic 1999).

The black-legged kittiwake is a holarctic species that breeds in coastal waters throughout Alaska except for southeast. The red-legged kittiwake is restricted to the Bering Sea and North Pacific and breeds only in four colonies in the BSAI (USFWS 1998a). Black-legged kittiwakes forage over the entire continental shelf and shelf break. Red-legged kittiwakes forage from the shelf break seaward. The foraging range during the breeding season is 100 km or more (Schneider and Hunt 1984, Schneider *et al.* 1986, Hatch 1993). Both also forage locally near the coast if schooling prey are available (Schneider *et al.*1990, Suryan *et al.* 1998b, Suryan *et al.* 2000). Black-legged kittiwakes require a shelf several tens of kilometers wide, where prey items are concentrated by upwellings, and are few or absent in colonies with a very narrow shelf (Springer *et al.* 1996, Byrd *et al.* 1997). Black-legged kittiwakes winter over the shelf and deep ocean (Gould 1983, Shuntov 1993). The wintering area of the red-legged kittiwake includes the waters south of the Aleutians and the western GOA (Harrison 1983, Sibley 2000).

The total number of black-legged kittiwakes from hundreds of colonies are estimated to be around 800,000 in the BSAI and 1 million in the GOA. Red-legged kittiwakes are easier to survey since they are limited to only a few colonies in the BSAI. They are estimated to number around 150,000, almost 80 percent of which nest on St. George Island in the Pribilofs (Table 3.5-62).

Kittiwake population trends, as opposed to population totals, are measured by censussing permanent sample -plots on an annual or semi-annual basis. Trends differ among regions of the state (Table 3.7-21, Hunt and Byrd 1999, Dragoo *et al.* 2001). Populations of both species declined steeply on the Pribilof Islands after 1976 (the year when monitoring began). Red-legged kittiwakes on the sample plots have declined to approximately half their original numbers. Black-leggeds declined by almost 75 percent on St. Paul and 65 percent on St. George. Although it appeared that black-legged kittiwake populations on St. George Island had stabilized by 1996 (Hunt and Byrd 1999), later counts continued the overall pattern of decline (Dragoo *et al.* 2001). It is not clear if the population of red-legged kittiwakes on St. Paul Island has stabilized (Hunt and Byrd 1999, Dragoo *et al.* 2001). In contrast, both species have increased in the smaller colonies of the western Aleutian Islands (Agattu and Buldir) from the mid-1970s until the present. Black-legged kittiwakes are stable or increasing in the northern Bering Sea (Bluff colony), Aleutian Islands, and parts of the northern GOA. However, populations are declining in Cook Inlet, Kodiak Island, and parts of Bristol Bay. At their largest colony in the GOA, Middleton Island, black-leggeds have declined on sample plots by almost 85 percent from their high in 1981. (Table 3.7-21; Dragoo *et al.* 2001).

Trophic Interactions

Prey are taken at the surface or by dives within a meter of the surface. Both species consume small schooling fish and zooplankton, relying primarily on fish when feeding their young. These species appear to depend on fatty species of forage fish as well as age-0 and age-1 pollock for successful reproduction (Hunt *et al.* 1996a).

The principal fish prey of black-legged kittiwakes are capelin and Pacific sand lance, herring or small cods in some locations, and myctophids (lanternfish) as well as juvenile pollock in the central Bering Sea. Black-legged kittiwakes also consume processing wastes in the North Sea when larger seabirds are not numerous near vessels (Furness and Ainley 1984). Little is known about the extent of scavenging by this species in Alaska. Red-legged kittiwakes consume the same fish but with more emphasis on myctophids and zooplankton (Hunt *et al.*1981a, Springer *et al.* 1984, Springer *et al.* 1986, Springer *et al.* 1987, Sanger 1987, Hatch 1993). Myctophids and probably zooplankton are taken primarily at night (Hatch 1993).

Capelin and Pacific sand lance vary greatly in availability among years, and breeding success in most areas is correlated with abundance of one or the other species in the diet (Troy and Baker 1985, Baird and Gould 1986, Springer *et al.* 1987, Baird 1990). Similarly, the availability of juvenile herring affects kittiwake foraging efforts and breeding success in PWS (Suryan *et al.* 2000). For kittiwake colonies in low productivity areas, the availability of all three forage species (capelin, Pacific sand lance, and herring) may be important to maintaining productivity (Suryan *et al.* 2000). Consumption of juvenile pollock, although prominent in kittiwake diets in the Pribilof Islands in some years, results in slower chick growth than other principal forage fish, which have a higher energy content (Romano *et al.* 1998). Winter diets are poorly known; both species probably rely more on invertebrates in winter than when feeding young (Hatch 1993).

Factors that limit the food availability to seabirds have been investigated primarily during the past ten years, and directed research is recent. Intensive work on the diets of kittiwakes, along with other species, has taken place in the southeastern Bering Sea (Springer *et al.* 1986, Schneider *et al.* 1990, Hunt *et al.* 1981a, Hunt *et al.* 1981b, Decker *et al.* 1995); northern Bering and Chukchi Seas (Springer *et al.* 1987, Elphick and Hunt 1993, Kinder *et al.* 1983); and Cook Inlet and PWS (Piatt *et al.* 1998, Suryan *et al.* 1998a, Suryan *et al.* 1998b, Suryan *et al.* 2000). In each place, only part of the factors affecting bird forage availability have been explored. All studies were restricted to summer. Limiting factors in areas that have not yet been studied are likely to differ in type and importance, and they may be completely different in winter when forage species and locations are different. Most critical is the lack of information on how events beyond a seabird's foraging range may influence prey availability. Such factors may include environmental changes, fluctuations in regionwide stocks of forage and non-forage species, and commercial fishery harvests.

Management Overview

Wildlife management responsibility for kittiwakes is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*).

The red-legged kittiwake is a USFWS "species of management concern" because 80 percent of its worldwide population nests in only one colony, St. George Island, and because its recent severe population decline has not been explained (USFWS 1995b). For these reasons, the species was recently assigned "vulnerable" status on the World Conservation Union's *Red List of Threatened Species* (IUCN 2000).

Past and Present Effects and Management Actions

<u>Direct Mortality: Harvest and Other Intentional Take</u>

Breeding colonies of seabirds have been used as a source of meat, eggs, and skins for clothing by Native peoples of the BSAI and GOA for thousands of years. Kittiwakes are not usually distinguished from other gull species in accounts of these traditional harvests but they probably never accounted for a large percentage of the take because of their small size and relatively inaccessible nests. Recent community harvest surveys estimate that in 1996, 476 black-legged kittiwakes and 688 red-legged kittiwakes were taken in the BSAI and GOA area, almost all of which were from the Aleutian and Pribilof Islands (Denlinger and Wohl 2001). Those same survey results indicate that over 100,000 seabird eggs were taken in the BSAI and GOA area in 1995 but there is no estimate what fraction of these, if any, were kittiwake eggs.

Direct Mortality from Incidental Take in External Fisheries

Past fisheries in the North Pacific, both foreign and domestic, have taken kittiwakes in the course of their operations. For most of these fisheries, the numbers of individual species taken were not recorded. One exception is the Japanese salmon mothership fishery where an estimated average of 95 black-legged kittiwakes (out of a total average of 165,000 birds) were taken every year between 1981-1984 (Jones and DeGange 1988). Although the land-based Japanese salmon gillnet fishery was responsible for millions of seabird deaths from 1952-1992, no kittiwakes were identified in those totals (DeGange and Day 1991). The incidental take of kittiwakes in the current foreign gillnet and longline fisheries is unknown.

Direct Mortality from Incidental Take on Groundfish Longlines

The numbers of seabirds caught in the BSAI and GOA groundfish longline fisheries are estimated from Observer Program data in Tables 3.7-2 and 3.7-3. Observers have individual species codes for the two kittiwakes but they are included in the "gull" category for analysis and reporting purposes. An unknown number of kittiwakes are also probably included in the "unidentified seabird" category. For just the gull category, the estimated average take was 2,707 birds per year in the BSAI and 114 birds per year in the GOA between 1993-2001.

Direct Mortality from Incidental Take in Groundfish Trawls

The numbers of seabirds caught in the combined BSAI and GOA groundfish trawl fisheries are estimated from Observer Program data in Table 3.7-4. Kittiwakes "other" are included in the "gull" category for analysis and reporting purposes. An unknown number of kittiwakes are also probably included in the "unidentified seabird" category. For just the gull category, the estimated average take was between 150 birds per year (low estimate) and 398 birds per year (high estimate) between 1997 and 2001.

Indirect Effects through Changes in Prey Availability.

Birds that breed in Alaska and prey on forage fish, including kittiwakes, may be impacted by indirect fishery effects on prey abundance and availability. Given the wide variety of foods used by kittiwakes and the extensive areas over which they forage, it seems unlikely that they are very susceptible to localized depletion of prey during the non-breeding season. However, while nesting, kittiwakes are more limited in their options and are more susceptible to localized depletions of prey around their colonies. Variability in food supplies around the colonies is likely to impact reproductive success rather than survival of adult birds but may effect survival if the depletion is severe.

The energy content of prey has recently been found to influence the growth of seabird chicks and reproductive success at the colony level (Hunt *et al.* 1996a, Kitaysky 1999, Kitaysky *et al.* 1999, Golet *et al.* 2000). Fish with high lipid and low water content provide the most efficient food "package" for growing seabird chicks; such fish include myctophid, capelin, Pacific sand lance, and larger age groups of herring. Energy-poor forage species include pollock and benthic fish. Slow-growing young birds in colonies may ultimately starve in the nest or be more vulnerable to post-fledgling stresses than well-fed young. For instance, kittiwakes are able to raise chicks on age-0 and age-1 pollock in the Pribilof Islands, where capelin and Pacific sand lance has declined dramatically since the mid-1970s (Hunt *et al.*1996c, Hunt *et al.* 1981a, Schneider and Hunt 1984). However, kittiwake breeding success is relatively low in these colonies compared with other parts of Alaska (Hatch *et al.* 1993), and the kittiwake populations have recently declined on the Pribilof Islands.

Black-legged kittiwakes occasionally die-off in large numbers during late summer, apparently due to widespread scarcity of prey at the surface during anomalous oceanographic conditions. Major die-offs were recorded in Alaska in 1983 and 1997 (Nysewander and Trapp 1984, Hatch 1987, Mendenhall *et al.* 1998). It has been hypothesized that the failure of the seabird populations on the Pribilof Islands to show enhanced reproductive performance subsequent to the reduction of breeding populations suggests that the carrying capacity of the southeastern Bering Sea declined for seabirds in the early 1980s and was reset at a new, lower level than had existed in the mid-1970s. Because kittiwake populations were apparently only affected at the Pribilof Islands, the mortality must have occurred when birds would have been near their colonies (Hunt and Byrd 1999). The cause(s) for this decrease in carrying capacity, whether due to climatic conditions and/or ecosystem effects related to commercial fishing, are being investigated. NPFMC has addressed fishery impacts on forage fish by prohibiting directed fisheries on this size class and group of species that are important to seabirds and some marine mammals (BSAI FMP Amendment 36 and GOA Amendment 39).

Other Past and Present Effects

The following issues have been identified as having potential impacts on kittiwakes but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through consumption of fishery discards.** Kittiwakes are attracted to fishing vessels and processors to eat discards and offal. Benefits of the food source are countered by increased risk of incidental take on longlines and trawls.

- **Indirect effects by introducing mammalian predators to nesting islands.** Cliff nesting species like kittiwakes are susceptible to predation by introduced rats. The USFWS has an extensive program to reduce the threat of new rat invasions. Efforts include maintaining networks of poison-bait boxes at ports on rat-free islands; training local communities to monitor and counteract rats aboard ships and on land; conducting public outreach programs to encourage operation of rat-free vessels in Alaskan waters; and training emergency-response teams to attack rats when they are found at remote shipwrecks. Some of the most intensive efforts in this regard have been carried out on the Pribilof Islands (A. Sowls, USFWS, personal communication).

Comparative Baseline

Black-legged kittiwakes are widespread and abundant in the BSAI and GOA. Red-legged kittiwakes are much less numerous and far more restricted in their breeding locations with the great majority nesting on St.

George Island. Substantial declines in their population have led to their classification as a USFWS species of management concern and "vulnerable" status under international conservation standards. Commercial fishing does not appear to have much direct impact on these species (i.e., through incidental take) but substantial population declines at some colonies in recent years, coupled with documented declines in forage fish, have instigated research on whether the fisheries are impacting fish-eating seabird species indirectly or whether the observed declines are attributable to natural environmental fluctuations. The past and present effects on kittiwakes are summarized in Table 3.7-22.

Status for Cumulative Effects Analysis

The frequency with which both species interact with the groundfish fisheries warrants further consideration in the cumulative effects analysis. Since some alternative FMPs call for special management goals for species of management concern, red-legged kittiwakes will be considered along with other species of management concern (marbled and Kittlitz's murrelets) in Chapter 4. Black-legged kittiwakes will be discussed in conjunction with the fish-eating (piscivorous) birds in Chapter 4.

3.7.14 Terns

- Arctic tern (*Sterna paradisaea*)
- Aleutian tern (*Sterna aleutica*)

Life History and Distribution

Terns are fork-tailed and sharp-winged relatives of the gulls that have a distinctive "floating" flight pattern. Arctic terns range all over the globe, migrating between the arctic and antarctic twice a year, and are common inland as well as in marine waters. Aleutian terns are more marine in nature and appear to be restricted to the North Pacific although their winter range is not known. Both species breed in coastal areas throughout the BSAI and GOA area.

The arctic tern population is roughly estimated to include 7,000 breeding birds in the BSAI and 20,000 in the GOA. Aleutian terns are estimated to number 9,000 breeding birds in the BSAI and 25,000 in the GOA (Table 3.5-62). Populations trends are not monitored in Alaska.

Trophic Interactions

Terns forage in coastal waters within a few miles of their colonies. They feed on the surface, or just beneath it, on small schooling fish (capelin, Pacific sand lance) and zooplankton. Fish are essential diet components when terns are feeding their young (Hunt *et al.* 1981c, Baird and Gould 1986, DeGange and Sanger 1986, Baird 1990).

Stratification of the water column can be disadvantageous to species that depend on complete mixing of the water column. In summer, lack of wind and strong solar heating can result in higher surface temperatures, which may in turn cause certain prey species to seek deeper water and be unavailable to such surface-feeding birds as terns (Baird 1990). The influence of stratification on tern foraging in most specific areas is unknown. Breeding success and population trends of kittiwakes, which have similar feeding habits as terns, are correlated with years when schools of Pacific sand lance are available (Springer *et al.* 1987, Hayes and Kuletz 1997). Schools must be at or near the surface in order for kittiwakes and terns to reach them. These birds are usually observed feeding on shoals of Pacific sand lance in years when reproductive success is high (Baird 1990).

Management Overview

Wildlife management responsibility for terns is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*).

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Terns are taken in small numbers by Alaska Native subsistence hunters in the Bristol Bay area. An unknown number of tern eggs are also taken in this area and around Kodiak (Denlinger and Wohl 2001).

Direct Mortality from Incidental Take in Fisheries

There are no specific records of terns being taken in any fisheries of the North Pacific, including the groundfish fisheries of the BSAI and GOA. There may be some terns included in "unidentified" seabird incidental take records from these fisheries but the extent of that take is unknown. Given the predominantly off-shore distribution of the groundfish fleet and the in-shore foraging habits of breeding terns, potential direct impacts of the fisheries appear to be minimal.

Other Past and Present Effects

The following issues have been identified as having potential impacts on terns but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impact of groundfish fisheries on the availability of prey to terns is likely to only be a factor if it leads to localized depletion of prey around breeding colonies. The extent of this potential impact on terns is unknown. NPFMC has prohibited directed fisheries on forage fish to minimize any indirect impact on seabirds (BSAI FMP Amendment 36 and GOA Amendment 39).

Comparative Baseline

Arctic and Aleutian terns are uncommon breeders in the BSAI and GOA that appear to have very little interaction with the groundfish fisheries. No population trend information is available in the project area. The past and present effects on terns are summarized in Table 3.7-23.

Status for Cumulative Effects Analysis

Since these species do not interact very often with the groundfish fisheries and there is no quantitative data on either their population trends or impacts of the fisheries, these species will not be carried forward for cumulative effects analysis except in the general category of fish-eating (piscivorous) birds.

3.7.15 Murres

- Common murre (*Uria aalge*)
- Thick-billed murre (*Uria lomvia*)

Life History and Distribution

Murres are the largest species in the Alcidae family, which also includes guillemots, murrelets, auklets, and puffins. Like the other alcids, murres use their wings to "fly" underwater and can dive to great depths. They are also fast fliers in the air, beating their relatively small, narrow wings very quickly. They are gregarious throughout the year and will come together on the water in very dense "rafts" prior to crowding onto their rocky nesting cliffs. They do not actually build a nest but lay their single egg directly on the rock. If an egg is lost early in the season, it will often be replaced, but only once. Both sexes look alike and share parental duties. Eggs are laid in late June, hatch about a month later, and chicks jump off the cliffs into the water, still unable to fly, by the end of August or early September. The parents continue to care for their chick at sea for some time, bringing fish to the surface until the chick is big enough to dive and catch fish on its own.

Both murre species are widespread in the North Pacific and Atlantic oceans. In Alaska, common murres breed on rocky coasts and islands throughout the BSAI and GOA. Thick-billed murres breed mostly in the BSAI and north of the Bering Strait but have some smaller colonies in the GOA (USFWS 1998a). Birds from colonies north of the Bering Strait winter in the central Bering Sea (Shuntov 1993, Hatch *et al.* 1996). The edge of the ice pack and polynyas within it provide important winter and spring habitat for murres and other seabirds that forage on zooplankton and fish of the ice-edge system (Hunt 1991, Hunt *et al.* 1996b).

The USFWS has compiled population estimates of seabirds, including both species of murres, from many researchers at many colonies throughout Alaska in the Beringian Seabird Colony Catalog (USFWS 1998a). Many of these estimates are rated as "poor" or "fair" in quality and the resultant population totals cannot be considered reliable for anything but the most generalized discussions. They are certainly not sufficient for documenting anything but the most extreme changes in population-levels. With that caveat, the total numbers of common murres from hundreds of colonies are estimated to be around 3 million in the BSAI and 2 million in the GOA. Thick-billed murres are estimated to number 5 million in the BSAI and 200,000 in the GOA (Table 3.5-62).

Murre population trends are determined by an index method using permanent sample plots in different colonies (Figure 3.7-1, Dragoo *et al.* 2001). Both species are monitored together in some areas because they are too difficult to distinguish reliably under common survey conditions. Trends differ between regions and sometimes between nearby colonies. In the northern Bering Sea (Bluff and Hall Island), common murre numbers have remained relatively stable since the early 1980s. Common murre trends have varied in the southeastern Bering, with steady declines at St. Paul Island, Cape Newenham, and Cape Pierce, and an increasing trend on St. George Island (Dragoo *et al.* 2001). No counts are made of just common murres in the Aleutians (combined counts with thick-bills are described below). In the GOA where separate common murre counts are made, numbers have either increased (E. Amatuli and Gull Islands) or remained stable (Nord Island). Thick-billed murres show a similarly mixed set of trends. In the northern Bering Sea (Hall Island), thick-billed murres have decreased since the early 1980s. At the Pribilofs, thick-bills decreased in the 1970s but have remained relatively stable since the early 1980s. Thick-bills have increased substantially on Buldir Island (western Aleutians) since the mid 1970s. No separate counts of thick-bills are made in the GOA. Among the colonies where common and thick-billed murres are counted together, Agattu Island (western Aleutians) had increasing numbers in the 1970s and 1980s and remained stable in recent years (Hunt and Byrd 1999). In the GOA, combined counts of murres have remained stable at Aiktak Island, increased at Chowiet Island, and decreased at Puale Bay, Middleton Island, and St. Lazaria Island (Dragoo *et al.* 2001).Table 3.7-21 summarize this trend data.

Trophic Interactions

Murres use their wings to propel themselves underwater and can dive as deep as 210 m to catch fish and other prey (Croll *et al.* 1992). Common murres consume small fish, especially energy-rich species such as capelin and Pacific sand lance, and will take juvenile pollock and cod as well as various kinds of zooplankton. Thick-billed murres eat the same fish and also myctophids (lanternfish). They will take larger numbers of zooplankton and other invertebrates than do common murres (Hunt *et al.* 1981a, Vermeer *et al.* 1987, Sanger 1987, Elliott *et al.* 1990, Schneider *et al.* 1990). Thick-billed murres nesting in the western Aleutian Islands feed primarily on squid (Springer *et al.* 1996). Both species are highly dependent on densely schooling prey (Cairns and Schneider 1990, Piatt 1990, Mehlum *et al.* 1996). During the breeding season, common murres have a foraging range of approximately 50 to 80 km while thick-bills range up to 100 km from the colonies (Schneider and Hunt 1984, Bradstreet and Brown 1985, Piatt and Nettleship 1985, Hatch *et al.* 1996).

Murres forage over the continental shelf, particularly in small areas where benthic terrain, currents, or upwellings create local prey concentrations. The inner front (boundary between wind-mixed and stratified water on the Bering Sea shelf) is associated with an upwelling 5 to 15 km in width, which tends to concentrate some zooplankton and their predators and is heavily used by murres (Schneider *et al.* 1987, Brodeur *et al.* 1997, Decker and Hunt 1996). Unusually high concentrations of both species of murres are known to regularly forage on euphausiids over a submarine ridge on the east side of St. George Island (Coyle *et al.* 1992). Thick-billed murres also forage over the outer shelf and shelf edge (Hunt *et al.* 1981b, Kinder *et al.* 1983, Schneider and Hunt 1984, Schneider *et al.* 1986, Schneider *et al.* 1990, Shuntov 1993, Decker and Hunt 1996). Common murres require a shelf at least several tens of kilometers wide and are few or absent in colonies with a very narrow shelf. In contrast, thick-billed murres tend to occupy areas near a shelf edge, although they also breed in a few northern colonies on broad shelves (Springer *et al.* 1996, Byrd *et al.* 1997, USFWS 1998a).

Upwellings also occur where tides or currents move water from the deep ocean onto the shelf, such as tidal upwellings onto the shelf between islands in the Pribilof Islands (Coyle *et al.* 1992) and the Aleutian Islands (Hunt *et al.* 1998), or the Anadyr Current west of St. Lawrence Island (Hunt *et al.* 1990). Upwelling of deep water onto the shelf north of the Barren Islands and in the western GOA supports large colonies of murres (Piatt and Anderson 1996). At the Pribilofs Islands, the currents that influence prey availability are mostly tidal, though zooplankton are advected from offshore (Hunt *et al.* 1996b, Stabeno *et al.* 1999). Currents that run parallel to the shelf break along the 100-m and 200-m isobaths, which spawn eddies that cross onto the shelf, are likely to be most important (Stabeno and van Meurs 1999). These currents may also be important for the transport of age-0 pollock to the Pribilofs, suggesting that pollock spawning events near Unimak Pass may influence prey availability at the Pribilofs (G. L. Hunt, Jr., University of California, Irvine, personal communication).

Murres can forage deeper than any other seabird species, which buffers them against changes in vertical distribution of their prey. However, their need for dense aggregations of prey may make them vulnerable to occasional die-offs when prey are scattered or otherwise unavailable (Piatt and van Pelt 1997). During the breeding season, murres can increase their daily foraging time away from the colony in order to obtain scarce or distant prey, and they sometimes are able to maintain breeding success under poor conditions.

Common murres occasionally die-off in large numbers during winter and early spring, apparently due to widespread scarcity of prey. Major die-offs of up to an estimated 120,000 birds were recorded in Alaska in 1970, 1993, and 1998 (Bailey and Davenport 1972, Piatt and van Pelt 1997, Mendenhall *et al.* 1998). Major shifts in seabird food habits occurred at the Pribilof Islands between the mid-1970s and the late 1980s. These diet shifts coincided with the decline of murre and kittiwake populations there, and with the decline of forage fishes and age 1 pollock in the bottom trawl surveys around the Pribilof Islands (Decker *et al.* 1995, Hunt *et al.* 1996a, 1996b). It has recently been hypothesized that declines in thick-billed murres at the Pribilof Islands were caused by large die-offs of adults from this population (Hunt and Byrd 1999).

Management Overview

Wildlife management responsibility for murres is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*). In 1999, protocol amendments to the Migratory Bird Treaty Act were ratified that mandated participation of subsistence users and their traditional knowledge in a co-management relationship between Native, Federal, and State of Alaska representatives. This co-management group is charged with developing conservation, research, and management plans for all species taken in subsistence harvests, including murres (Denlinger and Wohl 2001).

Past and Present Effects and Management Actions

<u>Direct Mortality: Harvest and Other Intentional Take</u>

Breeding colonies of murres have been used as a source of meat, eggs, and skins for clothing by Native peoples of the BSAI and GOA for thousands of years. An account from the mid-1800s describes the widespread use of baleen nooses to capture birds on the steep cliffs of the Aleutian Islands. These methods were efficient enough to cause noticeable declines in breeding populations, at least at colonies that were accessible from settlements (Veniaminov 1840). Harvest of adult birds from breeding colonies continues to the present time in some coastal communities, most commonly by means of shotguns and motorized boats (Denlinger and Wohl 2001). Egg collection is also a traditional early summer activity, usually conducted in family groups. Egging is limited to a short period of time when eggs are freshly laid but it provides a significant source of high quality food and is an important cultural tradition for many coastal communities (Lowenstein 1986). Historical catch data were not recorded but recent community surveys by the Alaska

Dept. of Fish and Game, USFWS, and tribal governments have provided some indication of the species-specific scope of seabird harvests (Denlinger and Wohl 2001). In 1996, communities in the BSAI and GOA area reported takes of 9,743 common murres, 433 thick-billed murres, and 150 unidentified murres. The great majority of these birds were taken in the St. Lawrence Island/Diomede Islands area. In 1995, about 100,000 seabird eggs were collected in the BSAI and GOA area, including an unknown number of murre eggs. Murre eggs were the most commonly collected eggs in the Seward Peninsula area but these totals also include large numbers of tern and gull eggs. These estimates are considered to be minimal given the nature of post-harvest user surveys. They do not include any estimates of the numbers of eggs that may have been lost during collection activities, either by falling off the cliffs when adults were disturbed or to predatory gulls and ravens when left unprotected.

Direct Mortality from Incidental Take in External Fisheries

Murres are not attracted to fishing vessels like many of the surface-feeding seabirds and are rarely caught by longline fisheries. They are more susceptible to being caught in trawl and drift nets which hang down into the water column where murres dive for fish. Past fisheries in the North Pacific, both foreign and domestic, have taken murres in the course of their operations. For most of these fisheries, the numbers of individual species taken were not recorded. One exception is the Japanese salmon mothership fishery where an average of 14,175 thick-billed murres and 1,850 common murres were taken every year between 1981-1984 (Jones and DeGange 1988). The land-based Japanese salmon gillnet fishery was responsible for an estimated 8 million seabird deaths from 1952-1987 (DeGange and Day 1991). In 1977 alone, this fishery killed an estimated 17,245 thick-billed and 2,150 common murres. In 1987, after substantial reductions in fishing effort, an estimated 4,625 thick-bills were taken along with 580 commons (DeGange and Day 1991). On the Russian side of the Bering Sea, Japanese salmon gillnet fisheries took an estimated 1.1 million seabirds between 1993 and 1998, 62 percent of which were alcids, and may have had population-level impacts on thick-billed murre colonies (Artukhin *et al.* 2000). The incidental take of murres in other current foreign gillnet fisheries is unknown.

State-managed salmon and herring gillnet fisheries in Alaska take murres incidentally on a regular but infrequent basis. Based on the perceptions of one bird-observant fisherman, the total number of murres taken in these coastal fisheries are probably less than 1000 birds per year in the entire BSAI and GOA (DeGange *et al.* 1993).

Direct Mortality from Incidental Take on Groundfish Longlines

The numbers of seabirds caught in the BSAI and GOA groundfish longline fisheries are estimated from Observer Program data in Tables 3.7-2 and 3.7-3. Observers have individual species codes for the two murres but they are included in the "alcid" category for analysis and reporting purposes. An unknown number of murres may also be included in the "unidentified seabird" category. The alcids accounted for an average of 15 birds per year taken in the BSAI between 1993 and 2001 and one bird per year in the GOA.

Direct Mortality from Incidental Take in Groundfish Trawls

The BSAI and GOA trawl fishery took between 178 alcids per year (low estimate) and 340 alcids per year (high estimate) between 1997 and 2001 (Table 3.7-4). The numbers of murres in these totals is unknown.

Indirect Effects through Contamination by Oil Spills

All types of oil and fuel are dangerous, and only a few drops of oil are enough, under some situations, to kill a seabird. The species at most risk are diving seabirds, which spend more time resting on the water than do surface-feeders (King and Sanger 1979). More specifically, alcids are considered to be the most vulnerable to oil of all bird groups. The EVOS Trustee Council (EVOS Trustee Council 2002e) reports that about 22,000 carcasses of oiled murres (mostly common murres) were picked up in the first four months following the oil spill in 1989. Piatt and Ford (1996) used drift recovery data to estimate that only 15 percent of seabirds that died as a result of EVOS were actually recovered as carcasses. By this estimate, about 146,000 murres were killed. Based on surveys of breeding colonies in the spill area, murre populations may have declined by about 40 percent following the spill. In addition to direct losses of murres, there is evidence that the timing of reproduction was disrupted and productivity reduced. Post-spill monitoring at the breeding colonies in the Barren Islands indicated that reproductive success was again within normal bounds by 1993, and it has stayed within these bounds each breeding season since then (EVOS Trustee Council 2002e).

Other Past and Present Effects

The following issues have been identified as having potential impacts on murres but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impact of groundfish fisheries on the availability of prey to murres is likely to only be a factor if it leads to localized depletion of prey around breeding colonies. The density and distribution of fish schools may change with the overall abundance of many forage fish species. The issue is whether particular fluctuations in forage fish populations are the result of natural environmental cycles or whether they are caused or compounded either directly or indirectly by fishing pressure. The complexity of the system is such that there will always be a great deal of scientific uncertainty regarding causality of such fluctuations. In the face of this uncertainty, NPFMC prohibited directed fisheries on forage fish to minimize any indirect impact on seabirds (BSAI FMP Amendment 36 and GOA Amendment 39, 1997).

- **Indirect effects by introducing mammalian predators to nesting islands.** Cliff nesting species like murres were decimated or seriously reduced on many islands in the Aleutian chain and GOA after the introduction of arctic and red foxes by fox farmers from the 1700s to the 1930s (Bailey and Kaiser 1993). The USFWS has exterminated foxes from many of these islands and murres have begun to recolonize them. At present, murres are susceptible to predation by introduced rats. The USFWS has an extensive program to reduce the threat of new rat invasions. Some of the most intensive efforts in this regard have been carried out on the Pribilof Islands which host large murre colonies (A. Sowls, USFWS, personal communication).

Comparative Baseline

Common and thick-billed murres are abundant in the BSAI and GOA. Population trends at breeding colonies are varied throughout the area with some colonies expanding while others are stable or decreasing. Food abundance and availability appear to be major factors in population fluctuations. Murres are hunted for meat and eggs by Alaska Natives and have been taken incidentally in various fisheries. The specific numbers of murres taken in the groundfish fisheries are not reported but the numbers appear to be rather small relative to their overall population-levels. The past and present effects on murres are summarized in Table 3.7-24.

Status for Cumulative Effects Analysis

The frequency with which common and thick-billed murres interact with the groundfish fisheries warrants further consideration in the cumulative effects analysis. Because there is no species specific quantitative data on the impacts of the fisheries, these species will be discussed in conjunction with the fish-eating (piscivorous) birds in Chapter 4.

3.7.16 Guillemots

- Black guillemot (*Cepphus grylle*)
- Pigeon guillemot (*Cepphus columba*)

Life History and Distribution

Guillemots are medium-sized alcids with black and white bodies and bright orange-red feet. They are much less gregarious than other alcids and generally nest in the vicinity of only a few other pairs of birds. Nest sites are in crevices, burrows, or among the rocks of seaside cliffs. These two species (along with *Synthliboramphus* murrelets) are unique among the alcids in that they can lay up to two eggs in a clutch. This may be an adaptation to compensate for high rates of predation on both young and adults (Piatt and Naslund 1995). Eggs are laid on the bare ground and tended by both parents in turn. Incubation and fledging each takes about one month (Terres 1980).

Black guillemots are circumpolar in distribution, breeding north of the Bering Strait and ranging into the Bering Sea in winter. Pigeon guillemots are restricted to Pacific waters, breeding in the entire BSAI and GOA area, and ranging into the central Pacific waters in winter. Black guillemots winter at sea in and near the pack ice while most pigeon guillemots prefer ice-free coastal waters (Ewins *et al.* 1993, Carter *et al.* 1995, Shuntov 1993).

The Beringian Seabird Colony Catalog (USFWS 1998a) includes an estimate of 100,000 pigeon guillemots in the BSAI and 100,000 in the GOA (Table 3.5-62). Since guillemots are highly dispersed, rather than concentrated in dense breeding colonies like most alcids, totals of their populations should be considered very rough estimates. Another estimate places their numbers in all Alaska waters (BSAI and GOA combined) at only 40,000 birds (Ewins *et al.* 1993). Black guillemots do not nest in the project area and are considered rare visitors in winter. Pigeon guillemot population trends are monitored only in PWS, where the population has declined over the past two decades, possibly due to reductions in prey availability (Hayes and Kuletz 1997).

Trophic Interactions

The foraging ecology of pigeon guillemots has been studied in detail in PWS. The diet is diverse and includes small schooling fish such as capelin, sand lance, and herring, as well as bottom-dwelling fish and invertebrates (DeGange and Sanger 1986, Kuletz 1983, Golet *et al.* 2000). Benthic fish are a reliable food source but support only modest reproductive success. Schooling fish allow higher reproductive success (because their abundance and energy content are higher), but their availability fluctuates in time and space (Kuletz 1983, Golet *et al.* 2000). Pigeon guillemot chick growth and reproductive success are correlated with the availability of schooling species (Golet *et al.* 2000).

Guillemots forage in coastal waters during the breeding season, within 10 km of the colony (Ewins *et al.* 1993, G. Golet, USFWS, unpublished data). Black guillemots dive to approximately 50 m (Piatt and Nettleship 1985) and pigeon guillemots up to 45 m (Ewins *et al.* 1993).

Management Overview

Wildlife management responsibility for guillemots is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*).

Past and Present Effects and Management Actions

<u>Direct Mortality from Incidental Take in External Fisheries</u>

Almost no species-specific data exists on the direct impact of past and present fisheries on guillemot populations. Since these are diving birds, they are more likely to be caught in drift and trawl nets than on longlines. In the Japanese land-based drift gillnet fishery, pigeon guillemots made up a small fraction of the seabirds caught, including an estimated 307 in 1977 and decreasing to 116 in 1987 (DeGange and Day 1991). Offshore fisheries have probably taken many fewer guillemots since they prefer nearshore waters. The Japanese high-seas salmon driftnet fishery only took an estimated annual average of 13 pigeon guillemots between 1981-1984 (Jones and DeGange 1988). Inshore gillnet fisheries probably take guillemots incidentally but there is no data on how many birds are caught in Alaska (Ewins *et al.* 1993).

<u>Direct Mortality from Incidental Take in Groundfish Fisheries</u>

The numbers of seabirds caught in the BSAI and GOA groundfish fisheries are estimated from Observer Program data (Tables 3.7-2 through 3.7-5). Guillemots are included in the "alcid" and perhaps the"unidentified seabird" categories. Although alcids are taken more frequently in trawls than in either longline or pot fisheries, the numbers of guillemots taken is unknown. Given their nearshore preferences and less gregarious behavior, it is unlikely that guillemots are taken regularly in any of the MSA groundfish fisheries.

<u>Indirect Effects through Contamination by Oil Spills</u>

The nearshore, benthic foraging behavior of pigeon guillemots and their tendency to socialize on intertidal rocks makes them susceptible to being killed in disproportionate numbers by oil spills (Oakley and Kuletz 1996). An estimated 10-15 percent of the population in the EVOS area died immediately following the spill. Pigeon guillemot populations still had not recovered from the EVOS disaster nine years later, probably because foraging conditions were inadequate to support an increase in the population (Hayes and Kuletz 1997).

Other Past and Present Effects

The following issues have been identified as having potential impacts on guillemots but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impact of groundfish fisheries on the availability of prey to guillemots is unknown. The density and distribution of fish schools may change with the overall abundance of many forage fish species. The issue is whether particular fluctuations in forage fish populations are the result of natural environmental cycles or whether they are caused or compounded either directly or indirectly by fishing pressure. The complexity of the system is such that there will always be a great deal of scientific uncertainty regarding causality of such fluctuations. In the face of this uncertainty, NPFMC prohibited directed fisheries on forage fish to minimize any indirect impact on seabirds (BSAI FMP Amendment 36 and GOA Amendment 39, 1997).

Comparative Baseline

Guillemots are distributed widely in the BSAI and GOA, especially in nearshore waters, but are not found in large concentrations anywhere. Overall population estimates are uncertain and population trends are monitored only for pigeon guillemots in PWS, where they have been decreasing. Guillemots are susceptible to changes in the local distribution and abundance of forage fish and have been impacted by past oil spills. Their direct interactions with the groundfish fleet are probably minimal. The past and present effects on guillemots are summarized in Table 3.7-25.

Status for Cumulative Effects Analysis

Because there is no species specific quantitative data on either their population trends (outside PWS) or impacts of the fisheries, these species will be discussed in conjunction with the fish-eating (piscivorous) birds in Chapter 4.

3.7.17 Murrelets

- Marbled murrelet (*Brachyramphus marmoratus*)
- Kittlitz's murrelet (*Brachyramphus brevirostris*)
- Ancient murrelet (*Synthliboramphus antiquus*)

Life History and Distribution

Murrelets are medium-sized alcids that share the ability to "fly" underwater with other members of the family. These three species have very different nesting sites and reproductive strategies that impact conservation efforts. Marbled and Kittlitz's murrelets are unique among the alcids in having a mottled brown, cryptic coloration in their breeding plumage. This is an indication that predation on adults (by raptors and possibly corvids) plays a major role in their life history strategy (Piatt and Naslund 1995). Other clues to the importance of predation include the fact that nest sites are dispersed, rather than colonial, and that parent birds travel to and from their nests only under low light conditions, a habit which has made it very difficult to locate nests. Marbled murrelets nest predominately on moss-covered limbs of huge trees, sometimes up to 70 km from the sea, and are thus associated with old-growth forests (Piatt and Ford 1993). Kittlitz's murrelets also nest away from the water but choose nest sites on rocky slopes of high alpine areas, especially in areas close to glaciers (Piatt *et al.* 1999). The remote, hidden, and dispersed nesting habits of these two species has greatly restricted research on their reproductive biology. Ancient murrelets are colonial, dig burrows under boulders, tree roots, or dense vegetation, and nest on islands free of mammalian predators. They are unusual among the alcids (along with guillemots) in having the capacity to lay up to two eggs in a clutch. This may have evolved as a way to compensate for high rates of predation and helps stabilize the population from other adult mortality factors (Piatt and Naslund 1995).

Marbled murrelets breed from the Aleutian Islands east along the coast of Alaska and south to the coast of California. Kittlitz's murrelets breed in selected areas throughout the BSAI and GOA. Ancient murrelets breed from the southern Bering Sea south and east to British Columbia. Ancients, more than the other two species, are more likely to winter offshore in deep waters.

Population estimates for seabird species with dispersed, well-hidden nests are best made from at-sea survey data. However, the reliability of these census techniques for population trend analysis is still under investigation (Ralph *et al.* 1995). For marbled murrelets, the total North American population is estimated to be about 300,000 birds, 85 percent of which breed along the coast of the GOA and in PWS (Ralph *et al.* 1995). An estimated 2,400 marbled murrelets breed in the BSAI (Piatt and Naslund 1995). The worldwide estimate for Kittlitz's murrelet was about 20,000 birds in 1993, 90 percent of which were in the GOA area (van Vliet 1993). Another estimate in 1993 put the figure in the 25,000-100,000 range (Ewins *et al.* 1993), although the upper limit has been challenged (Day *et al.* 1999). Ancient murrelet populations have been estimated at breeding colonies. Rough estimates of these underground nesters include 200,000 birds in the BSAI and 600,000 in the GOA (USFWS 1998a) (Table 3.5-62). No population trend data are available for ancient murrelets.

As stated above, population trend data are somewhat tenuous for marbled and Kittlitz's murrelets and are best documented in PWS due to the amount of research in that area following the EVOS in 1989. Based on Christmas Bird Count data from northern GOA communities, marbled murrelets are estimated to have declined by at least 50 percent between 1972 and 1992 (Piatt and Naslund 1995). Boat surveys in PWS, conducted in many areas and in both winter and summer, indicate that combined counts of the two *Brachyramphus* species declined by 67-73 percent between the early 1970s and late 1980s (Piatt and Naslund 1995). Numbers appeared to stabilize between 1989 and 1993 but then declined further in 1996 and 1998 (Agler and Kendall 1997 and 1998, Lance *et al.* 1999).

One early estimate for the Kittlitz's murrelet population in PWS concluded that there were about 60,000 birds in 1972 (Isleib and Kessel 1973). This estimate is much higher than recent estimates and its methodology has been challenged (Day and Nigro 1999). However, standardized surveys since the Exxon Valdez oil spill have also shown major and continuing declines in two major concentrations of Kittlitz's murrelets. In PWS, Kittlitz's numbers declined an average of over 14 percent per year from 1989-1998 (Lance *et al.* 1999). In Glacier Bay, the population of Kittlitz'z murrelets has declined by almost 80 percent between 1991 and 1999 and they have disappeared from areas where they were once common (USGS 2001).

These studies have been cited in a recent petition to the USFWS to list the species as "endangered" under the ESA (Center for Biological Diversity *et al.* 2001).

The typical alcid life history strategy is to compensate for low reproductive potential (one-egg clutches) with high adult survivorship and long life. Marbled and Kittlitz's murrelets have taken this to an extreme. Although there are no data on adult survival rates, there is evidence that reproduction rates are very low and impacted to a large extent by predation. This means that these populations may be especially sensitive to changes in natural mortality rates and additional anthropogenic sources of mortality (Piatt and Naslund 1995).

Trophic Interactions

Diets of murrelets are dominated by small schooling fish such as capelin and Pacific sand lance. Some zooplankton and other invertebrates are also consumed by Kittlitz's murrelet and especially by ancient murrelets (Sanger 1987, Ewins *et al.* 1993, Springer *et al.* 1993, Gaston 1994). All three murrelets forage by diving. Marbled murrelets dive in water primarily less than 20 m deep (Nelson 1997).

Marbled murrelets forage in shallow waters within 5 km of shore and are associated with sites of upwellings or small fronts that might make prey available (Nelson 1997, Kuletz *et al.* 1995). Kittlitz's murrelets prefer inlets and forage near glaciers where available (Sanger 1987, Ostrand *et al.* 1998, Day *et al.* 1999a, Day and Nigro 2000). Ancient murrelets forage over the shelf and shelf break, but also occur near land at sites of tidal upwellings (Gaston 1994). Some murrelets winter in ice-free bays throughout the state; others apparently move south or offshore to unknown areas (Ewins *et al.* 1993, Carter *et al.* 1995).

Management Overview

Wildlife management responsibility for murrelets is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*). In 1999, protocol amendments to the Migratory Bird Treaty Act were ratified that mandated participation of subsistence users and their traditional knowledge in a co-management relationship between Native, Federal, and State of Alaska representatives. This co-management group is charged with developing conservation, research, and management plans for all species taken in subsistence harvests, including murrelets (Denlinger and Wohl 2001).

In 1990, marbled murrelets were listed as "threatened" in British Columbia by the Canadian government because of significant population declines and loss of nesting habitat. For similar reasons, the species was listed as "threatened" under the ESA for California, Oregon, and Washington in 1993. Marbled murrelets are not listed under the ESA in Alaska. However, in 1995, the USFWS designated marbled and Kittlitz's murrelets as "species of management concern" (USFWS 1995b). These species are of concern because of 1) documented or apparent population declines, 2) small or restricted populations, or 3) dependence on restricted or vulnerable habitats. The Fish and Wildlife Conservation Act of 1980, as amended in 1988, requires the designation of concern for species that, without additional conservation action, are likely to become candidates for listing under the ESA. On May 9, 2001, a group of non-governmental organizations petitioned the Secretary of the Interior to list Kittlitz's murrelet as "endangered" under the ESA, citing evidence of major and consistent population declines in their core breeding areas in southeast Alaska (Center for Biological Diversity *et al.* 2001).

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Seabirds have been hunted by the Native peoples of Alaska for thousands of years. There are no historical records of the numbers of murrelets taken but the impact was probably small and limited to birds hunted on the water. In recent community surveys by the ADF&G, USFWS, and tribal governments, 30 ancient murrelets were taken in 1996, all from the Aleutian/Pribilof Islands District (Denlinger and Wohl 2001). No marbled or Kittlitz's murrelets were identified in the surveys but there were a reported 1,246 "unidentified seabirds" taken in 1996 from southeast Alaska, the area most likely to be harvesting murrelets.

Direct Mortality from Incidental Take in External Fisheries

Murrelets are not attracted to fishing vessels like many of the surface-feeding seabirds and are not likely to be caught by longline fisheries. They are more susceptible to being caught in trawl and drift nets which hang down into the water column where they dive for fish and other prey. Past fisheries in the North Pacific, both foreign and domestic, have taken murrelets in the course of their operations. For most of these fisheries, the numbers of individual species taken were not recorded. Some data is available from the Japanese salmon mothership fishery where an average of 1,533 ancient murrelets were taken every year between 1981-1984 (Jones and DeGange 1988). The land-based Japanese salmon gillnet fishery, active from 1953-1992, was responsible for killing an estimated 307 ancient murrelets in 1977. In 1987, after substantial reductions in the fishing effort, an estimated 116 ancient murrelets were taken (DeGange and Day 1991). On the Russian side of the Bering Sea, Japanese salmon gillnet fisheries took an estimated 1.1 million seabirds between 1993 and 1998, 62 percent of which were unspecified alcids (Artukhin *et al.* 2000). The incidental take of murrelets in other current foreign gillnet fisheries is unknown.

Because murrelets spend most of their time in nearshore waters, especially during the breeding season, they are susceptible to being caught in nearshore gillnet fisheries (i.e., state-managed fisheries). Largely anecdotal evidence suggested that perhaps thousands of murrelets were killed annually in coastal Alaska gillnet fisheries in the 1970s (Carter and Sealy 1984, DeGange *et al.* 1993). Based on quantitative seabird bycatch data from salmon fisheries in PWS, an estimated annual average of 690 marbled and 130 Kittlitz's murrelets were killed in 1990 and 1991 (Piatt and Naslund 1995). Extrapolating from the number of 1989 drift net permits and PWS bycatch rates, Piatt and Naslund (1995) estimate that 3,300 *Brachyramphus* murrelets are killed annually in Alaskan gillnet fisheries. Kittlitz's murrelets appear to be particularly susceptible to being caught. Kittlitz's represent only 7 percent of all murrelets in PWS but represent 30 percent of all murrelets caught (Day and Nigro 1999). Since most of these birds are adults and population dynamics of seabirds are typically driven by adult survival rates, this amount of mortality is a significant conservation concern. These estimates also do not include suspected mortality in set nets, pound nets, or seine nets (Piatt and Naslund 1995). Gillnet fisheries have also been shown to cause significant amounts of mortality in ancient murrelets in British Columbia (Bertram 1995) but no data exists for Alaska fisheries.

Direct Mortality from Incidental Take in Groundfish Fisheries

The numbers of seabirds caught in the BSAI and GOA groundfish fisheries are estimated from Observer Program data (Tables 3.7-2 through 3.7-5). Marbled and Kittlitz's murrelets have individual species codes under the observer protocol but are included in the "alcid" category for analysis and reporting purposes. An unknown number may also be included in the and "unidentified seabird" category. Alcids are taken more frequently in trawls than in either longline or pot fisheries but the numbers of murrelets taken is unknown. Given their nearshore preferences and less gregarious behavior, it is unlikely that murrelets are taken regularly in any of the MSA groundfish fisheries.

Indirect Effects through Contamination by Oil Spills

The threat of both catastrophic and chronic oil spills to seabirds is well-known (Piatt *et al.* 1990, Burger and Fry 1993, Piatt and Ford 1996, Huguenin *et al.* 1996). All types of oil and fuel are dangerous, and only a few drops of oil are enough, under some situations, to kill a seabird. The species at most risk are diving seabirds, which spend more time resting on the water than do surface-feeders, and marbled and Kittlitz's murrelets are rated as two of the most susceptible species in the state (King and Sanger 1979). More specifically, alcids are considered to be the most vulnerable to oil of all bird groups. Based on the actual numbers of birds recovered on beaches after the Exxon Valdez oil spill and estimates of carcass recovery rates, the spill killed an estimated 8,400 marbled murrelets and perhaps as many as 1000-2000 Kittlitz's, representing about 3 percent and 5 to 10 percent of their respective estimated Alaska populations (Piatt and Naslund 1995, van Vliet and McAllister1994).

Indirect Effects through Disturbance by Fishing Vessels

Although many surface-feeding birds are attracted to fishing vessels (Furness 1999), murrelets are disturbed by nearby boats (of all types) and may be displaced from forage areas by vessel activity (Kuletz 1996). Dramatic declines in Kittlitz's murrelets in Blackstone Bay in PWS may be attributable in part to the high numbers of recreational boaters in the area (Day and Nigro 1999). The popularity of tidewater glacier tours from cruise ships is also growing and since these areas are also preferred by Kittlitz's, there is growing concern about this disturbance impact.

Other Past and Present Effects

The following issues have been identified as having potential impacts on murrelets but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** Highly dispersed, non-colonial birds such as marbled and Kittlitz's murrelets may be particularly well adapted to patchy, highly dispersed prey in low-density schools (Ostrand *et al.* 1998, Kuletz 1999). However, in PWS, reproductive success of marbled murrelets correlated with years and sites of relative abundance of forage fish species (Kuletz unpublished data). The big unanswered question for murrelets, as with all piscivores, is whether variations in their food supplies are caused by human activities or are predominately natural cycles. Despite intensive and ongoing research into the factors that determine the composition, abundance, and availability of forage fish, it is still not clear how much impact various fisheries have in relation to climate and oceanography-driven changes in primary productivity and food web dynamics (Piatt and Anderson 1996, Agler *et al.* 1999, Anderson and Piatt 1999). In the face of this uncertainty, NPFMC prohibited directed fisheries on forage fish to minimize any indirect impact on seabirds (BSAI FMP Amendment 36 and GOA Amendment 39 1997).

- **Indirect effects by introducing mammalian predators to nesting islands.** Burrowing seabirds, including ancient murrelets, were decimated or seriously reduced on many islands in the Aleutian chain and GOA after the introduction of arctic and red foxes by fox farmers from the 1700s to the 1930s (Bailey and Kaiser 1993). The USFWS has exterminated foxes from many of these islands and ancient murrelets have begun to recolonize them. At present, ancient murrelets are susceptible to predation by introduced rats. The USFWS has an extensive program to reduce the threat of new rat invasions.

- **Indirect effects from logging.** Due to their nesting ecology, marbled murrelets also face the threat of habitat loss from logging operations, a rather unique threat for seabirds. This issue is addressed in great detail in the U.S. Forest Service's Tongass National Forest Land and Resource Management Plan (USDA 1997).

Comparative Baseline

Population data for all three murrelet species are imprecise. Marbled and Kittlitz's murrelets are species of management concern in Alaska due to recent dramatic declines in their numbers in core habitats in southeast Alaska. The numbers of murrelets taken in the groundfish fisheries is unknown due to lack of differentiation among alcids in the Observer Program. Several factors external to the groundfish fisheries have been identified as conservation concerns for marbled and Kittlitz's murrelets. Ancient murrelets are taken in small numbers by pelagic fisheries but there are no population trend data for this species which might be used to monitor or model impacts. The past and present effects on murrelets are summarized in Table 3.7-26.

Status for Cumulative Effects Analysis

Even though they do not appear to interact with the groundfish fisheries very regularly, the status of marbled and Kittlitz's murrelets as species of management concern warrants further consideration in the cumulative effects analysis. Since some Alternative FMPs call for special management goals for seabird species of management concern, marbled and Kittlitz's murrelets will be considered with the other species of management concern (red-legged kittiwakes) in Chapter 4. Because population trend data for ancient murrelets are not available and there is no species specific quantitative data on the impacts of the fisheries, ancient murrelets will be discussed in conjunction with the fish-eating (piscivorous) birds in Chapter 4.

3.7.18 Auklets

- Cassin's auklet (*Ptychoramphus aleutica*)
- Parakeet auklet (*Aethia psittacula*)
- Least auklet (*Aethia pusilla*)
- Whiskered auklet (*Aethia pygmaea*)
- Crested auklet (*Aethia cristatella*)

Life History and Distribution

Auklets are small (6 to 10 inches long) members of the Alcidae family, which also includes the murres and puffins. Like the other alcids, these birds are highly adapted to life at sea and come to land only to nest. They use their short, narrow wings to "fly" underwater in pursuit of prey. All of these auklets, except parakeet, are usually found in flocks at sea. Sometimes those flocks are huge and dense with thousands of birds. There are differences in their preferred nest sites but they all basically nest in crevices, burrows, or within rock piles. Parakeet auklets are the exception again in that they do not nest in dense aggregations like the others. All species lay just one egg on the bare ground and the sexes take turns incubating and brooding the young.

These auklets are all North Pacific birds and, with the exception of Cassin's auklet, breed only in the BSAI and GOA area. Cassin's nest from the Aleutians south to California. Whiskered auklets only breed in the central and western Aleutians. The other three species nest from the GOA north and west to the Bering Strait. Cassin's and parakeets are concentrated in northern waters but range south to California in winter. The other three species are restricted to waters around the Aleutians and Alaska Peninsula in winter.

Population estimates for these five auklet species are not very reliable because of their underground or hidden nesting habits. Numbers listed in the Beringian Seabird Colony Catalog (USFWS 1998a) should be used for only the most generalized discussions and are not sufficient for documenting anything but the most extreme changes in population-levels. Still, this is one of the most abundant groups of birds in the Bering Sea (Table 3.5-62). Cassin's auklets are estimated to number 250,000 in the BSAI and 750,000 in the GOA. Parakeets have an estimated 800,000 in the BSAI and 150,000 in the GOA. Least auklets are the most abundant species with an estimated 9 million birds, essentially all in the BSAI. There are only about 30,000 whiskered auklets, all in the BSAI. Crested auklets are abundant with an estimated 3 million in the BSAI and 50,000 in the GOA.

Population trends of auklets are poorly known at present because monitoring of their underground nests is extremely difficult. Least auklets have been monitored on Kasatochi Island (central Aleutians) since 1991 and have fluctuated but do not exhibit any consistent trend (Dragoo *et al.* 2001). Least auklets may be increasing in the central and northern Bering Sea (Springer *et al.* 1993). Crested auklets have been monitored at the same sites and appear to be stable or increasing (Table 3.7-21, Springer *et al.* 1993, Dragoo *et al.* 2001).

Trophic Interactions

The abundance and diversity of small auklets is much higher in the Bering Sea than elsewhere in the world, owing to the large-scale advection of oceanic zooplankton onto the shelf in areas such as the Aleutian passes and Bering Strait (Springer and Roseneau 1985). They seek water structures that concentrate small prey at depths of 5 to 30 m, such as pycnoclines, fronts, or tide rips over shallow sills (Hunt 1990, Hunt *et al.* 1990, Hunt *et al.* 1993). All forage by pursuit diving (Ashmole and Ashmole 1967). Cassin's auklets take a variety of zooplankton along with squid and some small fish. Parakeet auklets eat a diverse diet of small schooling fish such as Pacific sand lance and juvenile pollock, jellyfish, squid, other invertebrates, and zooplankton (Hunt *et al.* 1993, Springer *et al.* 1993, Hunt *et al.* 1998). Least auklets depend exclusively on zooplankton, especially *Neocalanus plumchrus*, a type of copepod (Hunt 1997). Whiskered auklets also depend exclusively on zooplankton. Crested auklets eat zooplankton and other invertebrates, especially the euphausid, *Thysanoessa raschii* (Hunt *et al.* 1998).

A recent study conducted in the shallow passes of the Aleutian Islands demonstrated that least, crested, and parakeet auklets timed their foraging in a pass to correspond with the presence of strong tidal currents. The diets of these three auklet species differed in composition despite the proximity of the areas in which they foraged. The researchers concluded that the three auklet species exhibited strong preferences for particular prey types, and that these prey preferences resulted in small-scale differentiation of preferred foraging sites. The strong tidal currents provided the energy for enhancing the availability of different prey (Hunt *et al.* 1998).

Numerous studies highlight the foraging ecology of auklets and relationships to physical oceanographic processes (Hunt and Harrison 1990, Russell and Hunt 1992, Hunt 1997, Hunt *et al.* 1998, Russell *et al.* 1999). Upwellings occur where tides or currents move water from the deep ocean onto the shelf, such as between the islands in the Pribilofs (Coyle *et al.* 1992), the Aleutian Islands (Hunt *et al.* 1998), or the Anadyr Current west of St. Lawrence Island (Hunt *et al.* 1990). Auklets nest abundantly in these areas because upwellings bring oceanic zooplankton to shallow waters nearby (Springer and Roseneau 1985, Hunt *et al.* 1993).

It has been suggested that auklet population trends are due in part to food-web changes following reductions in plankton-eating whales or other predators (Springer 1991b, Springer 1992, Springer *et al.* 1993). Other studies, however, indicate that decadal changes in primary productivity of northern versus southern Pacific waters have altered zooplankton abundance, which has not always resulted in population increases of seabirds (Francis *et al.* 1998, McGowan *et al.* 1998).

Management Overview

Wildlife management responsibility for auklets is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*). In 1999, protocol amendments to the Migratory Bird Treaty Act were ratified that mandated participation of subsistence users and their traditional knowledge in a co-management relationship between Native, Federal, and State of Alaska representatives. This co-management group is charged with developing conservation, research, and management plans for all species taken in subsistence harvests, including auklets (Denlinger and Wohl 2001).

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Auklets have been hunted for their meat, skins, and decorative beaks by Native peoples in the BSAI and GOA area for thousands of years. These hunts are usually done in family groups and are significant subsistence and cultural traditions. Harvest of adult birds from breeding colonies continues to the present time in some coastal communities, most commonly by means of shotguns and motorized boats. Recent community surveys by the ADF&G, USFWS, and tribal governments indicate that crested auklets are the most frequently taken seabird in subsistence hunts (Denlinger and Wohl 2001). In 1996 alone, an estimated 12,300 crested auklets were taken, all from the St. Lawrence/Diomede Islands area. A few hundred parakeet and least auklets were also taken in that year as well as about 4,700 unidentified auklets. Most of these birds are taken in the northern Bering Sea but they are also hunted in the Aleutians and Kodiak Island area (Denlinger and Wohl 2001).

Direct Mortality from Incidental Take in External Fisheries

Auklets are not attracted to fishing vessels because of fish scraps like many of the surface-feeding seabirds and are rarely caught by longline fisheries. They are more susceptible to being caught in trawl and drift nets which hang down into the water column where auklets dive for zooplankton and fish. Past fisheries in the North Pacific, both foreign and domestic, have taken auklets in the course of their operations. For most of these fisheries, the numbers of individual species taken were not recorded. Some data is available for the Japanese salmon high-seas driftnet (mothership) fishery where an average of 304 Cassin's, 583 parakeet, 219 least, and 5,565 crested auklets were taken every year between 1981-1984 (Jones and DeGange 1988). The land-based Japanese salmon gillnet fishery was responsible for millions of seabird deaths between 1952-1987, including an estimated 7,079 parakeet and 307 crested auklets in 1977. By 1987, fishing effort had been reduced and catch rates declined to an estimated 1,966 parakeet and 116 crested auklets (DeGange and Day 1991). On the Russian side of the Bering Sea, Japanese salmon gillnet fisheries took an estimated 1.1 million seabirds between 1993 and 1998, 62 percent of which were unidentified alcids (Artukhin *et al.* 2000). The incidental take of auklets in other current foreign gillnet fisheries is unknown.

Direct Mortality from Incidental Take on Groundfish Longlines

The numbers of seabirds caught in the BSAI and GOA groundfish longline fisheries are estimated from Observer Program data in Tables 3.7-2 and 3.7-3. Auklets are included in the "alcid" and "unidentified seabird" categories. The alcids accounted for an average of 15 birds per year taken in the BSAI between 1993 and 2001 and one bird per year in the GOA.

Direct Mortality from Incidental Take in Groundfish Trawls

The BSAI and GOA trawl fishery took between 178 alcids per year (low estimate) and 340 alcids per year (high estimate) between 1997 and 2001 (Table 3.7-4). The numbers of auklets in these totals is unknown.

Direct Mortality from Vessel Strikes

Crested auklets do not seem to strike fishing vessels very frequently but when they do, the incidents often involve large numbers of birds. According to preliminary analysis of the observer records of bird-strikes from 1993-2000, 1,305 crested auklets were involved in 7 recorded collisions. In one historical account, approximately 6,000 crested auklets were attracted to lights and collided with a fishing vessel near Kodiak Island during the winter of 1977 (Dick and Donaldson 1978). Monitoring these types of collisions is not part of the observer's normal duties so the true extent of this impact is not known (NPFMC 2002c).

Other Past and Present Effects

The following issues have been identified as having potential impacts on auklets but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** Although parakeet auklets take some fish, auklets are primarily plankton feeders and are much more likely to be affected by changes in the primary productivity of the ecosystem (due to climactic or ocean current shifts) rather than top-down effects. However, the relationship between the abundance and distribution of commercial fish stocks, most of which are also plankton feeders at some point in their life cycle, and food web dynamics is poorly understood.

- **Indirect effects through contamination by oil spills.** Alcids are considered to be the most vulnerable of all bird groups to the risk of chronic and acute oil contamination from all sources (King and Sanger 1979).

- **Indirect effects through plastics ingestion.** Parakeet auklets are among the species with the highest recorded frequencies of plastic ingestion even though most alcids ingest little or no plastic (Sievert and Sileo 1993).

- **Indirect effects by introducing mammalian predators to nesting islands.** Burrowing and cliff-nesting seabirds, including auklets, were decimated or seriously reduced on many islands in the Aleutian chain and GOA after the introduction of arctic and red foxes by fox farmers from the 1700s to the 1930s (Bailey and Kaiser 1993). The USFWS has exterminated foxes from many of these islands and auklets have begun to recolonize them. At present, auklets are susceptible to predation by introduced rats. The USFWS has an extensive program to reduce the threat of new rat invasions.

Comparative Baseline

The five species of auklets common to the BSAI and GOA area are generally abundant and widely distributed in the project area. Their population numbers and trends are poorly known. Direct auklet interactions with the groundfish fisheries appear to be infrequent and minor in scale except for the occasional mass collision of crested auklets with fishing vessels in poor weather. The specific numbers of auklets taken in the groundfish fisheries are not recorded by the Observer Program but the numbers appear to be rather small relative to their overall population-levels. The past and present effects on auklets are summarized in Table 3.7-27.

Status for Cumulative Effects Analysis

Because population trend data for these species are very limited and there is no species specific quantitative data on the impacts of the fisheries, these species will be discussed in conjunction with the “other planktivorous species” group in Chapter 4.

3.7.19 Puffins

- Rhinoceros auklet (*Cerorhinca monocerata)*
- Horned puffin (*Fratercula corniculata*)
- Tufted puffin (*Fratercula cirrhata*)

Life History and Distribution

Puffins are familiar to many people as the birds with the large, colorful bills that are frequently depicted on Alaska tee shirts and advertisements. The rhinoceros auklet is included in this account because it is much closer in size, behavior, and anatomy to the two puffins than to the other auklets. These three alcid species are all about the same size, 15 inches in length, and are more brightly colored in the summer than winter. They dig burrows for their nest sites on the tops of islands or less frequently nest within rock crevices. Following the conservative seabird pattern, they lay only one egg and take turns with parental care. They are usually seen singly or in small numbers at sea but can be abundant on waters around their colonies.

Rhinoceros auklets breed and winter along the coast from the Aleutian Islands to California. Horned puffins breed along the Alaska coast in the entire BSAI and GOA area and winter in the North Pacific. Tufted puffins have a similar range but will also breed in coastal waters south to California.

Population estimates for the puffin species are not very reliable because of their underground or hidden nesting habits. Numbers listed in the Beringian Seabird Colony Catalog (USFWS 1998a) are not sufficient for documenting anything but the most extreme changes in population-levels. There are an estimated 200,000 rhinoceros auklets in Alaska, essentially all of which nest in the GOA. Horned puffins have an estimated 500,000 in the BSAI and 1.5 million in the GOA. Tufted puffins are the most abundant species with an estimated 2.5 million birds in the BSAI and 1.5 million in the GOA (Table 3.5-62).

Population trends for burrow nesting species are very difficult to determine with any accuracy. Rhinoceros auklets are monitored on permanent sample plots in only one location, St. Lazaria Island (southeast Alaska). Since 1994, the density of burrow holes has fluctuated but shows no clear trend. Plots have been set up to monitor horned puffins on Buldir Island but no acceptable sampling method has been developed to date. The density of tufted puffin burrows have increased slightly on Bogoslof and Aiktak Islands (central and eastern Aleutians) and shows no obvious trend on E. Amatuli in the GOA or St. Lazaria. (Table 3.7-21, Dragoo *et al.* 2001).

Trophic Interactions

Rhinoceros auklets and the puffins forage both near shore and over the shelf, although rhinoceros auklets primarily feed near shore and the puffins primarily feed on the shelf (DeGange and Sanger 1986, Schneider *et al.* 1986, Sanger 1987). All three species dive for small schooling fish such as capelin, Pacific sand lance, and herring. Horned and tufted puffins also consume pollock, squid, and zooplankton. The rhinoceros auklet may forage more often at twilight than other puffins. The tufted puffin has the most diverse diet of the three and consumes the largest proportion of invertebrates (DeGange and Sanger 1986, Vermeer *et al.* 1987, Hatch and Sanger 1992, Byrd *et al.* 1997). Tufted puffin populations in PWS may be partly limited by low prey densities (Piatt *et al.* 1997).

Management Overview

Wildlife management responsibility for puffins is under the jurisdiction of the USFWS. These species are protected under the U.S. Migratory Bird Treaty Act (16 USC 703 *et.seq.*). In 1999, protocol amendments were ratified that mandated participation of subsistence users and their traditional knowledge in a co-management relationship between Native, Federal, and State of Alaska representatives. This co-management group is charged with developing conservation, research, and management plans for all species taken in subsistence harvests, including puffins (Denlinger and Wohl 2001).

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Puffins have been hunted for their meat, skins, and decorative beaks by Native peoples in the BSAI and GOA area for thousands of years. An account from the mid-1800s describes the widespread use of baleen nooses to capture birds on the steep cliffs of the Aleutian Islands. These methods were efficient enough to cause noticeable declines in breeding populations of puffins, at least at colonies that were accessible from settlements (Veniaminov 1840). These hunts are usually done in family groups and are significant subsistence and cultural traditions. Harvest of adult birds from breeding colonies continues to the present time in some coastal communities, most commonly by means of shotguns and motorized boats. Recent community surveys by the ADF&G, USFWS, and tribal governments indicate that puffins make up a small part of the harvest (Denlinger and Wohl 2001). In 1996, an estimated 48 horned puffins, 65 tufted puffins, and 115 unidentified puffins were taken in the BSAI area. It is not known whether any puffins were taken in the GOA that year (Denlinger and Wohl 2001).

Direct Mortality from Incidental Take in External Fisheries

Puffins are not attracted to fishing vessels like many of the surface-feeding seabirds and are not likely to be caught by longline fisheries. They are more susceptible to being caught in trawl and drift nets which hang down into the water column where they dive for fish. Past fisheries in the North Pacific, both foreign and domestic, have taken puffins in the course of their operations. For most of these fisheries, the numbers of individual species taken were not recorded. Some data is available for the Japanese salmon high-seas (mothership) fishery where an average of 19 rhinoceros auklets, 8,249 horned puffins, and 38,600 tufted puffins were taken every year between 1981-1984 (Jones and DeGange 1988). The land-based Japanese salmon gillnet fishery, operating from 1952-1992, was responsible for killing an estimated 4,929 rhinoceros auklets, 1,229 horned puffins, and 31,403 tufted puffins in 1977. In 1987, after substantial reductions in the fishing effort, an estimated 1,387 rhinoceros auklets were taken along with 462 horned puffins and 9,481 tufted puffins (DeGange and Day 1991). Driftnet fisheries targeting flying squid were started in the late 1970s by Japan, Korea, and Taiwan. At their peak in the late 1980s, these fisheries deployed millions of kilometers of driftnet. Rough estimates of the total number of seabirds killed by the squid driftnet fisheries were between 875,000 and 1,660,000 seabirds annually, including up to 250,000 tufted puffins and 100,000 horned puffins per year (DeGange *et al.* 1993). Due to the tremendous amount of waste and ecosystem damage associated with the high-seas driftnet fisheries, they were outlawed by international agreement through United Nations Resolution (46/215) in December of 1992 (Paul 1994). On the Russian side of the Bering Sea, Japanese salmon gillnet fisheries took an estimated 1.1 million seabirds between 1993 and 1998, 62 percent of which were unidentified alcids (Artukhin *et al.* 2000). The incidental take of puffins in other current foreign gillnet fisheries is unknown.

<u>Direct Mortality from Incidental Take on Groundfish Longlines</u>

The numbers of seabirds caught in the BSAI and GOA groundfish longline fisheries are estimated from Observer Program data in Tables 3.7-2 and 3.7-3. Rhinoceros auklet and both puffins have individual species codes in the observer protocols but are included in the "alcid" category for analytical and reporting purposes. An unknown number of these species may also be included in the "unidentified seabird" category. The alcids accounted for an average of 15 birds per year taken in the BSAI between 1993 and 2001 and one bird per year in the GOA.

<u>Direct Mortality from Incidental Take in Groundfish Trawls</u>

The BSAI and GOA trawl fishery took between 178 alcids per year (low estimate) and 340 alcids per year (high estimate) between 1997 and 2001 (Table 3.7-4). The numbers of puffins in these totals is unknown.

Other Past and Present Effects

The following issues have been identified as having potential impacts on puffins but not enough information is available to assess the extent of these impacts quantitatively or at a population-level. The nature of these effects are outlined in the introduction to seabirds (see Section 3.7.1).

- **Indirect effects through changes in prey availability.** The impact of groundfish fisheries on the availability of prey to puffins is unknown. The big unanswered question for puffins, as with all piscivores, is whether variations in their food supplies are caused by human activities or are predominately natural cycles. In the face of this uncertainty, NPFMC prohibited directed fisheries on forage fish to minimize any indirect impact on seabirds (BSAI FMP Amendment 36 and GOA Amendment 39, 1997).

- **Indirect effects through contamination by oil spills.** Alcids are considered to be the most vulnerable of all bird groups to the risk of chronic and acute oil contamination from all sources (King and Sanger 1979).

- **Indirect effects by introducing mammalian predators to nesting islands.** Burrowing and crevice-nesting seabirds, including puffins, were decimated or seriously reduced on many islands in the Aleutian chain and GOA after the introduction of arctic and red foxes by fox farmers from the 1700s to the 1930s (Bailey and Kaiser 1993). The USFWS has exterminated foxes from many of these islands and auklets have begun to recolonize them. At present, puffins are susceptible to predation by introduced rats. The USFWS has an extensive program to reduce the threat of new rat invasions.

Comparative Baseline

All three puffin species are common or abundant in the BSAI and GOA area. Population trend data for these species are either unavailable or very limited. These species were impacted heavily by the now illegal high-seas drift fisheries. The numbers of puffins taken in the groundfish fisheries is unknown due to lack of differentiation among alcids in the Observer Program but the numbers appear to be rather small relative to their overall population-levels. The past and present effects on puffins are summarized in Table 3.7-28.

Status for Cumulative Effects Analysis

Because population trend data for these species are very limited and there is no species specific quantitative data on the impacts of the fisheries, these species will be discussed in conjunction with the fish-eating (piscivorous) birds in Chapter 4.

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3.8 Marine Mammals

The purpose of this chapter is to describe the baseline condition of marine mammals as they relate to the federally managed groundfish fishery in Alaska. This baseline condition includes a description of the pertinent natural history for each species and an assessment of the various natural and anthropogenic factors that have shaped the status of each species in Alaskan waters. These accounts summarize the human and natural effects on each species, to the extent that they are known, and thus provide the historical and scientific basis for analyzing the potential effects of the alternative FMPs in Chapter 4.

The geographical and temporal scope of material presented in this chapter is not consistent between different species because of the wide variability in their distributions and the incompleteness of historical information. For some species, like many of the baleen whales, commercial whaling that took place many years ago and often in distant waters have greatly influenced their present status in Alaska. For other species, like the "ice seals" (spotted, bearded, ribbon, and ringed), there are few historical records of impacts and basic biological parameters such as population abundance are still not known. The intent is to provide as much relevant information as possible for each species. In order to minimize redundancy in the individual species accounts, general information on the types of effects that may impact marine mammal populations are described below. Information pertinent to only one species will be presented in the individual species accounts.

Marine mammals occur in diverse habitats, including deep oceanic waters, the continental slope, and the continental shelf (Lowry *et al.* 1982). In the areas fished by the federally managed groundfish fleets, twenty-six species of marine mammals are present from the orders Pinnipedia (seals, sea lion, and walrus), Carnivora (sea otter and polar bear), and Cetacea (whales, dolphins, and porpoises) (Lowry and Frost 1985). Most species are resident throughout the year, while others seasonally migrate into and out of Alaskan waters.

Marine Mammal Protection Act

The MMPA of 1972 (16 USC 1361 *et seq.*), as amended through 1996, establishes a federal responsibility to conserve marine mammals. Management responsibility for cetaceans and pinnipeds other than walrus is vested with the NOAA Fisheries Protected Resources Division. The USFWS is responsible for management of walrus and sea otters. The MMPA's primary management objective is to maintain the health and stability of the marine ecosystem, with a goal of obtaining an optimum sustainable population of marine mammals within the carrying capacity of the habitat. The MMPA is intended to work in concert with the provisions of the ESA. If a fishery affects a marine mammal population, then the potential impacts of the fishery must be analyzed in the appropriate environmental assessment document, and NPFMC or NOAA Fisheries may be requested to consider regulations to mitigate adverse impacts.

Assessment of Population-Level Effects

In order to fulfill their oversight responsibilities under the MMPA, NOAA Fisheries and USFWS have developed appropriate survey methodologies to census the various species of marine mammals. The results of these surveys, and other factors that affect the status of each species, are published in an annual "Marine Mammal Stock Assessment" report that is available on the internet at:
http://www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/sars.html.

Some species are much more difficult to census accurately than others so there is a great deal of variation in the uncertainty of various population estimates. In addition, the huge expanses over which many species traverse and the remoteness of their habitats make surveys logistically difficult and expensive. For budgetary and logistical reasons, surveys of most species are not carried out every year and survey effort is prioritized for species of management concern. As a result, population estimates for some species may be outdated and trend information may not exist. While it is the intent of this chapter to assess the past effects of various events on the various populations of marine mammals, including fishery management actions, those efforts may be limited in quantitative detail by the availability of population trend information.

Some species are divided into separate stocks for management purposes based on genetic, morphological, behavioral, or home range information. Even though some individual animals may cross over from one stock to another, the following species accounts concentrate on the stocks that regularly spend at least part of the year in the project area.

Past and Present Effects on Marine Mammals

Direct Mortality from Intentional Take

Commercial harvests of marine mammals have occurred at various times and places, sometimes with devastating impacts on the populations of particular species. In some cases, such as the northern right whale, the species have not recovered to pre-exploitation population-levels even though commercial whaling was halted decades ago.

Marine mammals have been hunted by Alaska Natives for thousands of years and continue to be an important source of food, clothing, and material for a variety of uses. They also have an overriding cultural significance that goes far beyond their value as subsistence resources. Data on the harvest of marine mammals in subsistence hunts is collected by several entities, including the ADF&G and various Alaska Native organizations. In some cases, Alaska Native groups have entered into cooperative management agreements with NMFS, USFWS, and ADF&G to regulate subsistence takes.

Direct Mortality from Incidental Take in Fisheries

Some types of fisheries are much more likely to catch marine mammals incidentally than others. High seas driftnet fishing killed thousands of mammals before it was prohibited in 1991. Longline and pot fisheries very rarely catch marine mammals directly. NMFS requires all commercial fisheries in the U.S. EEZ to report the incidental take and injury of marine mammals that occur during their operations (50 CFR 229.6). In addition to self-reported records, which NMFS considers to be negatively biased and under representing actual take levels, certified observers are required in some fisheries to provide independent monitoring of incidental take as well as other fishery data. Marine mammal incidental take data from the North Pacific Groundfish Observer Program is included in each of the following species accounts.

Section 118 of the MMPA (50 CFR 229.2) requires all commercial fisheries to be placed into one of three categories, based on the frequency of incidental take (serious injuries and mortalities) relative to the value of potential biological removal (PBR) for each stock of marine mammal. PBR is defined as the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. In order to categorize each fishery, NMFS first looks at the level of incidental take from all fisheries that interact with a given marine mammal stock. If the combined take of all fisheries is less than or equal to 10 percent of PBR, each fishery in that combined total is assigned to Category III, the minimal impact category. If the combined take is greater than 10 percent of PBR, NMFS then looks at the individual fisheries to assign them to a category. Category I designates fisheries with frequent incidental take, defined as those with takes greater than or equal to 50 percent of PBR for a particular stock; Category II designates fisheries with occasional serious injuries and mortalities, defined as those with takes between one percent and 50 percent of PBR; Category III designates fisheries with a remote likelihood or no known serious injuries or mortalities, defined as those with takes less than or equal to one percent of PBR. Owners of vessels or gear engaging in Category I or II fisheries are required to register with NMFS to obtain a marine mammal authorization in order to lawfully take a marine mammal incidentally in their fishing operation (50 CFR 229.4). In Alaska, this registration process has been integrated into other state and federal permitting programs to reduce fees and paperwork. Owners of vessels or gear engaging in Category III fisheries are not required to register with NMFS for this purpose. Every year, NMFS reviews and revises its list of Category I, II, and III fisheries based on new information and publishes the list in the FR.

Under provisions of the MMPA, NMFS is required to establish take reduction teams with the purpose of developing take reduction plans to assist in the recovery or to prevent the depletion of strategic stocks that interact with Category I and II fisheries. A “strategic” stock is one which: 1) is listed as endangered or threatened under the ESA, 2) is declining and likely to be listed as threatened under the ESA, 3) is listed as depleted under the MMPA, or 4) has direct human-caused mortality which exceeds the stock’s PBR.

The immediate goal of a take reduction plan is to reduce, within six months of its implementation, the incidental serious injury or mortality of marine mammals from commercial fishing to levels less than PBR. The long-term goal is to reduce, within five years of its implementation, the incidental serious injury and mortality of marine mammals from commercial fishing operations to insignificant levels approaching a zero serious injury and mortality rate, taking into account the economics of the fishery, the availability of existing technology, and existing state or regional FMPs. Take reduction teams are to consist of a balance of representatives from the fishing industry, fishery management councils, state and federal resource management agencies, the scientific community, and conservation organizations. Fishers participating in Category I or II fisheries must comply with any applicable take reduction plan and may be required to carry an observer onboard during fishing operations.

In 2002, all of the MSA groundfish fisheries (trawl, longline, and pot gear in the BSAI and GOA) were listed as Category III fisheries (67 FR 2410). In addition, a number of state-managed salmon drift and set gillnet fisheries are listed in Category II, including those in Bristol Bay, Aleutian Islands, Alaska Peninsula, Kodiak, Cook Inlet, PWS, and southeast Alaska. NMFS has recently proposed reclassifying the Cook Inlet drift and set gillnet fisheries from Category II to Category III (68 FR 1414).

Indirect Effects through Entanglement

The following effects are classified as indirect because the impacts are removed in time and/or space from the initial action although in the analysis, these effects are considered together with the direct effect of incidental take. In some cases, individual marine mammals may be killed outright by the effect. In other cases, individuals are affected in ways that may decrease their chances of surviving natural phenomenon or reproducing successfully. These sub-lethal impacts may reduce their overall "fitness" as individuals and may have population-level implications if enough individuals are impacted.

Although some fisheries have no recorded incidental take of marine mammals, all of them probably contribute to the effects of entanglement in lost fishing gear. Evidence of entanglement comes from observations of animals trailing ropes, buoys, or nets or bearing scars from such gear. Sometimes stranded marine mammals also have evidence of entanglement but it may not be possible to ascertain whether the entanglement caused the injury or whether the corpse picked up gear as it floated around after death. Sometimes an animal is observed to become entangled in specific fishing gear, in which case an incidental take or minor injury may be recorded for that particular fishery, but many times the contributions of individual fisheries to the overall effects of entanglement are difficult to document and quantify.

The Marine Plastic Pollution Research and Control Act of 1987 (33 USC §§ 1901 *et seq.*), implements the provisions relating to garbage and plastics of MARPOL. These regulations apply to all vessels, regardless of flag, on the navigable waters of the U.S. and in the EEZ of the U.S. It applies to U.S. flag vessels wherever they are located. The discharge of plastics into the water is prohibited, including synthetic ropes, fishing nets, plastic bags, and biodegradable plastics.

Indirect Effects through Changes in Prey Availability

The availability of prey to marine mammals depends on a large number of factors and differs among species and seasons. Among these factors are oceanographic processes such as upwellings, thermal stratification, ice edges, fronts, gyres, and tidal currents that concentrate prey at particular times and places. Prey availability also depends on the abundance of competing predators and the ecology of prey species, including their natural rates of reproduction, seasonal migration, and movements within the water column. The relative contributions of factors that influence prey availability for particular species and areas are rarely known. Most critical is the lack of information on how events outside an animal's foraging range or in a different season may influence the availability of prey to animals in a particular place and time.

Marine mammal species differ greatly from one another in their prey requirements and feeding behaviors, leading to substantial differences in their responses to changes in the environment. For some species, such as the baleen whales, diets consist largely of planktonic crustaceans or small squid and have no overlap of prey with species that are targeted or taken as bycatch in the groundfish fisheries. For other species, notably Steller sea lions, there is a high degree of overlap between their preferred size and species of prey and the groundfish catch. Many other species are in between, perhaps feeding on the same species but smaller sizes of fish than what is typically taken in the fisheries. Although they may take a wide variety of prey species during the year, many species may depend on only one or a few prey species in a given area and season. In addition, the prey requirements and foraging capabilities of nursing females and subadult animals may be much more restricted than for non-breeding adults, with implications for reproductive success and survival.

The question of whether different types of commercial fisheries have had an effect on the availability of prey to marine mammals has been addressed by examining the degree of direct competition (harvest) of prey and by looking for potential indirect or cascading effects of the fisheries on the food web of the mammals. For marine mammals whose diets overlap to some extent with the target or bycatch species of the fisheries, fishery removals could potentially decrease the density of prey fields or cause changes in the distribution of prey such that the foraging success of the marine mammals is affected. If alternate prey is not available or is of poorer nutritional quality than the preferred species, or if the animal must spend more time and energy searching for prey, reproductive success and/or survival can be compromised. In the case of marine mammals that do not feed on fish or feed on different species than are taken in the fisheries, the removal of a large number of target fish from the ecosystem may alter the predator/prey dynamics and thus the abundance of another species that is eaten by marine mammals. The mechanisms and causal pathways for many potential food web effects are poorly documented because they are very difficult to study scientifically at sea (Loughlin *et al.* 1999).

Although reductions in the availability of forage fish to marine mammals have been attributed to both climatic cycles and commercial fisheries, a NRC study on the Bering Sea ecosystem (NRC 1996) concluded that both factors probably are significant. Regime shifts are major changes in atmospheric conditions and ocean climate that take place on multi-decade time scales and trigger community-level reorganizations of the marine biota (Anderson and Piatt 1999). Two cycles of warm and cold regimes have been documented in the GOA in the past 100 years, with the latest shift being from a cold regime to a warm regime in 1977. The consequences of this shift on fish and crustacean populations have been documented, including major improvements in groundfish recruitment and the collapse of some high-value forage species such as shrimp, capelin, and Pacific sand lance (Anderson and Piatt 1999). Directed fisheries on forage fish can deepen and prolong their natural low population cycles (Duffy 1983, Steele 1991), with potential effects on marine mammal foraging success. There is some evidence that another regime shift may have begun in 1998 with colder water temperatures and increases in certain forage populations (NPFMC 2002c), but the implications for marine mammals are still unclear. Climate change may also affect the dynamics of the ice pack, with serious consequences for the marine mammals associated with the ice pack, such as bowhead whales, the ice seals, and walrus.

Direct Effects through Disturbance by Fishing Vessels

The effects of disturbance caused by vessel traffic, fishing operations, engine noise, and sonar pulses on marine mammals are largely unknown. With regard to vessel traffic, many baleen and toothed whales appear tolerant, at least as suggested by their reactions at the surface. Observed behavior ranges from attraction to the vessel to course modification or maintenance of distance from the vessel. Dall's porpoise, Pacific white-sided dolphins, and even beaked whales have been observed adjacent to vessels for extended periods of time. Conversely, harbor porpoise tend to avoid vessels. However, a small number of fatal collisions with various vessels have been recorded in California and Alaska in the past decade and others likely go unreported or undetected (Angliss *et al.* 2001).

Reactions to some fishing gear, such as pelagic trawls, are poorly documented, although the rarity of incidental takes suggests either partitioning of foraging and fishing areas or avoidance. Given their distribution throughout the fishing grounds, at least some individuals may be expected to occasionally avoid contact with vessels or fishing gear, which would constitute a reaction to a disturbance. Assuming these instances occur, the effects are likely temporary. Sonar devices are used routinely during fishing activity as well as during vessel transit. The sounds produced by these devices may be audible to marine mammals and may thus constitute disturbance sources. Wintering humpback whales have been observed reacting to sonar pulses by moving away (Maybaum 1990, 1993), although few other cases of reaction have been documented.

Indirect Effects through Contamination by Oil Spills

For species such as the pinnipeds and sea otters that spend a substantial amount of time on the surface of the water or hauled out on shore, oil spills pose a significant environmental hazzard, even in small amounts. The toxicological effects of ingested oil, ranging from potential organ damage to weakening of the immune system, are poorly known for most species, especially in regard to chronic low doses. Sea otters are particularly susceptible to oil spills because they depend on their thick fur to protect them from cold water, rather than layers of fat, and oil destroys the insulative properties of their fur. Thousands of sea otters died over a large expanse of the GOA as a result of the EVOS in 1989 (Garshelis 1997, Garrot *et al.* 1993, DeGange *et al.* 1994). There is very little data on the mortality of marine mammals from the much smaller volumes of oil that are more typical of marine vessel spills, resulting from fuel transfer accidents and bilge operations.

3.8.1 Steller Sea Lion (*Eumetopias jubatus*)

Life History and Distribution

The Steller sea lion, also found in the literature as Steller's sea lion and northern sea lion, is a member of the order Pinnipedia and is in the same family (Otariidae) as northern fur seals. Sea lions are strongly dimorphic, meaning that mature males and females look very different. Females weigh up to 600 pounds (270 kg) and reach 7 ft (2.1 m) in length while males can reach 2000 pounds (900 kg) and reach 10.5 ft (3.2 m) in length (Burt and Grossenheider 1976). Steller sea lions have a highly polygynous mating system, with males defending territories to restrict access to females.

Pupping and breeding occur in rookeries on relatively remote islands, rocks, and reefs. Females generally return to the rookeries where they were born to mate and give birth (Alaska Sea Grant 1993, Calkins and Pitcher 1982, Loughlin *et al.* 1984). Males establish territories in May in anticipation of the females' arrival in late May through June (Pitcher and Calkins 1981). Viable births begin in late May and continue through early July; the sex ratio at birth is slightly in favor of males. Steller sea lions give birth to a single pup each year; twinning is rare. Females breed again about two weeks after giving birth. Copulation may occur in the water, but mostly occurs on land (Pitcher *et al.* 1998, Gentry 1970, Gisiner 1985). The mother nurses the pup during the day. She stays with her pup for the first week, then goes to sea on feeding trips. Pups generally are weaned before the next breeding season, but it is not unusual for a female to nurse her offspring for a year or more. Females reach sexual maturity between three and eight years of age and may breed into their early twenties. Females can have a pup every year but may skip years as they get older, or when nutritionally stressed. Males also reach sexual maturity at about the same ages but do not have the physical size or skill to obtain and keep a breeding territory until they are nine years of age or older. Males may return to the same territory for up to seven years, but most return for no more than three years (Gisiner 1985). During the breeding season, males may not eat for 1 to 2 months. The rigors of fighting to obtain and hold a territory and the physiological stress of the mating season reduces their life expectancy. Males rarely live beyond their mid-teens, while females may live as long as 30 years.

Although most often found within the continental shelf region, sea lions may be found in pelagic waters as well (Bonnell *et al.* 1983, Fiscus *et al.* 1976, Kajimura and Loughlin 1988, Kenyon and Rice 1961, Merrick and Loughlin 1997). Observations of Steller sea lions at sea suggest that large groups usually consist of females of all ages and subadult males; adult males sometimes occur in those groups but are usually found individually. On land, all ages and both sexes haul out in aggregations during the non-breeding season. Steller sea lions are not known to migrate, but they do disperse widely at times of the year other than the breeding season. For example, sea lion pups marked near Kodiak, Alaska, have been sighted in British Columbia, Canada (about 1,700 km distant) (Raum-Suryan *et al.* 2002). Generally, animals up to about 4 years of age tend to disperse farther than adults. As they approach breeding age, they have a propensity to stay in the general vicinity of the breeding islands, and, as a general rule, return to their island of birth to breed as adults.

Steller sea lions range along the NPO rim from northern Japan to California (Loughlin *et al.* 1984), with centers of abundance and distribution in the GOA and Aleutian Islands, respectively (Figure 3.8-1). The northernmost rookery in the Bering Sea is on Walrus Island near the Pribilof Islands and in the GOA on Seal Rocks just outside of PWS (Kenyon and Rice 1961).

Population assessment for Steller sea lions has been achieved primarily by aerial surveys and on-land pup counts. Historically, this included surveys of limited geographical scope in various portions of the species' range, in many cases conducted using different techniques, and occasionally during different times of year. Consequently, population trends for Steller sea lions from the 1970s and earlier, and over a large geographical area, must be reconstructed from a patchwork of regional surveys conducted over many years. Prior to 1997, only one population of Steller sea lions was recognized in Alaskan waters. Based largely on differences in genetics, morphology, and population trends, this single population was split into two distinct population segments (DPSs) (Bickham *et al.* 1996, Loughlin 1997, 62 FR 30772). The term DPS is used in reference to the status under ESA (16 USC 1532). NOAA Fisheries, under the MMPA, uses the term "stock" when referring to a population or population segment, however for this discussion the term population is used when referring to Steller sea lions. The western DPS (western population) of Steller sea lions occurs from 144°W (approximately at Cape Suckling, just east of PWS) westward to Russia and Japan, including the Bering Sea. The eastern DPS (eastern population) of Steller sea lions occurs from southeast Alaska southward to California. Recent evidence suggests that the western population consists of two distinct sub-populations: the central population, from 144°W through the Aleutian Islands and the Commander Islands (Russia); and the Asian population, which includes all animals that breed on the Kamchatka Peninsula, Kuril Islands, and the Sea of Okhotsk (J. Bickham, Texas A&M University, report to the Steller sea lion recovery team).

<u>Western Distinct Population Segment of Steller Sea Lions</u>

Aerial surveys conducted from 1953 through 1960 resulted in combined counts of 170,000 to 180,000 Steller sea lions in what we now define as the western population in Alaska (Mathisen 1959, Kenyon and Rice 1961). Surveys during 1974 through 1980 suggested an equivocal increase to about 185,000, based on maximal counts at sites over the same area, as summarized by Loughlin *et al.* (1984). It was concurrent with the advent of more systematic aerial surveys that population declines were first observed. Declines of at least 50 percent were documented from 1957 to 1977 in the eastern Aleutian Islands, the center of what now is the western population (Braham *et al.*1980). Merrick *et al.* (1987) estimated a population decline of about 50 percent from the late 1950s to 1985 over a much larger geographical area, the central GOA through the central Aleutian Islands, based on a patchwork of regional counts and surveys (Figure 3.8-2). The population in the GOA and Aleutian Islands declined by an additional 50 percent from 1985 to 1989, resulting in an overall decline of about 70 percent from 1960 to 1989 (Loughlin *et al.* 1992).

The decline of the western population has been apparent in all regions, although not at the same rate. The decline was first observed in the eastern Aleutian Islands (Braham *et al.* 1980). During subsequent years the decline was noted in adjacent regions in the Aleutian Islands and GOA (Merrick *et al.* 1987). In the eastern Aleutian Islands, the rate of decline decreased and by 1989 or 1990 the population there appeared to stabilize, but at very low levels. Since 1975 throughout the entire range of the western population there has been a steady rate of decline of at least 6 percent a year, with an additional drop of about 8.7 percent per year during the late 1980s when the population from the Kenai Peninsula to Kiska Island in the central Aleutian Islands declined at about 15.6 percent per year (York *et al.* 1996). Other regions have demonstrated short periods of stability within a general declining trend. With the exception of the differentiation between the eastern and western populations, however, these regional boundaries are not based on ecological or other biological parameters, and differences in regional trends should be interpreted with caution.

Much of the population trend analyses during recent years has focused on trend sites as designated by the Steller Sea Lion Recovery Team (NMFS 1992, NMFS 1995b). Trend sites are those rookeries and haul-out sites surveyed consistently from the mid 1980s to the present, thus allowing analysis of population trends on a decadal scale. Trend sites include about 75 percent of animals observed in recent surveys (Strick *et al.* 1997, Sease *et al.* 1999, Sease and Loughlin 1999, Sease *et al.* 2001, Sease and Gudmundson 2002). During the 1990s, the average annual rate of decline was consistently around 5 percent (Strick *et al.* 1997, Sease *et al.* 1999, Sease and Loughlin 1999, Sease *et al.* 2001) (Figure 3.8-3). Recent surveys at 84 trend sites have shown the first region-wide increase in the last two decades. Between 2000 and 2002, non-pup abundance increased by 5.5 percent (Sease 2002, Sease and Gudmundson 2002). A similar trend was documented within the Kenai-to-Kiska subareas , an index count area of 70 sites between the Kenai Peninsula and Kiska Island, near the western end of the Aleutian Island which showed an increase of 4.8 percent from 2000 to 2002. However, the long-term trend was still a decline of 3.1 percent per year from 1991 to 2002 and an overall decrease of 26 percent from 1991 to 2002 (Loughlin and York 2000, Sease 2002, Sease and Gudmundson 2002).

Although numbers of non-pups increased in five of the six western population sub-regions from 2000 to 2002, these changes involve only a few hundred animals. The western Aleutian Islands region continued to decline by 24 percent from 2000 to 2002 following a 44 percent decline from 1998 to 2000. The overall decline in the western Aleutian Islands was 75 percent from 1991 to 2002 (Sease and Gudmundson 2002).

In most years, pups within the western population in Alaska have been counted only at selected rookeries and on an alternating schedule to minimize potential cumulative effects of disturbance. Range-wide survey efforts included pup counts at virtually all western population rookeries in Alaska in 1998, and all except the Near Islands in the western Aleutian Islands in 1994 (Strick *et al.* 1997, Sease and Loughlin 1999). The composite pup count for 2001 and 2002 for the western population, which includes counts from 24 rookeries in 2002 and seven in 2001, showed continuing decline in pup production. The area with the longest series of region-wide pup counts is the Kenai-to Kiska index area. In this area, 2002 numbers were down 7.8 percent from 1998, 24 percent from 1994, and 42.4 percent from 1990 to 1991. Pup counts increased in only one region (5.5 percent in the western GOA) from 1998 to 2002, but declined in the five other regions. The western Aleutian Islands experienced the largest decline in pup abundance (39 percent) from 1998 to 2002 (Sease and Gudmundson 2002).

The most recent comprehensive census of the U.S. portion of the western population of Steller sea lions was conducted in 1998 and 1999. Combining pup counts (9,373) and non-pup counts (26,658) with an estimate for unsurveyed sites (757) resulted in a minimum abundance estimate of 38,788 sea lions for the U.S. portion of the western population in 1998 (Angliss and Lodge 2002). The June 2002 survey of all surveyed sites for the western population resulted in a total count of 26,602 non-pup sea lions. Combining pup counts from 2001 (3,927) and 2002 (5,650) and non-pup counts from 2002 resulted in a minimum abundance of 36,179 sea lions for the western population in 2002 (Sease and Gundmundson 2002). These estimates are considered minimums because they do not account for animals that may have been at sea during the counts.

For the Russian and Japanese portion of the western population of Steller sea lions, recent and historic counts in the Russian Federation indicate that the present number of animals is about one-third of historic levels (NMFS 1992). In some instances, the decrease in numbers has been accompanied by complete disappearance of rookeries (Perlov 1991). Numbers of adults and juvenile sea lions at major rookeries and haulouts in the Kuril Islands declined 74 percent, from 14,076 in 1969 to 3,615 in 1989 (Merrick *et al.* 1990). Most of the decline occurred between 1969 and 1974. The numbers since 1974 appear to have remained relatively stable. Pup numbers have declined 60 percent, from 3,673 in 1963 to 1,476 in 1989. Based on 1989 counts, Burkanov *et al.* (1991) estimated that the total number of sea lions, including those on haulouts, rookeries and those observed swimming in the water near the site at the time of the survey, along the Kamchatka Peninsula and Commander Island was between 3,500 and 3,800. Estimates for this region between 1982 and1985 were 1.6 to 3.5 times larger. This decline is similar to what has occurred in the U.S. portion of the western population in the Bering Sea, and is thought likely to continue (Perlov 1991). There are about 2,000 sea lions on a few small islands in the Sea of Okhotsh, where numbers are reduced from previous levels, but stable (Perlov 1991).

Eastern Distinct Population Segment of Steller Sea Lions

The earliest abundance estimate for what is now known as the eastern population of Steller sea lions is derived from surveys conducted in southeast Alaska in 1996 (10,907 non-pups and 3,714 pups for a total of 14,621 sea lions), British Columbia in 1994 (8,091 non-pups and 1,186 pups for a total of 9,277 sea lions), and the combined coasts of Washington, Oregon, and California in 1996 (5,464 non-pups and 1,091 pups for a total of 6,555 sea lions). The total of these 1994 to 1996 counts was 30,453 sea lions in the eastern population, which is considered a minimum estimate because there was no correction for animals that may have been at sea during the surveys (Angliss *et al.* 2001). In the southeast Alaska part of the range alone, surveys conducted in 1998 and 2000 yielded a minimum estimate of 12,417 non-pups and 4,257 pups for a total of 16,674 sea lions.

Loughlin *et al.* (1992) described southeast Alaska as the only region of Alaska in which the Steller sea lion population appeared to be stable in 1989. Based on a series of counts at index, or "trend", sites, the numbers of non-pup sea lions (adults and juveniles combined) in southeast Alaska increased by an average of 3.5 percent to 4.0 percent per year from 1985 to 1989 for an overall increase of about 16 percent. Calkins *et al.* (1999) estimated that the Steller sea lion population in southeast Alaska increased by an average of 5.9 percent per year from 1979 to 1997, based on pup counts at the three rookeries in the region. The increase was lower than the average over the longer time period. From 1989 to 1997, pup numbers increased by only 1.7 percent and counts of non-pups at 12 index sites were stable (average change of +0.5 percent per year). The Steller Sea Lion Recovery Team employed a different set of index sites for monitoring population status (NMFS 1992, NMFS 1995b). Counts of non-pup sea lions at these three rookeries and ten haulout trend sites showed an overall increase of 29.3 percent from 1990 to 2000, or an average annual increase of 1.9 percent (Sease *et al.* 2001). Pup counts in 2002 suggest that numbers of pups in southeast Alaska increased by about 11 percent from 1998 to 2002, consistent with the average rate of about 3 percent per year over the last decade (Sease and Gudmundson 2002). Despite differences in individual index sites or model type (e.g., based on counts of pups versus non-pups), the conclusion is that numbers of Steller sea lions in southeast Alaska are stable or increasing.

Steller sea lions in southeast Alaska are not an isolated population, as demonstrated by genetic data and by the movement of branded and tagged animals from southeast Alaska to British Columbia and Washington (Raum-Suryan *et al.* 2002). The number of non-pup sea lions in British Columbia is similar to southeast Alaska, and increased by about 2.5 percent per year during the last decade (Figure 3.8-4). Pup numbers in British Columbia have increased by about 1.5 percent per year during the same time (personal communication from P. Olesiuk, Pacific Biological Laboratory, Nanaimo, British Columbia). Counts of Steller sea lions in Oregon and northern California have been stable during recent decades at about a third as many animals as in either British Columbia or southeast Alaska. Counts of non-pups and pups in central and southern California have been low and decreasing at about 4.5 percent to 5.0 percent per year since 1982 or as much as 10 percent per year since 1990 (NMFS 1995b, Calkins *et al.* 1999, Ferrero *et al.* 2000, Angliss *et al.* 2001). Despite the observed declines in southern and central California, the eastern population as a whole is stable or increasing.

Trophic Interactions

In the BSAI and GOA, the Steller sea lion diet consists of a variety of schooling fishes (e.g., pollock, Atka mackerel, Pacific cod, flatfish, sculpin, capelin, Pacific sand lance, rockfish, Pacific herring, and salmon), as well as cephalopods, such as octopus and squid (Calkins and Goodwin 1988, Lowry *et al.* 1982, Merrick and Calkins 1995, Perez 1990). An analysis of 1990 to 1998 trends in prey consumption across the western population showed pollock and Atka mackerel as the two dominant prey species, followed by Pacific salmon and Pacific cod (Sinclair and Zeppelin 2002). Other primary prey species consistently occurring in Steller sea lion scats at frequencies > 5 percent include arrowtooth flounder, Pacific herring, Pacific sand lance, Irish lord, squid, and octopus (Sinclair and Zeppelin 2002). Steller sea lion prey varies in adult body size. Pollock and Atka mackerel, for instance, range in body length from approximately 10 to 70 cm. (Zeppelin *et al.* in press). The most recent diet study of the western population (Sinclair and Zeppelin 2002) indicates that prey remains in scat are primarily from late stage juvenile to adult size fish. Seasonal and regional patterns in prey consumption by western population Steller sea lions indicate that they target prey which are densely schooled in spawning aggregations nearshore, over or near the continental shelf, or along oceanographic boundaries (Sinclair and Zeppelin 2002).

Merrick *et al.* (1997) documented Steller sea lion consumption from scat samples throughout their range and identified seven prey categories in the GOA: 66.5 percent are gadids (pollock, Pacific cod, Pacific hake, and unidentified gadids), 20.3 percent are Pacific salmon, 6.1 percent are small schooling fish, 3.9 percent are flatfish, 2.9 percent are squid or octopus, and 0.3 percent are Atka mackerel. Merrick and Calkins (1996) determined 70 percent of the stomachs collected from animals in the GOA during the 1970s and 1980s also contained gadids.

Recent analyses of fecal samples collected on Steller sea lion haulouts and rookeries suggest that Atka mackerel is particularly important for Steller sea lions in the central and western Aleutian Islands. Over 70 percent of the animals' summer diet in this area is Atka mackerel. Pollock represents over 60 percent of the diet in the central GOA, 29 percent in the western GOA and eastern Aleutian Islands, and over 35 percent in parts of the central Aleutian Islands (Merrick and Calkins 1995). Small pollock (less than 20 cm) appear to be more commonly eaten by juvenile sea lions than older animals (Merrick and Calkins 1995). Pollock are also a major prey species in southeast Alaska where the population has showed an increase over the last ten years (Winship and Trites 2002).

The most recent analysis of Steller sea lion diet compares trends in prey species consumption among seasons and areas with different rates of sea lion decline (Sinclair and Zeppelin 2002, Winship and Trites 2002). Regions of diet similarity closely correspond to the Steller sea lion metapopulations defined by York *et al.* (1996), suggesting that diet differences and population trends of Steller sea lions are linked. Overall, where population trends are most positive, diet diversity is highest but more supporting data is needed to draw firm conclusions. Recent data from more intensive sampling at rookeries and haulouts suggest sea lions have a much more diverse diet than previously thought (Wynne, unpublished). Regional diet patterns generally reflect regional foraging strategies learned at or near the natal rookery site, with sea lions concentrating on seasonally dense prey patches characteristic of that area (Sinclair and Zeppelin 2002).

Steller sea lion foraging distribution is inferred from at-sea sightings or observations of presumed foraging behavior (Fiscus and Baines 1966, Kajimura and Loughlin 1988, NMML unpublished data[a] from the Platform of Opportunity Program [POP]), records of incidental take in fisheries (Perez and Loughlin 1991), and satellite telemetry studies (Merrick *et al.* 1994, Merrick and Loughlin 1997). Three foraging areas were designated as critical habitat for Steller sea lions based on observations and incidental takes in the vicinity of Seguam Pass, the southeastern Bering Sea, and Shelikof Strait (Loughlin and Nelson 1986, Perez and Loughlin 1991).

The value of a given area for foraging sea lions depends not only on the nutritive quality of the prey available but also on the energetic effort required to obtain that prey. Foraging efficiency, as a function of net energy gain, thus depends in part on how far sea lions must travel, how deep they must dive, and how much time they must spend to catch prey. These parameters have been and continue to be studied with satellite telemetry techniques. The NMFS Alaska Ecosystem program and the ADF&G Steller sea lion research program collaborated to produce a "white paper" on the use of satellite telemetry to study Steller sea lion movements and foraging behavior (ADF&G and NMFS 2001). The limitations of this data and its use in establishing protective measures for sea lions is described in the Steller sea lion protection measures FEIS and the associated BiOp (NMFS 2001b and NMFS 2001c). NOAA Fisheries has completed a supplement to the 2001 BiOp which presents recent telemetry data, how that scientific information was interpreted with relation to foraging needs of Steller sea lions, and its relevance to the efficacy of sea lion protection measures (NMFS 2003). These telemetry studies suggest that foraging distributions vary by individual, size, age, season, site, and reproductive status (Merrick and Loughlin 1997, ADF&G and NMFS 2001, Loughlin *et al.* 2003).

Compared to other pinnipeds, Steller sea lions tend to make relatively shallow dives, with few dives recorded to depths greater than 250 m. Foraging patterns of adult females differ during summer months when females are with pups versus winter periods when considerable individual variation has been observed. Trip duration (the period between haulouts) for females with young pups in summer is approximately 18 to 20 hours. Dives are typically shallow (mean = 21 m), of short duration (mean = 1.4 min), and frequent (mean = 13/h). Trip length averages 17 km, and sea lions dive approximately 4.7 hours per day. In winter, females with young of the year (5 to 10 months of age) have trips averaging almost one day in duration while females with yearlings (17 to 22 months of age) had trips averaging 2.3 days (Loughlin *et al.* 2003). During winter, mean trip length is about 130 km, and dives total about 5.3 hours per day (Merrick and Loughlin 1997). In winter, yearling sea lions' foraging trips average 30 km in distance and 15 hours in duration, with less effort devoted to diving than adult females during their trips (mean of 1.9 hours per day). Estimated home ranges are 320 km^2 for adult females in summer, about 47,600 km^2 (with large variation) for adult females in winter, and 9,200 km^2 for yearlings in winter (Merrick and Loughlin 1997).

Recent telemetry studies have examined the movement patterns of immature sea lions (6 - 22 months of age) whose survival rate is considered an important component in the Steller sea lion decline (Loughlin *et al.* 2003). Young-of-the-year sea lions (6 to 12 months of age) had dives that were more brief in duration and more shallow than yearlings (13 to 22 months of age). The length of trips taken by sea lions less than 10 months of age was much shorter than trips taken by older juveniles (means = 7.0 km and 24.6 km respectively). The length of foraging trips, dive characteristics, and depth of dives, began to increase substantially after 9 months of age, corresponding with the presumed age of weaning (Loughlin *et al.* 2003). This study also compared the diving characteristics of sea lions from Washington with those from Alaska and found that the Washington animals spent more time diving and dove deeper than Alaska sea lions. These differences were attributed to localized differences in where their prey are concentrated (Loughlin *et al.* 2003). The recent telemetry data suggests that the areas of highest use are within 0 to 10 nm of rookeries and haulouts. However, both older juveniles and adult females may utilize the 10 to 20 nm zone of critical habitat to a greater extent in the winter. NOAA Fisheries concluded that the 0 to 10 nm zone was of "high" concern from potential overlap with fisheries, the 10 to 20 nm zone was "low to moderate", and beyond 20 nm was of "low" concern (NMFS 2003).

A brief review of predation on Steller sea lions by killer whales was presented in the 2000 BSAI and GOA FMP groundfish BiOp (NMFS 2000a).

Based on stomach contents of six stranded killer whales and feeding habit studies in PWS and British Columbia, sea lions were estimated to comprise 5 to 20 percent of transient killer whale diet in these areas (Matkin *et al.* 2001). In a study dedicated to tracking killer whales in PWS between 1984 and 1996, of the 31 documented marine mammal kills by transient killer whales, none were Steller sea lions (Saulitas *et al.* 2000). In the northern GOA, only 9 of the 49 known or suspected transient killer whales in the area have been observed to prey on or harass sea lions (Matkin *et al.* 2003). This may indicate that there is some predatory specialization among transient killer whales, with only a portion of transient killer whales attempting to capture sea lions (Matkin *et al.* 2003). Based on surveys of researchers, fishermen, tour boat operators and others, killer whale predation on sea lions may occur more frequently in the Aleutian Islands compared to other parts of Alaska (Barrett-Lennard *et al.* 1995).

The decline of the western population of Steller sea lions has prompted researchers to explore whether killer whale predation has played a major or minor role in the decline. Estimates vary in how many transient killer whales regularly hunt in the BSAI/GOA and how many sea lions they might eat. According to NOAA Fisheries latest marine mammal stock assessment (Angliss and Lodge 2002), preliminary photographic and genetic data indicate that there are approximately 86 transient killer whales in the range of the western population of Steller sea lions (PWS, GOA, and western Alaska). Matkin et al. (2001) give a conservative estimate of 125 to 175 transients in the same area, although they acknowledge that there has been little photographic research conducted in the western Aleutians. These authors calculate a range of predation rates on sea lions and conclude that killer whale predation was insufficient to cause the historical decline of sea lions but may be an important factor in limiting their recovery (Matkin *et al.* 2001, Matkin *et al.* 2003).

In contrast, a recent paper estimates that there are many more killer whales than previously believed, including at least 272 transients in the Aleutian archipelago alone, and that killer whale predation could be more than ten times the level necessary to cause the historic Steller sea lion population decline (Springer *et al.* 2003). According to this top-down hypothesis, killer whales may have been forced to eat more pinnipeds and sea otters after their preferred prey, great whales, were decimated by post-World War II industrial whaling. Although additional research is needed to corroborate their population estimates and dietary assumptions, these authors conclude that killer whale predation may be responsible for the population declines not only of Steller sea lions, but of harbor seals, northern fur seals, and sea otters in the Aleutians (Springer *et al.* 2003).

One complication for all top-down hypotheses that seek to explain the decline of the western population of Steller sea lions is the need to compare and reconcile the proposed mechanisms with the increasing population trend of the eastern population of Steller sea lions. If increased killer whale predation (or any other top-down mechanism) has contributed to a massive collapse of the western population, what is the mechanism that prevented the same thing from happening with the smaller eastern population of Steller sea lions? There are many transient killer whales in the range of the eastern population of Steller sea lions (219 transients, Angliss and Lodge 2002) and they appear to make up a much higher percentage of all killer whales (35 percent) than in western Alaska waters (7 to 12 percent) (Matkin *et al.* 2001, Springer *et al.* 2003). It is currently not known whether western Alaska transient killer whales are taking a much higher percentage of sea lions in their diet than whales in the eastern portion of their range. Unfortunately, data on transient killer whale diet is very limited and difficult to obtain. Therefore, comparisons among different geographic locations are problematic. Additional research on population size and feeding behavior is needed to determine the contribution of killer whale predation to the decline and recovery of Steller sea lion populations.

Attacks by great white sharks have been documented on sea lions at the southern end of their range in California (Ainley *et al.* 1985). Though Alaska waters are north of the normal range of white sharks, sleeper sharks (*Somniosus pacificus*) range throughout the GOA and Bering Sea, and small marine mammals have been documented in sleeper shark stomach contents (Yang and Page 1999). However, no remains of Steller sea lions were found in 13 sleeper shark stomachs collected in the GOA between June and August 1996 in areas near active sea lion rookeries and haulout sites (Yang and Page 1999). In a recent study of sleeper sharks, a total of 198 sleeper shark stomach contents were analyzed from sharks taken near rookeries, and preliminary analysis found no direct evidence of sea lion parts (Hulbert *et al.* 2002).

Management Overview

Steller sea lions are under the management jurisdiction of NOAA Fisheries, Protected Resource Division, as established by the MMPA of 1972. In November 1990, NOAA Fisheries listed Steller sea lions as "threatened" range-wide under the U.S. ESA (55 FR 49204). In 1997, two populations were formally recognized (Bickham *et al.* 1996, Loughlin 1997). The western population, which occurs from 144°W (approximately at Cape Suckling) westward to Russia and Japan, was listed as "endangered" in June 1997 (62 FR 24345). The eastern population, which occurs from southeast Alaska southward to California, remains classified as threatened. Aquatic critical habitat for the western population of the Steller sea lion was designated in 1993 (50 CFR 226.202) and consists of the areas within 20 nm (37 km) of designated rookeries and haulouts and key foraging areas in the Bogoslof District, Seguam Pass, and Shelikof Strait. Designated aquatic critical habitat for the eastern population of the Steller sea lion consists of the areas within 3,000 ft (0.9 km) of designated rookeries and haulouts. Terrestrial critical habitat for both populations consists of areas landward within 3,000 ft (0.9 km) of designated rookeries and haulouts.

Critical habitat designation does not automatically preclude particular activities, such as commercial fishing, but it defines areas that are important to the continued survival and recovery of ESA-listed species. The ESA (Section 7) requires the responsible agency, in this case NOAA Fisheries PRD, to assess whether proposed activities in the range of ESA-listed species would jeopardize the continued existence or recovery of the species or adversely modify its critical habitat. These assessments are made for all federally funded or managed activities that might impact the listed species and the resulting document is called a BiOp. NOAA Fisheries has issued many BiOps regarding the BSAI and GOA groundfish fisheries since 1991. The history of these plans and a summary of their respective findings is detailed in Appendix B and Appendix F-4 of this document.

Under the direction of NPFMC, NOAA Fisheries Office of Sustainable Fisheries has implemented many management measures to protect Steller sea lions and their foraging habitat. These measures are described in Appendix F-4 of this document. The following are examples of the types of management measures that have been taken but are not meant to be comprehensive.

In 1990, coincident with the ESA listing, NOAA Fisheries: 1) prohibited entry within 3 nm of listed Steller sea lion rookeries west of 150°W; 2) prohibited shooting at or near Steller sea lions; and 3) reduced the allowable level of take incidental to commercial fisheries in Alaskan waters (50 CFR 227.12) (Fritz *et al.* 1995). The 1991 to 1995 period saw broad implementation of fishery area and time closures to protect Steller sea lions. Measures taken in this time period to protect Steller sea lions were the first pervasive restrictions on the operations of the fishing fleet. Trawling was prohibited in the BSAI within 10 nm of 37 Steller sea lion rookeries year-round and within 20 nm of five rookeries during the pollock A season (January 20 to April 15). Similar closures were instituted in the GOA. To reduce competition for prey, the pollock TAC was spread over three areas, and limits were placed on the amount of excess pollock that could be taken in a quarter. These groundfish fishery management measures were designed to spread the harvests out over time and space to avoid potential localized depletion of prey for sea lions, and to greatly reduce the amount of harvest from areas designated as critical habitat for Steller sea lions. Additional rookeries and haulout areas were closed to certain types of fishing and the entire Bogoslof and Aleutian Islands management areas were closed to pollock fishing. In 1998, the Atka mackerel fishery in the Aleutian Islands was modified to restrict removals from inside critical habitat, seasonal apportionments were established, and the Aleutian

Islands were closed to pollock trawling. In June 1999, the NPFMC developed a set of measures to protect Steller sea lions and avoid jeopardy and adverse modification under the ESA and implemented these measures. The measures were subsequently challenged in court and were revised. The final set of measures was accepted by the courts and implemented for the following season.

Groundfish fisheries for pollock, Pacific cod and Atka mackerel in the BSAI and GOA presently operate under a suite of restrictions on where, when, and how fish can be taken. Many of these restrictions were imposed to protect Steller sea lions. The most recent BiOp was issued in October 2001 (NMFS 2001c), with a supplement to the BiOp published in June 2003 (NMFS 2003). In conjunction with that BiOp, a series of Steller sea lion protection measures were developed by NPFMC to protect the Steller sea lion from effects of the groundfish fisheries. These protection measures were analyzed in a separate EIS (NMFS 2001b). The NPFMC adopted a preferred alternative and the Steller sea lion protective measures were implemented by emergency rule in January, 2002 (67 FR 956).

Steller sea lions prey on a variety of species and sizes of fish, some of which, such as members of the families of Osmeridae (smelt), Myctophidae (lanternfish) and Clupeidae (Pacific herring), are considered "forage fish" and are not targeted by the groundfish fisheries. Forage fish are thought to be important for certain individuals (i.e., juvenile sea lions) at particular times and places. As part of their efforts to protect the food supplies of sea lions and the ecosystem needs of other species, NPFMC adopted Amendment 36 to the BSAI FMP and Amendment 39 to the GOA FMP in April 1997 to prevent the development of commercial fisheries for forage fish. NOAA Fisheries published the final rule implementing the regulations on March 17, 1998 (63 FR 13009).

Under the 1994 reauthorization of the MMPA, direct human-related mortality is monitored using a formula for the PBR to calculate the maximum number of individuals that can theoretically be taken without adversely affecting the population. Values for PBR have been calculated for both populations of Steller sea lions in Alaska based on the latest minimum population estimates. For the western population, PBR is 208 Steller sea lions per year. For the eastern population, PBR is 1,396 Steller sea lions per year (Angliss and Lodge 2002). These calculations take into account the different status of the populations under the ESA. Any population that is listed under the ESA is automatically considered to be a depleted and strategic stock under the MMPA.

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Little information is available on the fluctuations of Steller sea lion population prior to the 1960s, but it is suspected that decreases in population numbers were likely due to human exploitation (NRC 1996). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). It is likely that historic commercial harvests also have had residual effects on the present day population-levels of Steller sea lions in certain areas. However, a drastic decline in Steller sea lion numbers has still occurred in some North Pacific regions since commercial hunting was prohibited in 1972 by the MMPA.

The Steller sea lion has been harvested for subsistence purposes throughout history by the indigenous people of the Bering Sea, Aleutian Islands, and GOA regions. Current harvest is primarily in communities within the range of the western population. The eastern population is subject to an average of only two Steller sea lions taken per year from southeast Alaska (1992 through 1997) (Angliss and Lodge 2002). Of those sea lions taken from the western population, most are harvested in the Pribilof Islands. Subsistence take of Steller sea lions during the 1993 to 1995 period was estimated to average 412 animals annually (Angliss and Lodge 2002). Estimates of the total number of Steller sea lions taken (harvested plus struck and lost) declined over the six year period from 1992 to 1998 from 549 to 171 per year (Angliss and Lodge 2002), with an overall mean annual take of 329 sea lions for the entire period. In 2001, subsistence harvest of Steller sea lions was estimated to be 198 individuals (Wolfe *et al.* 2002). This is very close to the calculated value of PBR of 208 for this population (Angliss and Lodge 2002).

Based on a published life table and the current rate of decline, Loughlin and York (2000) estimate the total number of mortalities of non-pup Steller sea lions in 2000 was about 6,425 animals; of those, 4,710 (73 percent) were mortalities that would have occurred if the population were stable, and 1,715 (27 percent) were additional mortalities that fueled the decline. Loughlin and York (2000) classified 438 anthropogenic mortalities and 779 anthropogenic plus some predation mortalities as "mortality above replacement"; this accounted for 25 percent and 45 percent of the estimated total level of "mortality above replacement." The remaining mortality (75 percent and 55 percent, respectively) was not attributed to a specific cause and may be the result of nutritional stress.

Direct Mortality from Incidental Take in External Fisheries

It was not until after the 1950s that large numbers of Steller sea lions were taken in the commercial fisheries in the Alaska region (Alverson 1992). The take of Steller sea lions was substantial after this time with over 20,000 animals believed to have been incidentally killed in the foreign and JV groundfish fisheries from 1966 to 1988, although data from this period is not complete (Perez and Loughlin 1991). Based on telemetry data indicating that sea lions from the western population rarely leave the waters of the U.S. EEZ and on the minimal amount of international net fisheries in nearby waters, NOAA Fisheries has concluded that the current amount of sea lion incidental take from international fisheries is likely to be insignificant (Angliss and Lodge 2002).

Steller sea lions are incidentally taken by commercial fisheries other than groundfish fisheries, including some state-managed nearshore salmon gillnet fisheries and halibut longline fisheries. Based on observer data from 1990 to 1991, an estimated 14.5 sea lions were incidentally taken each year in the PWS drift gillnet fisheries (Wynne *et al.* 1992). Very few state-managed fisheries have been monitored with independent observers but fisherman are required to report incidental takes of all marine mammals. Based on incomplete records of self-reported salmon and longline fisheries, the minimum estimated average take is 5.4 sea lions per year. This is considered to be a minimum estimate because self-reported take data is considered unreliable and negatively biased (Wynne *et al.* 1992).

Direct Mortality from Incidental Take in Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the BSAI and GOA groundfish trawl, longline, and pot fisheries during 1990-2000. Steller sea lions were observed to be taken in the BSAI and GOA trawl fisheries and in the GOA longline fisheries. No incidental takes were observed in the pot fisheries or in the BSAI longline fishery (Angliss and Lodge 2002). In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 per year in the early 1990s to an average of 7.8 sea lions per year from 1996-2000. Sea lion takes occur less often in the GOA, with an average of 0.6 animals taken per year in the trawl fishery and 1.2 per year in the longline fishery (1996-2000) (Angliss and Lodge 2002). The combined incidental take from BSAI and GOA groundfish fisheries is thus 9.4 sea lions per year based on observer data from 1996-2000.

Direct Mortality from Illegal Shooting

Intentional shooting of Steller sea lions, other than in subsistence hunts, became illegal after the species was listed as threatened under the ESA in 1990. It is thought that shooting used to be a significant source of mortality prior to that time. It is possible that intentional shooting could have contributed to the steep decline in the late 1980s but this is largely speculative. NOAA Fisheries Alaska Enforcement Division has successfully prosecuted two cases of illegal shooting involving four sea lions from the eastern population (Angliss *et al.* 2001). It is not known whether, and to what extent, illegal shooting continues in either population.

Indirect Effects through Changes in Prey Availability

Key prey species of Steller sea lions include species that are targeted or taken as bycatch by the BSAI and GOA groundfish fisheries and parallel fisheries in state waters. This was also true for past foreign and JV groundfish fisheries, and there is partial overlap with other state-managed fisheries. NOAA Fisheries issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat. The NMFS 2001 EIS and BiOp (NMFS 2001b and 2001c) explores this subject indepth.

Although the factors and mechanisms for the decline of the western population of Steller sea lions have been, and continue to be, the subject of intensive research, it is generally thought that the decline is due to a combination of nutritional stress from climate-induced or fisheries-related declines in prey abundance or availability (bottom-up hypotheses), or resulting from human-related mortality and predation (top-down hypotheses) (NRC 1996, NMFS 2001b and 2001c, NRC 2001). The causes of the decline of the western population of Steller sea lion are not clearly understood, and experts agree that these causes have probably changed over time (DeMaster *et al.* 2001, Loughlin and York 2000). Reasons for the steep decline in the 1980s are thought to be related to different factors than those resulting in the more gradual declines during the 1990s (NRC 2001). The marked change in the rate and spatial extent of the decline over the past decade suggests that factors that contributed most strongly to the more rapid declines prior to the 1990s may not be the most significant factors operating today (Bowen *et al.* 2001). In addition to the direct taking of animals through commercial and subsistence harvests and interactions with fisheries, evidence from the 1970s and 1980s supports that sea lions were nutritionally stressed which, resulted in reductions in recruitment and reproductive rates in the first phase of the decline (DeMaster *et. al.* 2001). Hypotheses to explain the second phase or continued decline of the western population of Steller sea lions include potential nutritional stress due to competition with fisheries for prey and/or changes in the ocean environment due to climate change and an increase in the natural predation of Steller sea lions by sharks and killer whales. However, direct evidence for the nutritional stress hypothesis in the second phase of the decline is lacking (DeMaster *et al.* 2001).

It is believed that some of these factors such as nutritional stress may have acted most strongly against juveniles between the time they are weaned and when they are grown to adult size and foraging capability. Adult females may also be negatively affected by these factors because of the physiological stress and limited geographic mobility when caring for pups. Hence, mitigation efforts have focused on protecting the integrity of food supplies near rookeries and haulouts. It is important to realize that the key issue for the survival and reproductive success of sea lions is not the total amount of fish that are present, but how available they are to foraging sea lions. Major changes in the abundance and distribution of preferred prey species may lead to animals not being able to catch enough to eat and/or to spending more time foraging, thus exposing them to increased predation pressure from killer whales and sharks. Since NOAA Fisheries cannot control climate and oceanic changes, such as ENSO, or the behavior of killer whales, their management efforts are focused on human-caused adverse effects to Steller sea lions including fisheries that focus on important sea lion prey. The allocation of TAC among different seasons, areas, and gear types is the main thrust of these management efforts. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of sea lion protective measures.

Indirect Effects through Contamination by Oil Spills

Other human-controlled factors such as oil spills have had effects on Steller sea lions in past years. A number of Steller sea lion haulouts and rookery sites were affected by the EVOS in PWS in 1989, but insufficient data exists to determine the overall impact of the spill on the population.

Comparative Baseline

Steller sea lions were split into two separate populations in 1997 based on several factors, including major differences in their population trends. The western population was estimated to be approximately 185,000 Steller sea lions in the late 1970s but has declined precipitously to an estimated 34,595 animals in 2002 (Angliss and Lodge 2002). Surveys in 2002 indicated the first region-wide increase in population in over 20 years but it remains to be seen whether this positive trend will continue. The western population was listed as endangered under the ESA in 1997 so it is automatically considered a depleted and strategic stock under the MMPA. According to current estimates, incidental take from the BSAI and GOA groundfish fisheries and other fisheries (29) and subsistence harvest (198) exceeds the PBR (208) for this population (Angliss and Lodge 2002). The eastern population, in contrast, has been stable or increasing in most parts of its range. Current estimates place the eastern population abundance at a minimum of 30,453 sea lions (Angliss and Lodge 2002) but could be as high as 45,000, a historic high for this population (Pitcher *et al.* 2003). The eastern population is listed as threatened under the ESA. Subsistence and incidental take in this population is relatively small.

A great deal of effort has been expended on trying to understand the reasons that the western population declined at the same time that the eastern population grew. The effects of natural factors, such as climate and oceanographic fluctuations, as well as human-influenced factors, including commercial fishing, have been studied on their own and are increasingly studied as part of complex models. While research continues, fishery management efforts have focused on trying to minimize the spatial and temporal competition between the fisheries and sea lions, which have a very substantial overlap of preferred prey with species taken in the groundfish fisheries as both target species and non-target species taken as bycatch. The past/present effects on Steller sea lions are summarized in Table 3.8-1.

Status for Cumulative Effects Analysis

Because the eastern and western populations of Steller sea lions are listed as threatened and endangered, respectively, under the ESA, have very different population trends, and are subject to very different intensities of interaction with the groundfish fisheries, each population will be considered separately in the analysis of Alternative FMPs in Chapter 4.

3.8.2 Northern Fur Seal (*Callorhinus ursinus*)

Life History and Distribution

The northern fur seal ranges throughout the North Pacific Ocean from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan. The species is strongly sexually dimorphic, meaning that mature males and females look very different. Females weigh about 135 pounds (61 kg) and reach 4.5 ft (1.4 m) in length while males average about 600 pounds (270 kg) and reach 6 ft (1.8 m) in length (Burt and Grossenheider 1976). Northern fur seals have a highly polygynous mating system, breeding in dense colonies on islands located near highly productive marine areas (Gentry 1998). Breeding is restricted to only a few sites: the Pribilof Islands (where 74 percent of the population breeds), Commander Islands (Russia), Bogoslof Island, and San Miguel Island (California) (Gentry 1998, Angliss *et al.* 2001).

The northern fur seal breeding cycle is highly stable, with adult males arriving on land during May and June to establish territories at traditional breeding areas (Bigg 1986). Females and juvenile males arrive on the breeding islands in late June through August with arrival times occurring progressively earlier as seals increase in age. Northern fur seals exhibit strong site fidelity and philopatry (Baker *et al.* 1995, Gentry 1998). The tendency to return to land at the natal area increases with age for both juvenile male and female northern fur seals (Baker *et al.* 1995). Female northern fur seals give birth to a single pup within 1 to 2 days after arrival on land and mate within 4 to 7 days after parturition (Bartholomew and Hoel 1953). Northern fur seal females undergo a period of delayed implantation characteristic of all pinnipeds (Boyd 1993); the embryo does not implant in the uterus and begin to develop until late November (York and Scheffer 1997). Approximately 7 to 8 days after giving birth, lactating females begin a series of foraging trips to sea alternating with 1 to 2 days on land to nurse their pups (Gentry *et al.* 1986). Pups are weaned in October and November, at about 125 days of age, and go to sea soon afterward (Gentry and Kooyman 1986).

Most females, pups, and juveniles leave the Bering Sea by late November and are pelagic in the North Pacific Ocean during the late fall and winter, migrating south as far as Southern California in the eastern North Pacific and Japan in the western North Pacific, until they begin returning to the rookeries in March (Bartholomew and Hoel 1953). In 1989 through 1990, radio-tagged pups departed St. Paul Island in mid-November and entered the North Pacific Ocean through the Aleutian Islands from Samalga Pass to Unimak Pass an average of 10 to 11 days later (Ragen *et al.* 1995). Of four fur seal pups tracked by satellite during 1996, two pups left the Bering Sea after 10 and 13 days, while two other pups traveled northwest of St. Paul Island and remained in the Bering Sea for 50 and 68 days until late January (D. DeMaster, AFSC, personal communication.). Adult males appear to migrate only as far south as the GOA and Kuril Islands (Kajimura and Fowler 1984, Loughlin *et al.* 1999).

Two separate stocks of northern fur seals are recognized within U.S. waters: an eastern Pacific stock, which includes all the animals in the BSAI and GOA, and a San Miguel Island (California) stock. Population estimates for the eastern Pacific stock are calculated by estimating the number of pups at rookeries and then multiplying by an expansion factor (4.5) that approximates a life table analysis (Angliss and Lodge 2002). Since 1990, pup counts have been made every other year on St. Paul and St. George Islands, but less frequently on Sea Lion Rock (a small reef just off St. Paul Island) and Bogoslof Island. Based on pup counts made during 2000, the most recent estimate of the number of fur seals in the eastern Pacific stock is 941,756 (Angliss and Lodge 2002).

Population Trends

Until the mid-1970s, northern fur seal population trends could be explained largely by commercial harvest patterns in the NPO. Large population declines coincided with large harvests of female and juvenile fur seals. The fur seal population has shown a resiliency to sustained harvests of adult males when females and juveniles were not harvested. The history of pelagic sealing (1875 - 1909), its impact on the fur seal population, and a subsequent treaty banning pelagic sealing is found in Gentry (1998). At the peak of pelagic sealing (1891 to 1900), more than 42,000 fur seals (mostly lactating females) were taken annually in the Bering Sea (Scheffer *et al.* 1984). Because the takes were greatly reducing the fur seal stock, Great Britain (for Canada), Japan, Russia, and the United States ratified the Treaty for the Preservation and Protection of Fur Seals and Sea Otters in 1911. With the signing the treaty, commercial pelagic harvests ended.

The population grew rapidly after the cessation of pelagic sealing until the mid 1940s. There was no commercial harvest from 1912 to 1917. From 1918 to about 1941, the Pribilof Island fur seal stock grew at eight percent per year under a land based harvest of males that ranged from 15,862 in 1923 to 95,016 in 1941 (NMML unpublished data[b]). The Alaska population of fur seals peaked at a high of approximately 2 million during the 1950s. In 1957, the signatories of the 1911 Treaty ratified a new agreement. During those negotiations, calculations presented by the U.S. suggested that maximum sustained productivity would occur at lower female population-levels than those of the early 1950s. Consistent with that analysis, from 1956 to 1968, a total of about 300,000 female fur seals were killed on the Pribilof Islands (York and Hartley 1981). Concurrently, 30,000 to 96,000 juvenile males were harvested each year and a pelagic collection of about 16,000 females was taken for research purposes by the United States and Canada. This harvest of females and juveniles caused a large population decline into the late 1960s.

With the cessation of female and juvenile harvests, the population increased only briefly into the mid-70s. The population then began a steady decline of 6 to 8 percent per year into the 1980s; the cause for this decline has not been determined. By 1983 the population was estimated to be 877,000 seals (Angliss *et al.* 2001). Annual pup production on St. Paul Island remained relatively stable between 1981 through 1998, indicating that the population had not changed very much. Since 1998, population estimates from pup surveys indicate that the population is declining at a rate of more than five percent per year. The cause for this decline is unknown.

Trophic Interactions

Studies on northern fur seal diets began with the work of Lucas (1899). The most extensive research was based on the pelagic sampling of over 18,000 fur seals between 1958 and 1974 (Perez and Bigg 1986). Of the fur seal stomachs collected, 7,373 contained food and an additional 3,326 had trace remains. Based on the frequency of occurrence, the diet consisted of 67 percent fish (34 percent pollock, 16 percent capelin, 6 percent Pacific herring, 4 percent deep-sea smelt and lantern fish, 2 percent salmon, 2 percent Atka mackerel, and no more than one percent eulachon, Pacific cod, rockfish, sablefish, sculpin, Pacific sand lance, flatfish, and other fish) and 33 percent squid (Perez 1990). These data showed marked seasonal and geographic variation in the species consumed. In the EBS, pollock, squid, and capelin accounted for about 70 percent of the energy intake. In contrast, sand lance, capelin, and herring were the most important prey in the GOA. However, no fur seal stomach samples have been collected following the decline in abundance of forage fish in the GOA after the regime shift in the mid 1970s.

One study of gastrointestinal contents of 73 northern fur seals collected from the Bering Sea in the early 1980s indicated that a positive correlation exists between pollock year-class strength and the frequency of pollock in fur seal diets (Sinclair *et al.* 1994). The same report concluded that northern fur seals are size-selective midwater feeders during the summer and fall in the eastern Bering Sea. Since 1987, studies of northern fur seal diets have been based on fecal samples (scat). A comparative study of fur seal diets based on the current method of scat analysis versus stomach content analysis from the 1980s collections demonstrated that the different methods yield very similar results (Sinclair *et al.* 1996). Based on diet studies conducted since the early pelagic collections (Sinclair *et al.* 1994, Sinclair *et al.* 1996, Antonelis *et al.* 1997), some prey items, such as capelin, have disappeared entirely from fur seal diets in the eastern Bering Sea and squid consumption has been markedly reduced. At the same time, pollock consumption has tripled and the age category of pollock eaten has decreased.

Recent studies have used bio-chemical methods to study the diet of northern fur seals. Kurle and Worthy (2000) used carbon and nitrogen isotope analysis of fur seal skin and whole prey to investigate the feeding ecology of female and juvenile male northern fur seals during the spring migration and of lactating female fur seals during the breeding season. Their results suggest that lactating females eat prey at trophic levels equivalent to 2 to 4 year-old walleye pollock and small Pacific herring during the fall. Nitrogen isotope ratios used to determine the trophic level of prey did not indicate a diet of juvenile pollock. During the northward spring migration, nitrogen isotope ratios indicated that the diet of both pregnant females and juvenile males consisted of prey at the same trophic level as capelin, herring, or adult pollock. Carbon isotope ratios suggested that migrating adult females fed in coastal areas while juvenile males and females were feeding further offshore. Using fatty acid signature analysis of fur seal milk to study the foraging patterns of lactating females on the Pribilof Islands, Goebel (2002) determined that prey of shallow-diving seals foraging off the continental shelf differs from shallow divers on-shelf, and that prey of deep diving females differs from both types of shallow divers. Milk of deep diving seals had fatty acid signatures most similar to fatty acid signatures of walleye pollock. The results of this study indicate that different dive patterns and foraging locations of lactating females likely result from exploitation of different prey resources. In waters over the continental shelf, adult walleye pollock are generally found near the bottom while juvenile pollock are usually concentrated in the surface layer above the thermocline (Bailey 1989) suggesting that the diet of deep diving fur seals in these areas includes adult pollock.

Management Overview

Northern fur seals are managed by NOAA Fisheries and by co-management agreements with Alaska Native Organizations under Section 119 of the MMPA. Northern fur seals were listed as depleted under the MMPA in 1988 because population-levels had declined to less than 50 percent of those observed in the late 1950s (NMFS 1993a). The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives.

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Commercial harvest of fur seals were a major source of human-induced mortality for over 200 years and the abundance of fur seals fluctuated greatly in the past, largely due to this commercial harvest (NMFS 1993a). Commercial harvest of fur seals peaked in 1961 with over 126,000 animals, but was halted in 1985. Commercial harvests of females from 1956 through 1968 likely contributed to the decline of the population from the 1950s to the 1970s, and may have had lingering effects after it's cessation (York and Hartley 1981). The population increased slightly in the early 1970s, though, and declines since then are difficult to explain. At present, the PBR for this population is 17,138 animals per year (Angliss and Lodge 2002).

Alaska Natives are allowed to harvest fur seals for subsistence purposes, with a take range determined by annual household surveys. From 1986 to 1996, the average annual subsistence take was 1,605 from St. Paul and St. George. From 1995 to 2000 this average take dropped to 1,340 seals per year, which represents about 8 percent of PBR. Only juvenile males are taken in the subsistence hunt, which minimizes the impact of the hunt on population growth. Subsistence take in other areas besides the Pribilofs is known to occur, but is thought to be minimal (Angliss and Lodge 2002).

Intentional killing of fur seals by commercial fishermen, sport fishermen, and others likely occurs but the magnitude of this mortality is not known. Intentional take is illegal under the MMPA except for subsistence uses of Alaska Natives.

Direct Mortality from Incidental Take in External Fisheries

Incidental take of fur seals from the foreign and joint venture groundfish fisheries averaged 22 animals per year from 1978 to 1988 (Perez and Loughlin 1991). The high seas driftnet fisheries killed thousands of fur seals every year, including an estimated 5,200 fur seals in 1991, the last year before these fisheries were outlawed by United Nations Resolution (46/215) (Hill and DeMaster 1999). Illegal driftnet fishing apparently continues at low levels, but no quantitative information is available on incidental take.

Based on self-reported mortalities, state-managed salmon fisheries took an average of 15 fur seals per year from 1990 to 1998. Most of these mortalities came from the Bristol Bay salmon drift gillnet fishery. Self-reported data are considered negatively biased, so these results are taken as minimum estimates (Angliss *et al.* 2001).

Another mechanism for incidental take of fur seals is through entanglement with fishing gear, packing bands, and other debris lost or ejected from fishing vessels, shipping vessels, and shoreside sources. Some gear may continue to circulate in the environment for many years. The contribution of particular fisheries to this problem is not known. The numbers of animals entangled at sea that never make it back to land are not known, but this issue has been cited as making a significant contribution to the decline of the population in the 1970s and early 1980s (Fowler 1987). Surveys of fur seals on St. Paul indicated that the proportion of animals with debris wrapped around part of their bodies decreased from 0.4 percent in 1976 to 1985 to 0.2 percent in 1988 to 1992 and 1995 to 1997 (Angliss *et al.* 2001). Some efforts have been made by NOAA Fisheries and Pribilof Island villagers to capture and remove debris from fur seals, with over 100 seals treated each year from 1995 through 1997.

<u>Direct Mortality from Incidental Take by MSA Groundfish Fisheries</u>

The incidental take of northern fur seals is uncommon in the groundfish fisheries. The last recoreded mortality in any Alaskan groundfish fishery occurred in 1996, when the take rate was one animal per 1,862,573 mt of groundfish harvested. Observer Program data from 1990 to 1998 indicate that fur seals were taken incidentally only in the BSAI groundfish trawl fishery, despite observer placement in pot, longline, and trawl fisheries in both the BSAI and GOA. Estimated average take in trawls is less than one seal per year (Angliss *et al.* 2001). This level of take contributes little to the northern fur seal PBR and is inconsequential to population trends. The contribution of the MSA groundfish fisheries to gear and debris that causes entanglement of fur seals is unknown.

<u>Indirect Effects through Changes in Prey Availability</u>

Ecological interactions between northern fur seals and the groundfish fisheries are caused by spatial and temporal overlap between fur seal foraging areas and groundfish fisheries and from competition for target and bycatch species taken by the fisheries. The diet of northern fur seals includes a wide range of fish species, with less apparent dependance on Pacific cod and Atka mackerel compared to Steller sea lions. However, both adult and juvenile pollock occur in the diet of northern fur seals and consumption rates vary according to the abundance of different age classes of pollock in the foraging environment (Swartzman and Haar 1983; Sinclair *et al.*, 1996). Evaluation of the indirect effects of fisheries on northern fur seals focuses less on removals of Pacific cod and Atka mackerel and more broadly on removals of pollock and small schooling fishes.

Fishing effort displaced by Steller sea lion protection measures may be concentrated in areas important to fur seals. The proportion of the total June through October pollock catch in fur seal foraging habitat (defined as the combined home ranges of females from the Pribilofs) increased from an average of 40 percent between 1995 and 1998 to 69 percent from 1999 to 2000 (NMFS 2001b). There is a particular concern for the potential impact of this increased fishing pressure on lactating females from St. George Island where catch rates were consistently higher than in areas used by females from St. Paul Island.

Comparative Baseline

Northern fur seals are numerous in the BSAI and GOA, with an estimated population of over 940,000 animals. However, they are listed as a "depleted" stock under the MMPA because of major population declines from 1950s to the late 1960s and again from the mid 1970s through the early1980s. Subsistence hunts make up the great majority of anthropogenic mortality, but these levels are well below PBR. Incidental take in the groundfish fisheries hovers around zero, but there is still concern about potential competitive interactions on prey availability, especially as fishing effort is diverted from Steller sea lion habitat to areas around the fur seal rookeries on the Pribilof Islands. Pup counts in 2000 were significantly less than in 1990. The past/present effects on northern fur seals are summarized in Table 3.8-2.

Status for Cumulative Effects Analysis

Because of their "depleted" status under the MMPA and potential for competitive overlap for prey with the groundfish fisheries, northern fur seals will be considered as a separate species in the analysis of Alternative FMPs in Chapter 4.

3.8.3 Pacific Walrus (*Odobenus rosmarus*)

Life History and Distribution

The Pacific walrus occurs primarily in the shelf waters of the Bering and Chukchi Seas (Allen 1880, Smirnov 1929). Most of the population congregates during the summer at the southern edge of the Chukchi Sea pack ice between Long Strait, Wrangell Island, and Point Barrow (Fay *et al.* 1984). The remainder of the population, primarily adult males, stays in the Bering Sea during summer (Brooks 1954, Burns 1965, Fay 1955, Fay 1982, Fay *et al.* 1984). Females and subadult males migrate toward Bering Strait in the autumn when the pack ice begins to re-form (Fay and Stoker 1982a). Walruses use terrestrial haulout sites when suitable haulout sites on ice are unavailable. The major haulout sites are located along the northern, eastern, and southern coasts of the Chukchi Peninsula, on islands in the Bering Strait, on the Punuk Islands, on Round Island in Bristol Bay (Lentfer 1988), and at Cape Seniavan on the north side of the Alaska Peninsula.

The population of Pacific walrus has never been known very precisely and has fluctuated substantially over the past 150 years, presumably as a result of changes in human exploitation. Prior to commercial hunting in the late 1700s, the population was estimated at 200,000 to 250,000 but decreased to an estimated 50,000 to 100,000 in the 1950s (USFWS 2002a). After U.S. and Soviet protection measures reduced hunting pressure, the population increased dramatically. A series of cooperative aerial surveys between the U.S. and the Soviet Union (and later, Russia) from 1975 to 1985 yielded population estimates of about 221,000 to 246,000 (USFWS 2002a). The survey methodology had technical problems so the results should be considered rough estimates. The most recent cooperative aerial survey was made in 1990 and yielded an estimate of just over 200,000 animals. However, this survey did not include an area that had been used by walrus in previous years and should be considered conservative. These cooperative surveys were discontinued after 1990 because of financial limitations and because of continuing technical difficulties in survey methodology (USFWS 2002a). The current size and trend of the Pacific walrus population are unknown but efforts have been made in recent years to improve survey methodology.

Trophic Interactions

Walrus feed almost exclusively on benthic invertebrates (bivalve mollusks) which they locate with their vibrissae and dislodge prey with jets of water and suction and sucking the meat out of the shells (Fay 1982, Fay and Stoker 1982a and 1982b). Feeding occurs in depths of 10 to 50 m, with a maximum depth of about 80 m (Fay and Stoker 1982a, Vibe 1950). Walrus diets in the EBS are more than 97 percent invertebrates and less than one percent fish. Some walruses, primarily males, occasionally feed on seals (Lowry and Frost 1981).

Management Overview

In contrast to the other pinnipeds, management of the Pacific walrus is the responsibility of the USFWS. The species is protected under the MMPA but it is not considered a "depleted" or "strategic" stock. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. In 1997, the USFWS entered into a cooperative agreement with the Eskimo Walrus Commission to facilitate the participation of subsistence hunters in the conservation and management of walrus in Alaska. This agreement has strengthened harvest monitoring programs and promoted locally-based subsistence harvest guidelines (USFWS 2002a). Based on the 1990 population estimate of 200,000 animals, but recent current populations size is not known, therefore, a PBR can't be calculated. (USFWS 2002a). The accuracy of this value for present use is not known. Round Island, south of Togiak in Bristol Bay, is an important haulout site and is part of the Walrus Islands State Game Sanctuary. FRs prohibit entry of fishing vessels inside 12 miles of this sanctuary (672.22[a][4]).

Past and Present Effects and Management Actions

<u>Direct Mortality: Harvest and Other Intentional Take</u>

Walrus are an important subsistence species for certain coastal communities in western Alaska and Russia, being used for meat, hides, and ivory. The combined Russian-Alaskan subsistence harvest of walrus has ranged from 3,200 to 16,100 animals per year with an average of about 7,000 per year for the past forty years (USFWS 2002a). These numbers include a correction factor to account for the number of walrus shot but lost during the hunt. An analysis of hunting success concluded that approximately 42 percent of animals struck by bullets were lost and that very few of them survived their injuries (Fay *et al.* 1994). Recent subsistence harvests have been smaller than the historic average, perhaps for a variety of reasons. The estimated harvest during 1996 to 2000, adjusted for animals shot but lost, was about 5,798 walrus per year (USFWS 2002a).

<u>Direct Mortality from Incidental Take in External Fisheries and Research</u>

There are no data on incidental take from Russian fisheries but it is to be believed to be very low. Between 1996 and 2000, 15 mortalities were associated with research activities, including 5 orphaned walrus calves. This data leads to an estimated loss of four walrus per year from research (USFWS 2002a).

<u>Direct Mortality from Incidental Take by MSA Groundfish Fisheries</u>

Walrus have been reported to be taken incidentally in the Bering Sea groundfish trawl fisheries. NOAA Fisheries observer data collected from 1992 to 1996 indicate that approximately 17 animals were caught each year (USFWS 2002a). Between 1996 and 2000, 63 walrus were caught (USFWS 2002a). However, the great majority of animals caught in trawls were already decomposed, indicating that many of the mortalities were unrelated to fisheries interactions. These carcasses came from animals that were either lost during subsistence hunts or from natural mortality. It is estimated that the amount of incidental take directly related to the fishery is about two walrus per year (USFWS 2002a).

Comparative Baseline

There is no reliable estimate of the current population of walrus in Alaska waters and there is little to indicate the current trend. Walrus eat benthic clams so their prey do not overlap with species caught in the groundfish fisheries. Incidental take in the groundfish fisheries is a rare occurrence. The species is an important subsistence resource for Alaska Natives. The past/present effects on walrus are summarized in Table 3.8-3.

Status for Cumulative Effects Analysis

Because there is little indication of a positive or negative trend in the walrus population and they infrequently interact with the groundfish fisheries, Pacific walrus will be considered in the "other pinniped" group in the analysis of Alternative FMPs in Chapter 4.

3.8.4 Harbor Seal (*Phoca vitulina*)

Life History and Distribution

The harbor seal is a widespread species in both the north Atlantic and Pacific Oceans and is found in Alaska along the coast from British Columbia north to Kuskokwim Bay and west throughout the Aleutian Islands. Adults weigh about 180 pounds (82 kg) with males somewhat larger than females. Sexual maturity occurs between 3 and 7 years. Maximum ages estimated from annual rings in their teeth are 26 years for a male and 32 years for a female. In Alaska, single pups are born between May and mid-July. The young pups are able to swim almost immediately after birth. They normally remain with their mothers about one month, after which they are weaned and separate from their mother. Births of harbor seal pups are not restricted to a few major rookeries (as is the case for many species of pinnipeds) but occur at many hauling sites (ADF&G 1994b).

Satellite radio-collar and tagging studies indicate that harbor seals do not appear to make long annual migrations but undertake considerable local movements. Most harbor seals are associated closely with coastal waters although there have been occasional observations of seals up to 50 miles (81 km) from shore. Harbor seals haul out of the water periodically to rest, give birth, and nurse their pups. Reefs, sand and gravel beaches, sand and mud bars, and glacial and sea ice are commonly used for hauling sites. Harbor seals are sometimes found in rivers and lakes, usually on a seasonal basis (present in summer, absent in winter) (ADF&G 1994b).

State and federal biologists have been collecting harbor seal count data sporadically since the 1940s. However, until the past decade most of these counts have been incidental to other ongoing studies. With the reauthorization of the MMPA in 1988, an increased effort began on federal and state levels to establish reliable population estimates for Alaska pinnipeds. In 1991, the National Marine Mammal Laboratory (NMML) initiated a survey project to generate a minimum population estimate for Alaska harbor seals. The surveys represent the first state-wide attempt targeting harbor seals throughout their Alaskan range. Aerial census procedures have been developed and are being updated annually using state-of-the-art imaging, mapping, and computer technologies. NMML biologists have also developed new capture techniques for tagging studies in order to generate correction factors to improve the accuracy of Alaska harbor seal abundance estimates. For budgetary and logistical reasons, the state is divided into five survey regions, only one of which is surveyed each year on a rotating basis. Hence, population estimates for the entire state are produced once every five years (AFSC 1999).

NMML aerial surveys are conducted in cooperation with ADF&G surveys and are scheduled to coincide with the Alaska harbor seal's annual molt in August, the longest time the animals spend hauled out on land or ice. During the second or third week in August, a tidal cycle is selected when the tides are low during daylight hours and the cycle of near-minus tides lasts from 8 to 10 days. Surveys are flown within 2 hours on either side of low tide when the greatest number of seals is expected to be hauled out (AFSC 1999).

For the past 30 years, three separate harbor seals stocks have been recognized in Alaska waters: (1) the Bering Sea stock, including all waters north of Unimak Pass; (2) the GOA stock, occurring from Cape Suckling to Unimak Pass, including animals throughout the Aleutian Islands; and (3) the southeast Alaska stock, occurring from the Alaska/British Columbia border to Cape Suckling (Hill and DeMaster 1999). Note that this stock division is different than that used in the fisheries. Population sizes and mortality rates in fisheries have been calculated separately. However, new genetic research indicates that there may be as many as 14 genetically isolated stocks of harbor seals in Alaska. NOAA Fisheries is presently working with the Alaska Native Harbor Seal Commission and ADF&G to redefine harbor seal stocks (Angliss *et al.* 2001, 67 FR 54792).

Bering Sea

The Bering Sea stock was surveyed during the autumn molt of 1995 throughout northern Bristol Bay and along the north side of the Alaska Peninsula (Withrow and Loughlin 1996). The estimated abundance, corrected for animals in the water, is 13,312 (Hill and DeMaster 1999).

Land-based counts at Nanvak Bay (in northern Bristol Bay) are used as an index to estimate local population trends (Pitcher 1990). Trends were estimated and adjusted for covariates (date, time of day, tide, weather variables, and count quality). In 1975, the first year standardized counts were conducted , maximum counts during pupping and molting were 375 and 2942 respectively. In the early 1990s, maximum counts during pupping were 2-3 times less than in 1975 but counts during molting were 6 times less than 1975. By 2000, the maximum count during pupping (477) was greater than in 1975 while the maximum count during molting (575) was still 5 times lower than in 1975 (Jemison *et al.* 2001). Annual surveys were conducted from 1990 through 2000 (excluding 1999). Results from this period indicate that total seal numbers increased 9.2 percent per year during the pupping period and 2.1 percent per year during the molting period (ADF&G 2001b).

At Otter Island (in the Pribilof Islands), pupping period surveys were made for all seals and for pups in 1974, 1978, and 1995. Maximum counts of all seals declined progressively from 1175 seals in 1974, to 707 seals in 1978, and to only 202 seals in 1995. This represents an 83 percent decline from 1974 to 1995. Maximum counts of pups went from 228 pups in 1974, to 114 pups in 1978, and to only 28 pups in 1995. This represents an overall decline in pups of 88 percent. This decline may have been exacerbated by the increasing presence of Northern fur seals that began to haul out on Otter Island in the early 1980s and reached numbers greater than 1000 by 1995 (Jemison *et al.* 2001).

A new ADF&G trend survey route was established in 1998 along the north side of the Alaska Peninsula from Port Moller northeast to Kvichak Bay. This new "Bristol Bay" trend route was flown again in 1999, with subsequent annual surveys planned to estimate population trend in this southeast region of the Bering Sea. A preliminary comparison between NOAA Fisheries counts in 1995 and ADF&G's counts in 1999 indicates that harbor seal numbers were stable for the Bristol Bay trend route area during 1995 through 1999. However, this crude comparison does not take into account all the differences between the NOAA Fisheries and ADF&G survey logistics that are known to substantially influence the number of seals hauled out (ADF&G 2001b).

GOA/Aleutian Islands

The GOA/Aleutian Islands stock was assessed by photographic aerial surveys in sections during the autumn molt in 1994 and 1996. Using a correction factor to account for harbor seals in the water (i.e., not accounted for in aerial photographs, the estimate was 29,175 (Hill and DeMaster 1999).

Tugidak Island (40 kilometers southwest of Kodiak Island) offers one of the most important data sets for population trend analysis because it has one of the largest concentrations of harbor seals in Alaska, it can be surveyed from land, and it has been surveyed since 1976 (by ADF&G). At Tugidak, seal counts decreased by 90 percent from 1976 to 1992 (NMFS and ADF&G 2000). This major population decline appears to have turned around in the early 1990s. From 1994 to 1999, the trend estimate turned positive with an increase of 4.9 percent during the molting period. The trend estimate for the 30 haulout sites that comprise the ADF&G's survey route on the east side of Kodiak Island for 1993 to 1999 was a positive 5.6 percent per year, representing the first documented increase in harbor seal numbers over a relatively broad area in the GOA. Despite increasing trends, the population remains greatly reduced from the 1970s (ADF&G 2001b).

<u>Prince William Sound</u>

The ADF&G began systematic surveys in 1984. For the period between 1984 and 1997, the population estimate decreased by 63 percent in this area (NMFS and ADF&G 2000).

<u>Southeast Alaska</u>

The most recent comprehensive aerial surveys of the southeast Alaska stock were conducted during the autumn molt in 1997 and 1998. Using a correction factor to account for harbor seals in the water (i.e., not accounted for in aerial photographs), the combined population estimate for southeast Alaska is 77,917 (Hill and DeMaster 1999).

In contrast to population trends in the GOA and Bering Sea, harbor seal populations in southeast Alaska did not undergo large declines in the 1970s and 1980s, but have generally increased over this period. Population trends have not been consistent in all areas, ranging from slight declines in the Glacier Bay area to 7 percent increases in southern southeast Alaska and similar increases along the coast to California (Jemison *et al.* 2001). In the Sitka area, the number of harbor seals increased in the 1984 to 1999 period by 1.1 percent per year. In the Ketchikan area, the number of harbor seals increased 7.4 percent per year during 1983 to 1998, followed by a slightly lower rate of growth (5.6 percent per year) during the more recent 1994 to 1998 period (ADF&G 2001b).

Trophic Interactions

Harbor seals generally feed in waters less than 80 m in depth, although they are able to dive to depths exceeding 600 feet (183 m) and can remain submerged for over 20 minutes (Stewart 1984). They have a relatively diverse diet that appears to vary by seasonal and local availability. Scat and stomach analyses indicate that harbor seal diets include sand lance, smelt, sculpins, herring, capelin, shrimp, mysids, octopus, pollock, and flatfishes (Lowry *et al.* 1982). Based on an average of data for the Aleutian Islands and EBS, harbor seal diet composition is approximately 75 percent fish (12 percent pollock, 9 percent Atka mackerel, 9 percent sculpin, 8 percent greenling, 8 percent Pacific cod, 5 percent capelin, 5 percent Pacific herring, 4 percent eulachon, 4 percent Pacific sand lance, 3 percent flatfish, 3 percent saffron cod, 2 percent other fish, and no more than one percent Arctic cod, eelpouts, rockfishes, and Pacific salmon) and 25 percent invertebrates (Perez 1990). Daily consumption rates of 6 to 8 percent of total body weight have been estimated for captive harbor seals. For a 180 pound seal, this would translate into a daily consumption of 11 to 14 pounds of food. Food consumption by captive subadult harbor and spotted seals, as reported by Ashwell-Erickson and Elsner (1981), was about 4 percent of body weight in March through August, and about 8 percent of body weight in the winter.

Prey quality may also be an important factor in harbor seal diets. Studies on captive animals have shown that certain blood parameters change when harbor seals consume different prey. The significance of these findings on wild populations of seals is unknown but is under investigation (NPFMC 2001).

Harbor seals are known to be prey of killer whales, Steller sea lions, and sharks. The impact of these predators on harbor seal populations is unknown but may be significant, especially when seal numbers are low (Frost 1997). There is some concern that the decrease in Steller sea lion populations, a favorite prey of killer whales, has led the whales to prey more heavily on harbor seals than when sea lions are less abundant.

Management Overview

Most marine mammals, including harbor seals, fall under the jurisdiction of the NOAA Fisheries and are protected under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. In 1994, an amendment to the MMPA included provisions for the development of cooperative agreements between the USFWS, NOAA Fisheries, and Alaska Native organizations to conserve marine mammals, and provide for co-management with Alaska Natives. NOAA Fisheries has entered into an agreement with the Alaska Native Harbor Seal Commission (ANHSC) for co-management of the seals. In addition, the ADF&G has management authority in state waters (less than 3 nm from shore) which includes much of the seal's habitat.

The ANHSC is a consortium of Native communities organized in 1995 to strengthen the role of Alaska Natives in resource policy and management decisions concerning harbor seals. ANHSC collaborates with federal and state agencies in scientific studies and educates the public on traditional Native uses of marine mammals (ANHSC 2002).

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Fifty years ago, the harbor seal was so abundant in Alaska (and perceived to be in conflict with commercial salmon fisheries) that the state issued a bounty for the animal (ADF&G 1994b). State-sponsored bounties and predator control programs, as well as commercial harvest of harbor seals, occurred on a regular basis throughout the animal's range until the passage of the MMPA. Both adult seals and pups were harvested for pelts (Pitcher and Calkins 1979). An estimated 3,000 seals, mostly pups, were harvested annually for their pelts along the Alaska Peninsula between 1963 and 1972, accounting for 50 percent of the pup production (Pitcher 1986).

Harvest of harbor seals for subsistence purposes is likely the highest cause of anthropogenic mortality for this species since the cessation of commercial harvests in the early 1970s. Between 1992 and 1998, the state-wide harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which were taken in southeast Alaska (Wolfe and Mishler 1993, 1994, 1995, 1996, 1997, and 1998; Wolfe and Hutchinson-Scarbrough 1999). Aside from their value as a food source, harbor seals play an important role in the culture of many Native Alaskan communities (ANHSC 2002). The Bering sea stock of harbor seals is approximately 13,000 animals, and the calculated PBR is 379 animals. The annual subsistence harvest from this stock from 1994 to 1996 was approximately 161 animals, 42 percent of PBR for this species (Wolfe and Mishler 1995, 1996, and 1997). In 1998, 178 harbor seals from this stock were taken in the subsistence harvest (Wolfe and Hutchinson-Scarbrough 1999). For the GOA stock, the calculated PBR is 868 animals (Hill and DeMaster 1999). The average annual subsistence harvest from the GOA between 1992 and 1996 was 791 animals, representing 91 percent of the PBR for this stock (Wolfe and Mishler 1995, 1996, and 1997). The latest available harvest data from 1998 (792) is comparable to the average subsistence harvest of harbor seals from previous years (Wolfe and Hutchinson-Scarbrough 1999). For the southeast stock, the calculated PBR is 2,114 animals (Hill and DeMaster 1999). The average annual subsistence harvest from southeast between 1992 and 1996 was 1,749 animals, representing 83 percent of the PBR for this stock.

Direct Mortality from Incidental Take in External Fisheries

Foreign and JV groundfish fisheries in the 1960s and 1970s have likely contributed to some level of direct harbor seal mortality from entanglement in gear, but there is no data on the actual effects. Based on the near-shore distribution of harbor seals, minimal direct interaction seems likely between the early foreign fisheries and harbor seals, and mortality from those fisheries is believed to have been very low.

Harbor seal mortality in the state-managed salmon drift and set net fisheries has been estimated to average about 31 animals per year over a 6-year period in the 1990s for the Bristol Bay area, one of the most heavily fished areas (Hill and DeMaster 1999). In the GOA, a minimum estimate of incidental take is 36 seals per year. In southeast, the minimum estimate is 35 seals per year, mostly from the Yakutat area. However, these fisheries self-report harbor seal mortality and actual take of animals in these fisheries is likely to be under reported (Angliss *et al.* 2001).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

Observer Program data from 1990 to 1996 yield minimum estimates of harbor seals taken incidentally in groundfish gear. In the Bering Sea, 4 harbors seals are estimated to be killed each year in all groundfish gear combined. In the GOA, less than one harbor seal per year is estimated to be killed in trawls. In southeast Alaska, 4 harbors seals are estimated to be killed each year on longlines (Angliss *et al.* 2001).

Indirect Effects through Changes in Prey Availability

Harbor seals have a varied diet and may compete directly with various fisheries for their natural prey. Climate and oceanographic fluctuations also impact prey populations. The relative contributions of fisheries and natural influences on prey availability is unknown. As a precautionary measure in the face of this uncertainty, NPFMC established a forage fish category and allocated a zero harvest quota to that category specifically to benefit marine mammals (FMP Amendments BSAI 36 and GOA 39).

Indirect Effects through Contamination by Oil Spills

The EVOS adversely affected harbor seals in the PWS area. An estimated 300 seals died in the immediate months following the spill from direct contact with oil in the water and on beaches. Toxicological effects were documented for a couple years after the spill but dissipated as seals molted oiled fur and oil was washed from the beaches. The accident apparently exacerbated the existing local seal population declines, at least in the short-term (Frost *et al.* 1999).

Comparative Baseline

Harbor seal populations suffered a major decline in the Bering Sea and GOA during the 1970s and 1980s. In situations similar to Steller sea lions, the southeast Alaska stock appeared to be stable or increasing during this same period. The causes of this massive decline in one part of their range while an adjacent population prospers are still a matter of debate and intensive scientific research. Populations of harbor seals in the groundfish FMP areas seem to have turned the corner in the late 1980s and early 1990s and now appear to be stable or increasing, albeit at much lower levels than their historic numbers. Subsistence take is the largest source of direct anthropogenic mortality. Groundfish takes of this predominately nearshore species are minimal. There is some overlap of prey species with targeted groundfish but harbor seals have many alternative prey and forage species mostly inshore of MSA groundfish operations. The past/present effects on harbor seals are summarized in Table 3.8-4.

Status for Cumulative Effects Analysis

Because harbor seals have undergone major population declines in the GOA, interact with the groundfish fisheries on an infrequent but regular basis, and have some direct competition for prey, they will be considered as a separate species in the analysis of Alternative FMPs in Chapter 4.

3.8.5 Spotted Seal (*Phoca largha*)

Life History and Distribution

Spotted seals are distributed along the continental shelf of the Beaufort, Chukchi, Bering, and Okhotsk Seas south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977). They are also known to occur around the Pribilof Islands, Bristol Bay, and the eastern Aleutian Islands. Of eight known breeding areas, three occur in the Bering Sea. Only the Alaska stock is recognized in U.S. waters.

Pups are born in the pack ice during March and April and the seals move to coastal habitats after the ice retreats (Fay 1974, Shaughnessy and Fay 1977, Braham *et al.* 1984). From August to October, spotted seals inhabit coastal and estuarine habitats in the northen Bering and Chukchi Sea (Braham *et al.* 1984, Lowry *et al.* 2000). Availability of food nearby and freedom from disturbance seem to be important criteria for selection of coastal haulout sites (Lowry 1982). Satellite tagging studies indicate that spotted seals summering along the Chukchi Sea coast migrate south in October and pass through the Bering Strait in November (Lowry *et al.* 1998), moving south into the Bering Sea with the ice edge through December (Lowry *et al.* 2000). Preferred habitat for spotted seals in Alaska from January to April is the "front zone" of pack ice (the transition zone between the southern fringe of ice and the heavier southward-drifting pack ice, generally on rectangular floes 10 to 20 m in diameter with brash ice or open water in between (Burns *et al.* 1981a, Lowry *et al.* 2000).

Early estimates of the world population of spotted seals were in the range of 334,000 to 450,000 animals (Burns 1973). The population of the Bering Sea, including Russian waters, was estimated to be 200,000 to 250,000, based on the distribution of "family" groups (mother and pup, with attending male) on ice during the mating season (Burns 1973). However, comprehensive systematic surveys were not conducted to obtain these estimates. Reliable estimates of current population abundance and past trends are not available (Angliss and Lodge 2002).

Trophic Interactions

Adult spotted seals eat fish, crustaceans, and cephalopods. Their diet varies with region, season, and age. Spotted seals along the Sakhalin Island coast in Russia consume pink salmon, kundzha *(Salvelinus leucomaenis)*, redfin (*Leuciscus brandti*), *Myoxocephalus* sp., pleuronectids, and crab (Makhnyr and Perlov 1988). In the Bering Sea, they eat pollock, capelin, Arctic cod, and crustaceans. In winter, pollock, capelin, sand lance, Arctic cod, and shrimp are common in spotted seal diets (Sobolevskii 1996). During March through June, principal prey vary by region: pollock and eelpout in the central Bering Sea; capelin, small pollock, and herring in the southeast Bering Sea; Arctic cod, capelin, and saffron cod in the northern Bering Sea; and herring and smelt in both the southeastern Chukchi Sea and southwestern Seward Peninsula (Bukhtiyarov *et al.* 1984, Sobolevskii 1996). In summer, young seals eat mostly small crustaceans and euphausiids (Sobolevskii 1996). In the Bering Sea, the estimated diet composition of spotted seals is 96 percent fish and 4 percent invertebrates (Lowry *et al.* 1982, Bukhityarov *et al.* 1984). Spotted seal are preyed on by a number of larger predators such as killer whales, sharks, polar bears, brown bears, and to some extent Steller sea lions and walrus (Burns 1973).

Management Overview

Spotted seals are jointly managed by the ADF&G and the NOAA Fisheries PRD, and they are protected under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. Because there is no evidence that subsistence hunting is adversely affecting this stock, and because of the minimal interactions between spotted seals and any U.S. fishery, the Alaska stock of spotted seals is not classified as a "depleted" or "strategic" stock under the MMPA (Angliss and Lodge 2002). Because there are no reliable estimates of population abundance, no value for PBR has been calculated for this stock.

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Spotted seals are an important species for Alaskan subsistence hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions, with estimated annual harvests ranging from 850-3,600 seals (averaging about 2,400 annually) taken during 1966 to 1976 (Lowry 1984). Recent estimates of subsistence take from ADF&G surveys indicate that an average of 5,265 spotted seals is taken every year by Alaska Natives, which is a substantial increase from previous estimates (Angliss and Lodge 2002, Wolfe *et al.* 2002) .

Direct Mortality from Incidental Take in External Fisheries

One source of information on the number of spotted seals killed or injured incidental to external fishing operations is the logbook reports maintained by vessel operators in the Bristol Bay salmon drift gillnet and set gillnet fisheries during 1990 to 1993 (Angliss and Lodge 2002). These reports indicate an annual mean of 1.5 mortalities from interactions with commercial fishing gear, but these estimates are considered minimum, because logbook records are likely negatively biased (Credle *et al.* 1994).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the 1990 to 1999 BSAI groundfish trawl, longline, and pot fisheries. Observed incidental takes in the Bering Sea trawl fishery (three seals killed in 1996) form the basis for an estimated annual mortality of one incidental take per year over the 1995 to 1999 period (Angliss and Lodge 2002). Some of these observations may be harbor seals rather than spotted seals, due to the difficulty in distinguishing between the two species. However, the proximity of the observations to the sea ice indicate that at least two of these observations were probably spotted seals.

Comparative Baseline

There is no reliable estimate of the spotted seal population in Alaska waters, but they appear to be common and are believed to be stable. Spotted seals eat a variety of fish and have a partial overlap of prey with species caught in the groundfish fisheries. Incidental take in the groundfish fisheries has been documented but appears to be a rare occurrence. The species is an important subsistence resource for Alaska Natives. The past/present effects on spotted seal are summarized in Table 3.8-5.

Status for Cumulative Effects Analysis

Because their population appears to be stable and they infrequently interact with the groundfish fisheries, ringed seals will be considered in the “other pinniped” group in the analysis of Alternative FMPs in Chapter 4.

3.8.6 Bearded Seal (*Erignathus barbatus*)

Life History and Distribution

Bearded seals are circumpolar in their distribution, extending from the Arctic Ocean south to Hokkaido in the western Pacific. Only the Alaskan bearded seal stock is recognized in U.S. waters. In Alaskan waters, bearded seals occur on the continental shelves of the Bering, Chukchi, and Beaufort Seas (Burns 1981a, Johnson *et al.* 1966, Ognev 1935). The majority of bearded seals move south with the advancing sea ice in winter. Pups are born in the pack ice from March through mid-May. In summer, many of the seals that winter in the Bering Sea move north through Bering Strait during April through June, and are distributed along the ice edge in the Chukchi Sea during the summer. Some seals, particularly juveniles, may spend the summer in open-water areas of the Bering and Chukchi seas (Burns 1967 and 1981a).

Early estimates of the Bering-Chukchi Sea population range from 250,000 to 300,000 (Popov 1976, Burns 1981a, Burns *et al.* 1981). Aerial surveys in 1999 and 2000 yielded conflicting results, so additional surveys will be required to obtain reliable estimates of abundance. Reliable data on population trends are likewise unavailable although there is no indication that the population is declining.

Trophic Interactions

Bearded seals are primarily benthic feeders, and their distribution appears to be strongly linked to areas of shallow water and high prey biomass. They appear to be limited to feeding depths of less than 200 m but prefer depths of 25 to 50 m (Kosygin 1966, Burns 1981a, Stirling *et al.* 1982, Kingsley *et al.* 1985). Crabs, shrimp and mollusks make up most of the diet, although a wide variety of invertebrates and fish is also included. In the Bering Sea, the estimated diet composition of bearded seals is 23 percent fish and 77 percent invertebrates (Lowry *et al.* 1979, 1980a, 1981a, 1981b, Smith 1981, Burns and Frost 1983). Fish species most common in the diet are sculpins, Arctic cod , and saffron cod, although pollock are also eaten in the EBS (Lowry *et al.* 1996).

Management Overview

Bearded seals are jointly managed by the ADF&G and the NOAA Fisheries PRD, and they are protected under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. Due to a lack of information suggesting subsistence hunting is adversely affecting this stock, and because of the minimal interactions between bearded seals and any U.S. fishery, the Alaska stock of bearded seals is not classified as a strategic stock under the MMPA (Angliss *et al.* 2001). Since reliable population estimates are not available, no value for PBR has been calculated.

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Bearded seals are an important species for Alaskan subsistence hunters, with estimated annual harvests of 1,784 seals from 1966 to 1977 (Burns 1981a). Between August 1985 and June 1986, 791 bearded seals were harvested by hunters from five villages in the Bering Strait region (Kelly 1988a). The ADF&G estimates the average number of bearded seals currently taken by Alaska Natives for subsistence at approximately 6,788 seals per year (Angliss and Lodge 2002, Wolfe *et al.* 2002) . This number is substantially higher than previous estimates of harvest based on a limited sample of villages.

Direct Mortality from Incidental Take in External Fisheries

Logbook reports maintained by vessel operators in the Bristol Bay salmon drift gillnet fishery from 1990 to 1993 indicated that 14 mortalities and 31 injuries occurred to bearded seals in the Bristol Bay salmon drift gillnet fishery. However, these reports are suspect because it is unlikely that bearded seals would have been in the Bristol Bay vicinity during the summer salmon fishing season (Angliss *et al.* 2001).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the BSAI groundfish trawl, longline, and pot fisheries during 1990 to 1999. The only fishery with observed incidental takes was the Bering Sea trawl fishery (three in 1991, four in 1994, one in 1998, and two in 1999). These records form the basis for an estimated mean annual mortality of 0.6 bearded seals per year from the groundfish trawl fishery. The estimated minimum mortality rate incidental to commercial fisheries is 0.6 bearded seals per year, based on observer data (Angliss *et al.* 2001).

Comparative Baseline

There is no reliable estimate of the bearded seal population in Alaska waters, but they appear to be abundant and are believed to be stable. Bearded seals eat a variety of fish and invertebrates and have a partial overlap of prey with species caught in the groundfish fisheries. Incidental take in the groundfish fisheries has been documented but appears to be a rare occurrence. The species is an important subsistence resource for Alaska Natives. The past/present effect on bearded seal are summarized in Table 3.8-6.

Status for Cumulative Effects Analysis

Because their population appears to be stable and they infrequently interact with the groundfish fisheries, bearded seals will be considered in the "other pinniped" group in the analysis of Alternative FMPs in Chapter 4.

3.8.7 Ringed Seal (*Phoca hispida*)

Life History and Distribution

Ringed seals are found throughout the arctic in areas of seasonal sea ice as well as in areas covered by the permanent polar ice cap (McLaren 1958, Smith 1987, Kelly 1988b, Ramsay and Farley 1997, Reeves 1998). In the North Pacific Ocean, they are found in the Bering Sea and range as far south as the seas of Okhotsk and Japan. Most ringed seals overwinter, breed, give birth, and nurse their young within the shorefast sea ice, although some breeding seals (and pups) have been observed in pack ice (Smith and Stirling 1975, Finley *et al.* 1983). Only the Alaskan ringed seal stock, in the Chukchi, Bering, and Beaufort seas, is recognized in U.S. waters.

In the Chukchi and Beaufort seas, ringed seals haul out in highest densities in shorefast ice during the May-June molting season, immediately following the March-April pupping season (Johnson *et al.* 1966, Burns and Harbo 1972, Frost *et al.* 1988, 1997, 1998, and 1999). Little is known about the distribution of ringed seals during the "open water" season, from July to October, but ringed seals have been seen both hauled out on pack ice and foraging in open water some distance away from the nearest sea ice (Smith 1987). Whether ringed seals foraging in open water commute from ice edge haulout sites or forage in open water all summer long without hauling out is currently unknown. Ringed seals migrate north and south with the retreat and advance of the sea ice edge, but some seals in areas of seasonal shorefast sea ice may be sedentary (Burns 1970, Smith 1987, Heide-Jørgensen *et al.* 1992, Kapel *et al.* 1998, Teilmann *et al.* 1999). In addition to ice-associated migrations, ringed seals, particularly young seals, can also travel long distances east or west (greater than 2000 km) (Smith 1987, Kapel *et al.* 1998).

Crude estimates of ringed seal abundance in Alaskan waters range from 1 million to 3.6 million, based on aerial surveys conducted in 1985, 1986, and 1987 (Frost 1985, Frost *et al.* 1988). A reliable estimate for the current abundance of ringed seals in Alaska is not available (Angliss *et al.* 2001). Reliable data on population trends is also unavailable, although there is no evidence of declining population-levels (Angliss *et al.* 2001).

Trophic Interactions

Ringed seals prey primarily on fish (saffron cod, smelt, herring, and Arctic cod) during the fall and winter (November-April) and consume crustaceans (shrimps, amphipods, and euphausiids) and some fish (saffron cod) during the spring and summer (McLaren 1958, Fedoseev 1965, Johnson *et al.* 1966, Lowry *et al.* 1980b). In the Bering Sea, the estimated diet composition of ringed seals is 85 percent fish and 15 percent invertebrates (Kenyon 1962, Lowry *et al.* 1978, 1980b, and 1982, Lowry and Frost 1981).

Management Overview

Ringed seals are jointly managed by the ADF&G and the NOAA Fisheries PRD, and they are protected under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. Due to a lack of information suggesting subsistence hunting is adversely affecting this stock, and because of the minimal interactions between ringed seals and any U.S. fishery, the Alaska stock of ringed seals is not classified as a strategic stock under the MMPA (Angliss *et al.* 2001). Since reliable population estimates are not available, no value for PBR has been calculated.

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Ringed seals are an important species for Alaska Native subsistence hunters. The annual subsistence harvest in Alaska dropped from 7,000 to 15,000 during the period of 1962 to 1972 to an estimated 2,000 to 3,000 in 1979 (Frost 1985). Based on data from two villages on St. Lawrence Island, the annual take in Alaska during the mid-1980s likely exceeded 3,000 seals (Kelly 1988b). The ADF&G estimates that the average harvest of ringed seals by Alaska Natives, as of 2000, is 9,567 animals per year (Angliss and Lodge 2002, Wolfe 2001).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the BSAI groundfish trawl, longline, and pot fisheries during 1990 to 1999. Incidental take was only observed in the Bering Sea trawl fishery with two seals in 1992. No mortalities have been observed since then, so the estimated mean annual mortality due to trawl fisheries in the Bering Sea is zero seals per year (Angliss *et al.* 2001).

Comparative Baseline

There is no reliable estimate of the ringed seal population in Alaska waters, but they appear to be abundant and are believed to be stable. Ringed seals eat a variety of fish and invertebrates and have a partial overlap of prey with species caught in the groundfish fisheries. Incidental take in the groundfish fisheries has been documented but appears to be a rare occurrence. The species is an important subsistence resource for Alaska Natives. The past/present effects on ringed seal are summarized in Table 3.8-7.

Status for Cumulative Effects Analysis

Because their population appears to be stable and they infrequently interact with the groundfish fisheries, ringed seals will be considered in the "other pinniped" group in the analysis of Alternative FMPs in Chapter 4.

3.8.8 Ribbon Seal (*Phoca fasciata*)

Life History and Distribution

Ribbon seals inhabit the North Pacific Ocean and adjacent fringes of the Arctic Ocean, most commonly in the Okhotsk and Bering seas (Burns 1981b). During the breeding season, ribbon seals are found only in the pack ice of the Okhotsk and Bering seas (Kelly 1988c). Only the Alaskan stock is recognized in U.S. waters.

In Alaska waters, ribbon seals are found in the open sea, on the pack ice, and only rarely on shorefast ice (Kelly 1988c). Ribbon seals in Alaska range northward from Bristol Bay in the Bering Sea into the Chukchi and western Beaufort seas (Burns 1970, Burns 1981b, Braham *et al.* 1984, Moore and Barrowclough 1984). They inhabit the northern part of the Bering Sea ice front from late March to early May and move north with the receding ice edge in May to mid-July (Shustov 1965a, Tikhomirov 1966, Burns *et al.* 1981). Ribbon seals are thought to be associated with the Anadyr massif, a remnant of the pack ice that extends from the Gulf of Anadyr toward St. Matthew Island (Burns *et al.* 1981). Little is known of the distribution of ribbon seals after the ice recedes from the Bering Sea. They are presumed to be solitary and pelagic in summer and fall but their distribution is unknown (Burns 1981b, Kelly 1988c). Single ribbon seals have been observed during the summer (June-August) within 84 miles of the Pribilof Islands (Burns 1981b), near Cordova (Burns 1981b), and south of the Aleutian Islands (Stewart and Everett 1983).

The worldwide population of ribbon seals was estimated at 240,000 in the mid-1970s, with an estimate of 90,000 to 100,000 in the Bering Sea (Burns 1981b). Reliable data on stock structure, trends in population abundance, and current population estimates for the Alaska stock of ribbon seals are unavailable, although there is no evidence that population-levels are declining (Angliss *et al.* 2001).

Trophic Interactions

Ribbon seals eat crustaceans, cephalopods, and fish (Arsen'ev 1941, Shustov 1965b, Frost and Lowry 1980). Two ribbon seals collected in winter (February) had been feeding entirely on cod and pollock (Burns 1981b). Fish consumed in the Bering Sea in spring (March to June), when most animals have been collected, include pollock, Arctic cod, saffron cod, capelin, eelpout, sculpins, and flatfish. There appear to be regional differences in that small pollock and eelpout were most commonly eaten in the south-central and EBS, while Arctic cod were eaten only by seals taken in the northern Bering Sea (Frost and Lowry 1980, Lowry *et al.* 1996). Few data are available on seasonal variations in the diet, as the distribution of ribbon seals during the open water season (July to November) is poorly known. Knowledge of ribbon seal feeding habits is also limited by small sample sizes, as most of the seals sampled in spring (March to June) were not actively feeding.

Management Overview

Management of ribbon seals is the responsibility of the NOAA Fisheries PRD, and they are protected under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. Ribbon seals are an important target species for some Alaska Native subsistence hunters. Reliable estimates of the minimum population, PBR, and human-caused mortality and serious injury are currently not available. However, due to a lack of information suggesting that subsistence hunting is adversely affecting this stock, and because of the minimal interactions between ribbon seals and any U.S. fishery, the Alaska stock of ribbon seals is not classified as a strategic stock under the MMPA (Angliss *et al.* 2001).

Past and Present Effects and Management Actions

<u>Direct Mortality: Harvest and Other Intentional Take</u>

Ribbon seals are an important species for Alaska Native subsistence hunters, primarily from villages in the vicinity of the Bering Strait and to a lesser extent at villages along the Chukchi Sea coast (Kelly 1988c). The annual subsistence harvest was estimated to be less than 100 seals annually from 1968 to 1980 (Burns 1981b). In the mid-1980s, the Alaska Eskimo Walrus Commission estimated the subsistence take to be less than 100 seals annually (Kelly 1988c). A reliable estimate of the annual number of ribbon seals currently taken by Alaska Natives for subsistence is unavailable.

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the BSAI groundfish trawl, longline, and pot fisheries during 1990 through 1999. The Bering Sea trawl fishery was the only fishery to have observed incidental take of ribbon seals with one taken in 1990, one in 1991, and one in 1997. No ribbon seal mortalities were recorded in logbook reports from all Alaska fisheries. The estimated minimum mortality rate incidental to commercial fisheries is one ribbon seal per year, based exclusively on observer data (Angliss *et al.* 2001).

Comparative Baseline

The population of ribbon seals in Alaska waters has not been reliably estimated, but is thought to be stable. Incidental take in the groundfish fisheries has been documented but appears to be a very rare occurrence. Diets of ribbon seals are not well known, but do include fish targeted by the groundfish fisheries. The past/present effect on ribbon seals are summarized in Table 3.8-8.

Status for Cumulative Effects Analysis

Because their population trend is unknown and they infrequently interact with the groundfish fisheries, ribbon seals will be considered in the "other pinniped" group in the analysis of Alternative FMPs in Chapter 4.

3.8.9 Northern Elephant Seal (*Mirounga angustirostris)*

Life History and Distribution

Northern elephant seals range throughout the northeast Pacific Ocean from central Baja California, Mexico, to the GOA and eastern Aleutian Islands, with occasional sightings in the southern Bering Sea. Breeding occurs on islands from central Baja California north through central Oregon. Pupping and mating occurs on isolated islands and mainland rookeries during January and February. Following the breeding season, adults go to sea and forage until they return to rookery islands to molt in April (females) and July (males). Following the molt (which requires 4 to 6 weeks to complete), adults again return to foraging areas, where they feed until returning for the following breeding season.

Elephant seals complete two long distance migrations each year, with males traveling an average of 13,020 miles (21,000 km) and females 11,160 miles (18,000 km) (Stewart and DeLong 1995, LeBoeuf *et al.* 2000). Adult males and females occupy different foraging areas. Females forage in an area generally bounded by 38°N to 45°N, off the North American continental shelf, westward to the central Pacific Ocean. Adult males are distributed farther north than females, primarily occupying pelagic waters from Oregon northward to British Columbia, through the GOA, and westward to the eastern Aleutian Islands.

In Alaska, males that traveled to the Aleutian Islands showed a preference for Amutka Pass and Amchitka Pass (LeBoeuf *et al.* 2000) and deep water south of the eastern Aleutian Islands (Stewart and DeLong 1994).

The existing population of northern elephant seals is descended from perhaps 100 animals that survived in Mexico after the species was nearly exterminated by commercial hunting in the 19th century (Carretta *et al.* 2002). The population has expanded rapidly since hunting was halted. An estimated population of 127,000 northern elephant seals existed in U.S. and Mexican waters in 1991, of which 95,000 were in U.S. waters (Stewart *et al.* 1994). Approximately 101,000 animals were estimated to make up the U.S. population in 2001 (Carretta *et al.* 2002).

Trophic Interactions

All of the published food habits data on northern elephant seal are from California: adult males and females under anesthesia were lavaged on San Miguel Island (Stewart and DeLong 1993, Antonelis *et al.* 1987), and stomach contents were collected from dead animals along the southern California Bight northward through central California (Hacker 1986, Condit and LeBoeuf 1984). Cephalopods occurred in all animals containing food with 15 squid species occurred in 10 percent or more of the stomachs. Pacific hake occurred in 39 percent of the samples and was the only teleost fish that occurred in greater than 10 percent of the samples (Antonelis *et al.* 1994). The food habits of elephant seals while in Alaskan waters are unknown. Diving patterns of males feeding in Alaska imply that they are pursuing benthic prey (LeBoeuf *et al.* 2000). The adults that are feeding in very deep water off the continental shelf are probably primarily taking squid, as they do in California. The degree to which the smaller fraction of the northern elephant seal population frequenting areas on the continental shelf feed on demersal teleost fishes is unknown.

Males foraged in areas close to or over the continental shelf break during intense feeding (LeBoeuf *et al.* 2000) while females tended to forage in deeper waters off the continental shelf (Stewart and DeLong 1994, LeBoeuf *et al.* 2000). In these waters, elephant seals dive to average depths of 1312 ft (400 m), apparently feeding on organisms associated with the deep scattering layer. Some adult and subadult males occupy more coastal habitats where dive records suggest feeding on or near the bottom. While the proportion of the population using coastal habitats is unknown, most adult males and females appear to feed in the water column over very deep water.

Management Overview

Management of the northern elephant seal is the responsibility of the NOAA Fisheries PRD, and they are protected under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. Northern elephant seals are not an important target species for Alaska Native subsistence hunters. Because their annual human-caused mortality is much less than the calculated PBR for this stock (2,513), they are not considered a “strategic” stock under the MMPA (Carretta *et al.* 2002).

Past and Present Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

As mentioned above, commercial harvest of elephant seals nearly exterminated the species at the end of the 1800s.

Direct Mortality from Incidental Take in External Fisheries

An average of 86 elephant seals are taken each year in various gillnet fisheries from California to Washington (Carretta *et al.* 2002). Data from other external fisheries are not available, but the amount of incidental take of elephant seals is thought to be minimal.

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the 1990 to 1999 BSAI and GOA groundfish trawl, longline, and pot fisheries. Observed incidental kills included one in the Bering Sea trawl fishery in 1990, two in the GOA trawl fishery in 1990, and three in the GOA longline fishery in 1990. One juvenile elephant seal, originally misidentified as a bearded seal, was taken in the Bering Sea trawl fishery in 1991 (Angliss *et al.* 2001).

Comparative Baseline

The population of northern elephant seals in U.S. waters continues to expand and is presently over 100,000 animals. Male elephant seals spend part of their year in Alaska waters, but there is little information on their Alaska diet. Incidental take in the groundfish fisheries has been documented, but appears to be a very rare occurrence. The past/present effect on northern elephant seal are summarized in Table 3.8-9.

Status for Cumulative Effects Analysis

Because their population appears to be increasing and they infrequently interact with the groundfish fisheries, northern elephant seals will be considered in the "other pinniped" group in the analysis of Alternative FMPs in Chapter 4.

3.8.10 Sea Otter (*Enhydra lutris*)

Life History and Distribution

Adult male sea otters weigh 70 to 100 pounds (32-45 kg) while females average 40 to 60 pounds (18-27 kg). Unlike seals, which rely on a heavy layer of blubber for protection against cold water, sea otters depend on air trapped in their fur for maintaining body temperature. Sea otters mate at all times of the year, and young may be born in any season, but most pups in Alaska are born in late spring. Females can produce one pup a year, but in areas where food is limited, they may produce pups every other year. Sea otters seldom travel far unless an area has become overpopulated and food is scarce. They are gregarious, sometimes resting in pods of 10 to more than 1,000 animals. Many sea otters live for 15 to 20 years (Schneider 1994).

Sea otters inhabit shallow coastal waters of the North Pacific Ocean and the southern Bering Sea (Estes 1980, Estes and Van Blaricom 1985, Estes and Palmisano 1974). Habitat is generally shallow (less than 34 m) nearshore marine waters with sandy or rocky bottoms supporting substantial populations of benthic invertebrates. In some areas, large numbers of sea otters occur offshore. For example, in the Copper River Delta and inside PWS, sea otters are often present more than 8 km from shore (Garshelis and Garshelis 1984). Large aggregations have also been observed more than 30 km north of Unimak Island in the Bering Sea (Kenyon 1969).

Historically, sea otters occurred all across the North Pacific Rim and were estimated to number between 150,000 and 300,000 in the early 1700s. Following the arrival of Russian explorers in 1741, commercial harvest of otters for fur nearly resulted in their extinction. When sea otters were finally afforded protection under the International Fur Seal Treaty in 1911, there were probably fewer than 2,000 animals remaining in thirteen remnant colonies (Kenyon 1969).

Three genetically and geographically distinctive stocks of sea otters are recognized in Alaska: the southwest Alaska stock, which extends from the Bering Sea, Aleutian Islands, and Alaska Peninsula to the western shore of Cook Inlet; the southcentral Alaska stock, which extends from Cook Inlet east to Cape Yakataga, including Kachemak Bay, the Kenai Peninsula coast, and PWS; and the southeast Alaska stock, which extends from Cape Yakataga to the southern boundary of Alaska (Gorbics and Bodkin 2001).

Southwest Alaska

The first systematic aerial surveys for sea otters in southwest Alaska were conducted from 1957 to 1965. Those surveys indicated that the otter population was growing and that they were recolonizing former habitat. However, the population appears to have started a major decline in the 1980s. In the 1980s, the population of sea otters in the Aleutian Islands was estimated between 55,100 and 73,700 animals (uncorrected for sightability of otters). In 1992, USFWS conducted another systematic count of the Aleutians and the (uncorrected) population estimate was only 8,042 otters. This survey was repeated in 2000 and yielded an (uncorrected) estimate of 2,442 otters. This represents a 70 percent decline from 1992 and about a 95 percent decline from the 1980s (Doroff *et al.* 2003). Other sectors of the southwest stock have also declined over the same period. Comparing similar counts from aerial surveys in 1986 and 2000, USFWS estimates that sea otter populations declined 93 to 94 percent along the south shore of the Alaska Peninsula, and 27 to 49 percent along the north shore. Aerial surveys in the Kodiak Archipelago indicate a 40 percent decline in the population between 1994 and 2001 (USFWS 2002b, Doroff *et al.* submitted, Burn and Doroff submitted).

The most recent estimates of sea otters in southwest Alaska are based on aerial and boat-based surveys in 2000 and 2001 and have been corrected for sightability of otters under different conditions (and hence are different than the uncorrected estimates above). The combined estimate is 23,967 sea otters in the southwest Alaska stock, including the Aleutians (8,742), Alaska Peninsula (north side 5,756, south side 3576), and the Kodiak archipelago (5,893) (USFWS 2002b).

Southcentral Alaska

The most recent estimates of sea otter abundance in southcentral Alaska are based on a variety of aerial and small-boat surveys from 1989 to 1999. Combining corrected counts from various surveys with one small uncorrected count, the estimated abundance of sea otters in southcentral is 21,749. Although rates of population growth vary among locations, the trend for the southcentral stock is generally one of growth (USFWS 2002c).

Southeast Alaska

After being essentially extirpated by the fur trade, sea otters in the southeast Alaska stock result from a translocation of 412 animals from PWS and Amchitka Island in the late 1960s. The population has increased rapidly since that time. The most recent estimates of the sea otter population in southeast are based on small-boat and aerial surveys in 1994 and 1995. Combining corrected and uncorrected counts yields an estimated abundance of 8,807 sea otters. Although rates of population growth vary among locations, the trend for the southeast stock is one of growth (USFWS 2002d).

Trophic Interactions

Sea otters eat a wide variety of slow-moving benthic invertebrates, including sea urchins, clams, mussels, crabs, snails, octopus, squid, and epibenthic fishes (Kenyon 1969, Estes and Van Blaricom 1985, Reidman 1987). The sea otter's diet consists of an estimated 82 percent invertebrates and 18 percent fish (Kenyon 1969, Kenyon 1981, Lowry *et al.* 1982). The fish component includes lumpsuckers, sculpin, rock greenling, Atka mackerel, rockfish, sablefish, Pacific cod, and pollock. Captive animals require a daily food intake equal to one-quarter of their body weight. Of the total estimated annual fish consumption, commercial groundfish comprise 8 percent, which is considered a trace amount of the standing biomass of commercial groundfish consumed annually (by all predators) in the EBS (Perez and McAlister 1993).

Bald eagles prey on newborn pups, and killer whales prey on adults. In past years, predation rates were considered insignificant in regard to population growth (Schneider 1994). However, as noted above, sea otter populations in some areas have decreased dramatically in the past decade. Estes *et al.* (1998) suggested that increased predation by killer whales is the likely cause of these declines. Further, the authors speculate that the increased predation may have resulted from declines in the populations of other killer whale prey, namely Steller sea lions and harbor seals. If this hypothesis is correct, then any impact the groundfish fisheries may have on Steller sea lion recovery could also be considered a factor in the sea otter declines, in so far as they may have contributed to a shift in predator-prey relationships. Having said that, very little data currently exist to test the validity of this hypothesis. Surveys of Native Alaskan hunters in the False Pass area of the Aleutians failed to provide any support for killer whale predation on sea otters. The Alaska Sea Otter and Steller Sea Lion Commission continues to research this hypothesis (Jack 2000).

Sea otters also play an important ecosystem role in maintaining nearshore kelp bed habitats. In the Aleutian archipelago, sea urchins are a dominant herbivore and an important food source of sea otters (Estes *et al.* 1978). As has been demonstrated by historic sea otter declines, when sea otters disappear from an area, sea urchin populations are released from the control of sea otter predation and soon overgraze the attachments of bull kelp. Detached kelp is swept away, exposing remaining fish, crustaceans, and bivalves. A secondary consequence of the decline in sea otter populations in southwest Alaska is that kelp forests in many areas may also be in decline (Estes *et al.* 1998, USFWS 2002b).

Management Overview

The early Russian settling of Alaska was largely a result of the sea otter industry which greatly reduced the numbers of sea otters. Sea otters continued to be heavily exploited after Alaska was sold to the U.S. and became alarmingly scarce. Finally in 1911, when so few animals were left that it was no longer profitable to hunt them, sea otters were given full protection under the International Fur Seal Treaty. In 1960, the State of Alaska assumed management authority for sea otters. The management program conducted by the state included the successful reintroduction of sea otters to unoccupied habitat in southeast Alaska, British Columbia, and Washington. The MMPA transferred management authority to the USFWS in 1972 (Schneider 1994).

The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. The USFWS has cooperative agreements with the Alaska Sea Otter and Steller Sea Lion Commission, a consortium of 51 Alaska Native community groups. The Marking, Tagging, and Reporting Program is a USFWS program used throughout coastal Alaska to monitor the harvest of sea otters by Alaska Natives (Jack 2000).

Because of concerns about the severity and unknown cause(s) of the population decline in the southwest Alaska stock, the USFWS published a notice in the FR on November 9, 2000 designating the southwest Alaska stock of sea otters as a candidate species for protection under the ESA. In February 2004, the USFWS proposed listing the southwest Alaska DPS, which corresponds to the range of the southwest stock of sea otters under the MMPA, as threatened under the ESA due to their precipitous decline in numbers (69 FR 6600-6630 [11February 2004]). Critical habitat for these otters has not been designated under the proposed rule. The southwest Alaska stock of sea otters is not presently listed as depleted under the MMPA (USFWS 2002b).

The PBR for the southwest stock is calculated to be 830 animals. PBR for the southcentral stock is calculated to be 1,951 animals, and for southeast, PBR is calculated to be 871 animals (USFWS 2002b, 2002c, and 2002d).

Past and Present Human Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Commercial exploitation for pelts had a huge impact on sea otters dating from the mid-1700s to the late 1800s, causing them to become nearly extinct (Bancroft 1959, Lensink 1962). Protective measures instituted in 1911 have allowed remnant groups to increase and reoccupy much of the historic sea otter range in Alaska (Kenyon 1969, Estes 1980). Residual effects from this early harvest likely persist in several areas.

Alaska Natives have hunted sea otters for pelts and meat throughout history. Data on the subsistence harvest of sea otters has been collected by USFWS since 1988. For the southwest stock, the numbers of sea otters taken has varied from 25 to 175 animals each year with an average of 97 animals taken between 1996 and 2000, representing 9 percent of PBR (USFWS 2002b). For the southcentral stock, subsistence take has ranged between 25 and 425 animals per year with an average of 297 otters between 1996 and 2000, representing 15 percent of PBR (USFWS 2002c). For the southeast stock, subsistence take has ranged between 90 and 825 animals per year with an average of 301 otters between 1996 and 2000, representing 35 percent of PBR (USFWS 2002d).

Direct Mortality from Oil Pollution

Exploration, development, and transportation of oil and gas can adversely impact sea otters if these processes contaminate nearshore waters. Estimates of sea otters killed during the EVOS ranged from 750 to 2,650 in PWS (Garshelis 1997, Garrot *et al.* 1993) and additional thousands were killed elsewhere in the GOA because of the spill (DeGange *et al.* 1994). The EVOS demonstrated that spilled oil can travel long distances and kill large numbers of sea otters far from the point of initial release. There is no evidence that routine oil and gas development and transport have a direct impact on otter populations. At present, estimates of sea otter numbers in some areas of PWS are still below pre-spill estimates, indicating a possibly lingering effect from the catastrophe (USFWS 2002d).

Direct Mortality from Incidental Take in External Fisheries

Sea otter interactions with fishing gear of any type are infrequent. In the southcentral area, only a small fraction (2 to 5 percent) of the commercial salmon fisheries is covered by any observer program. No fishery-related sea otter injuries or mortalities have been observed in this area in the past decade and only one kill has been self-reported (USFWS 2002c). No fisheries operating in southeast Alaska are subject to the NOAA Fisheries observer program. Although the records are incomplete, there have been no self-reported injuries or fatalities related to commercial fishing in southeast in the past decade (USFWS 2002d). Laist (1997) reported that sea otter entanglement in marine debris is rare.

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

In 1992, fisheries observers reported eight sea otters taken incidentally by the Aleutian Island sablefish pot fishery. During that year, only a third of the fisheries were observed, yielding an estimate of 24 otters killed in pot gear in the sablefish fishery. No other sea otter takes were reported from observed fisheries in the range of the southwest stock from 1993 through 2000. In 1997, the BSAI groundfish trawl fishery reported one sea otter taken (USFWS 2002b).

Comparative Baseline

Sea otters have played an important role in the history and culture of Alaska. Their numbers have fluctuated greatly over time because of both major declines from relentless hunting pressure and tremendous growth from intentional reintroduction efforts. Current population trends parallel the situation for Steller sea lions and harbor seals in that sea otter numbers have declined dramatically from the Alaska Peninsula to the Bering Sea, but have remained stable or increased in southcentral and southeast Alaska. Unlike the historic population fluctuations, there is little agreement in the scientific community regarding the cause(s) of the present dynamic. There is only a small amount of overlap between their prey and the groundfish harvest. The species is an important subsistence resource for Alaska Natives, but take from the declining southwest stock is relatively low. The past/present effects on sea otters are summarized in Table 3.8-10.

Status for Cumulative Effects Analysis

Because their population in southwest Alaska is being considered for listing under the ESA and they interact with the groundfish fisheries on a regular basis, sea otters will be considered as a separate species in the analysis of Alternative FMPs in Chapter 4.

3.8.11 Blue Whale (*Balaenoptera musculus*)

Distribution and Abundance

The IWC recognizes only one stock of blue whales in the North Pacific (Donovan 1991, Best 1993), but some evidence suggests that there may be as many as five separate stocks, two of which are relevant to this analysis: the central stock near the Aleutian Islands, and the eastern GOA stock (Rice 1992, Calambokidis *et al.* 1995, Gilpatrick *et al.* 1996, Barlow 1995, Calambokidis and Steiger 1995, NMFS 1998c, Stafford *et al.* 1999). Analysis of whaling records from 1929 to 1965 indicates that there is a western stock off Kamchatka and the Kuril Islands that is separate from the central Aleutian Islands stock (Forney and Brownell 1996). Sightings of blue whales in Alaskan waters have been infrequent (Forney and Brownell 1996). Sightings reported in the Platform of Opportunity database (from 1960 to 1995) occurred primarily during the summer months. However, acoustic data collected from 1995 to 1999 from hydrophone arrays showed blue whales calling in Alaskan waters during all seasons, with the majority of calls in the GOA occurring in the fall and winter (Watkins *et al.* 2000a and 2000b). Surprisingly, blue whales did not appear to migrate and were numerous over deepwater regions in the North Pacific (Watkins *et al.* 2000a and 2000b). Blue whale range does not extend north of the Aleutian Islands, except rarely in the far southeastern corner of the Bering Sea (Rice 1998).

Estimates of abundance in the North Pacific Ocean have ranged from 1,400 to 1,900 individuals (Nishiwaki 1966, Omura and Ohsumi 1974, Rice 1978a, Tillman 1975), although these estimates are now considered outdated (Perry *et al.* 1999a). More blue whales are thought to be distributed on the east side of the North Pacific than on the west side (Omura 1955, Tomilin 1967). There are no reliable population estimates for blue whales in the south EBS or the GOA A minimum abundance estimate of 3,300 has been proposed for the North Pacific as a whole, including about 2,000 whales that breed in California waters (Wade and Gerrodette 1993, Forney *et al.* 2000). However, recent surveys conducted in previous commercial hunting areas in Alaska and Russia failed to find any blue whales (Forney and Brownell 1996).

Trophic Interactions

Blue whales are found both in coastal waters of the continental shelf and far offshore in pelagic environments. Blue whale distribution is likely governed largely by food requirements, as reported in two fine-scale studies of blue whale ecology offshore of southern California (Fiedler *et al.* 1998, Croll *et al.* 1998). Blue whales are almost exclusively euphausiid eaters, concentrating on *Thysanoessa inermis, T. longipes*, and *T. spinifera* in the Bering Sea (Tomilin 1957, Nemoto 1957, Klumov 1963, Nemoto and Kawamura 1977, Kawamura 1980). Blue whales occasionally consume copepods, pelagic gastropods, pelagic schooling squid, and fish such as sardines, capelin, and sand lance (Mizue 1951, Sleptsov 1955, Klumov 1963). A blue whale of average size, 23.5 to 24.5 m long and weighing 54 to 64 mt, eats about 1.8 to 2.3 mt of food per day (Klumov 1963). Estimates of total prey consumption are not available for this species.

Management Overview

Management of blue whales is the responsibility of the NOAA Fisheries PRD. Blue whales are listed as endangered under the ESA, and a recovery plan was finalized in 1998 (NMFS 1998c). The long-term goal of this plan is to promote the recovery of the blue whale to the extent that it is removed from ESA-listing. One of the primary means of achieving this goal is to minimize or eliminate human-caused mortality. Critical habitat has not been designated for the species. Its endangered status also means that the species is automatically classified as a depleted and strategic stock under the MMPA. The IWC instituted a ban on harvest of blue whales in 1966.

Past and Present Human Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

At least 9,500 blue whales were taken by commercial whalers from 1910 to 1965 in the North Pacific (Carretta *et al.* 2001). Blue whales were hunted by the Japanese along the south side of the Aleutian chain from 1952 to 1965 (Forney and Brownell 1996). Catches averaged 80 whales per year until 1961, after which annual catches included 67, 404, 119, and 121 whales (Forney and Brownell 1996). The IWC banned the hunt of blue whales in 1966, although it is likely that Soviet whaling continued and that Soviet catch reports under-represented the true harvest (Yablokov 1994).

Direct Mortality from Incidental Take in External Fisheries

The potential for human-caused mortality (from ship strikes and interactions with fisheries) exists, but few incidents have been reported and none have occurred in Alaskan waters (Forney *et al.* 2000).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

No blue whales have been reported taken in the groundfish fisheries since the Observer Program was initiated in 1989.

Comparative Baseline

Blue whales are an endangered species, but the number of whales that actually live in waters affected by the BSAI and GOA groundfish fisheries is unknown. Their diet does not overlap with species taken by the fisheries, and they do not appear to interact with the fleet on a regular basis (Table 3.8-11).

Status for Cumulative Effects Analysis

Because of their endangered status under the ESA and their documented presence in the action area, blue whales will be considered in the analysis of Alternative FMPs in Chapter 4. However, since they interact so infrequently with the groundfish fisheries, blue whales will be considered in the baleen whales species group.

3.8.12 Fin Whale (*Balaenoptera physalus*)

Distribution and Abundance

Fin whales are divided into three stocks for management purposes, including stocks in California and Hawaii. The northeast Pacific stock of fin whales ranges throughout the BSAI and GOA area (Angliss *et al.* 2001). Recent vessel surveys have documented large concentrations of fin whales in the central Bering Sea in July. Acoustic detections of fin whale calls indicate that fin whales also aggregate near the Aleutian Islands in summer (Moore *et al.* 1998). Some whale calls continue to be detected in northern latitudes throughout the winter with no noticeable migratory movement south (Watkins *et al.* 2000a and 2002b).

Pre-whaling estimates for the northeast Pacific stock of fin whales range from 42,000 to 45,000 whales, and post-whaling estimates range from 14,620 to 18,630 whales. However, these estimates are not considered reliable, and current abundance or population trends of fin whales are not available (Angliss *et al.* 2001). One recent survey yielded a regional estimate of abundance of 4,951 fin whales (95 percent confidence interval = 2,833-8,653) for the central Bering Sea shelf in the summer of 1999 (Angliss *et al.* 2001; Moore *et al.* 2000).

Trophic Interactions

Prey includes planktonic crustaceans (euphausiids and copepods), squid, fish (herring, cod, mackerel, pollock, and capelin), and cephalopods (Gambell 1985a). The total estimated annual food consumption by the EBS population is 57,500 mt, of which 9,200 mt (16 percent) is fish (Perez and McAlister 1993).

Management Overview

Fin whales fall under the jurisdiction of the NOAA Fisheries PRD. Fin whales are listed as endangered under the ESA and are therefore considered a depleted and strategic stock under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. A draft joint Recovery Plan has been develop in 1998 which covers both the fin and sei whales (NMFS 1998d). The long-term goal of this plan is to promote the recovery of these species to the extent that they are removed from ESA-listing. One of the primary means of achieving this goal is to minimize or eliminate human-caused mortality.

Past and Present Human Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

As noted above, commercial whaling about 100 years ago had a major impact on fin whale populations, including the northeast Pacific stock. Commercial whaling continued into modern times with 1,000 to 1,500 fin whales taken annually from the mid-1950s to the mid 1960s. Thereafter, catches declined sharply and ended altogether in 1976 when commercial whaling was outlawed (Angliss *et al.* 2001). There are no reports of subsistence takes of fin whales from either Alaska or Russia. Since population estimates are unreliable, no value for PBR has been calculated.

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

Prior to 1999, no fin whale mortalities were recorded by observers in the BSAI and GOA groundfish trawl, longline, and pot fisheries (Hill and DeMaster 1999). However, in 1999, one fin whale was killed incidental to the BSAI trawl fishery, resulting in an extrapolated take of three whales from this fishery in 1999 (Angliss *et al.* 2001). From this one recorded take, the average incidental take of fin whales is estimated to be 0.6 whales per year between 1995 and 1999. There are no records of fin whale entanglement in fishing gear.

Comparative Baseline

Fin whales are an endangered species due to commercial whaling prior to 1976. There are no reliable population estimates or trend information for the northeast Pacific stock. They are not hunted for subsistence purposes. Diets of fin whales overlap to a small extent with species taken by the groundfish fisheries, but they do not appear to interact with the fleet on a regular basis (Table 3.8-12).

Status for Cumulative Effects Analysis

Because of their "endangered" status under the ESA and their residence in the action area, fin whales will be considered in the analysis of Alternative FMPs in Chapter 4. However, since they interact so infrequently with the groundfish fisheries, fin whales will be considered in the baleen whales species group.

3.8.13 Sei Whale (*Balaenoptera borealis*)

Distribution and Abundance

Sei whales are found in all oceans, but remain in more temperate waters than other baleen whales. They migrate long distances from low latitude winter areas to higher latitude summer grounds, but infrequently venture into cold, polar waters (Gambell 1976 and 1985b, Rice 1998). In the North Pacific Ocean, the summer range extends from southern California to the GOA and across the North Pacific south of the Aleutian Islands, extending into the Bering Sea only in the deep southwestern Aleutian Basin (Gambell 1985b, Rice 1998). There is evidence, from catch data, of differential migration by reproductive class, with pregnant females leading the migration into and out of the feeding grounds (Masaki 1976). There is also evidence of segregation by age, with a higher proportion of older and larger sei whales in the higher latitudes (Gambell 1985b). Sei whales are usually seen alone or in small groups, and the species does not appear to have a well-defined social structure (Tomilin 1957).

The IWC recognizes only one stock of sei whales in the North Pacific for management purposes, although there is evidence that more than one stock exists (Horwood 1987, Masaki 1977, Donovan 1991). Based on data from commercial whaling operations, the North Pacific population of sei whales was estimated to be from 42,000 to 62,000 animals before commercial whaling began in the 1800s. In 1974, after whaling was prohibited, the population was estimated to be between 7,260 and 12,620 (Tillman 1977, Carretta *et al.* 2001). Current abundance or trends are not known for stocks in the North Pacific.

Trophic Interactions

In the northern North Pacific, sei whales feed primarily on copepods (*Calanus cristatus, C. plumchrus*, and *C. pacificus*), euphausiids *(Thysanoessa inermis* and *T. longipes)*, small schooling fish such as saury and squid (Kawamura 1973, Nemoto 1959, Nemoto and Kawamura 1977). Sei whales use both engulfing and skimming feeding strategies, depending on the type of prey (Nemoto 1959 and 1970, Perry *et al.* 1999b).

Management Overview

Sei whales fall under the jurisdiction of the NOAA Fisheries PRD. Sei whales are listed as endangered under the ESA and a joint recovery plan for fin and sei whales was drafted in 1998 (NMFS 1998c). The long-term goal of this plan is to promote the recovery of these species to the extent that they are removed from ESA-listing. Critical habitat has not been designated for the species. Because of its endangered status, the eastern North Pacific stock is automatically considered a depleted and strategic stock under the MMPA. For MMPA stock assessments, sei whales in the eastern North Pacific (east of 180°W) are considered a separate stock; however, there are no abundance estimates for sei whales along the west coast of the U.S. or in the eastern North Pacific (Barlow *et al.* 1997).

Past and Present Human Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Between 1946 and 1987, an estimated 61,500 sei whales were harvested throughout the North Pacific (Carretta *et al.* 2001). However, there is some evidence that Soviet whalers may have over-reported catches of about 3,500 sei whales, presumably to hide illegal catches of other protected species (Doroshenko 2000). Commercial whaling was prohibited in U.S. waters in 1972 by the MMPA, and sei whales were given full protection from hunting by the IWC in 1976.

Direct Mortality from Incidental Take in External Fisheries

Human-caused mortalities (i.e., incidental to commercial fishing operations or from ship strikes) have not been reported in the North Pacific (Perry *et al.* 1999b).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the 1990 to 1997 BSAI and GOA groundfish trawl, longline, and pot fisheries, but no mortalities or serious injuries of sei whales were observed (Hill and DeMaster 1999).

Comparative Baseline

Sei whales are listed as an endangered species under the ESA due to commercial whaling in the mid-1900s. Population trends and current status are unknown. Diets of sei whales do not overlap with species taken by the groundfish fisheries, and they do not appear to interact with the fleet on a regular basis. No incidental take from commercial fisheries has been reported (Table 3.8-13).

Status for Cumulative Effects Analysis

Because of their endangered species status and their presence in the action area in summer, sei whales will be considered in the analysis of Alternative FMPs in Chapter 4. However, since they interact so infrequently with the groundfish fisheries, sei whales will be considered in the baleen whales species group.

3.8.14 Minke Whale (*Balaenoptera acutorostrata*)

Distribution and Abundance

Minke whales are distributed worldwide. In the eastern North Pacific, minkes are relatively common in the Bering and Chukchi seas and in the inshore waters of the GOA, but are not considered abundant elsewhere (Stewart and Leatherwood 1985, Mizroch 1992). Minke whales in Alaska are managed as a separate stock from those in California, Oregon, and Washington. However, few data are available on the migratory behavior and apparent home ranges of eastern North Pacific minke whales (Dorsey *et al.* 1990). No estimates have been made for the number of minke whales in the North Pacific. (Angliss *et al.* 2001). In the central Bering Sea, 936 minke whales (95 percent confidence interval 473 to 1852) were observed in 1999 (Moore *et al.* 2000).

No estimates have been made for the number of minke whales in the entire North Pacific. In the central Bering Sea, an estimated 936 minke whale (95 percent confidence interval 473 to 1,852, coefficient of variation = 0.35) were observed during the summer of 1999 (Moore *et al.* 2000). However, this covers only a small portion of the Alaska stocks range. Seabird surveys around the Pribilof Islands indicated an increase in local abundance of minke whales between 1975 to 1978 and 1987 to 1989 (Baretta and Hunt 1994). No data exist on trends in abundance in Alaskan waters (Angliss *et al.* 2001).

Trophic Interactions

Prey preferences of eastern North Pacific minke whales are unknown. Data from western North Pacific minke whales indicate that, depending on season and region, pelagic schooling fishes (herring, pollock, mackerel, anchovy, and saury in particular) make up over 90 percent of the total prey by weight (Kasamatsu and Hata 1985, Tamura *et al.* 1998).

Management Overview

Minke whales fall under the jurisdiction of the NOAA Fisheries PRD and are protected under the MMPA. They are not listed as a depleted or strategic stock and are not listed under the ESA.

Past and Present Human Effects and Management Actions

<u>Direct Mortality: Harvest and Other Intentional Take</u>

Minke whales were not targeted by commercial whalers in the eastern North Pacific. Subsistence takes of minkes by Alaska Natives have been documented but occur only rarely. The last recorded subsistence take was two whales in 1989 (Angliss *et al.* 2001).

Direct Mortality from Incidental Take in External Fisheries

Minke whales have been taken in small numbers incidental to coastal set gillnet and offshore drift gillnet fisheries, but quantitative information is unreliable because these fisheries rely on self-reported interactions rather than independent observers (Angliss *et al.* 2001).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take during the 1990 to 1999 BSAI and GOA groundfish trawl, longline, and pot fisheries. No mortalities were observed during that time. One minke whale mortality was observed at Shelikof Strait in 1989 in a JV groundfish trawl fishery, the predecessor to the current Alaska groundfish trawl fishery (Hill and DeMaster 1999). In September 2000, one minke whale mortality occurred in the Bering Sea groundfish trawl fishery (NMFS 2000b).

Comparative Baseline

Minke whales in the eastern North Pacific are not listed under the ESA and have never been targeted by commercial whaling. Population trends and current status are unknown, although the species is relatively common in the action area based on the frequency of sightings. Diets of minke whales apparently overlap partially with species taken by the groundfish fisheries, but minkes do not appear to interact with the fleet on a regular basis. One minke whale mortality occurred in the Bering Sea groundfish trawl fishery in September 2000 (NMFS 2000b) (Table 3.8-14).

Status for Cumulative Effects Analysis

Because of their presence in the action area and partial overlap in diet with the groundfish fisheries, minke whales will be considered in the analysis of Alternative FMPs in Chapter 4. However, since they interact so infrequently with the groundfish fisheries, minke whales will be considered in the baleen whales species group.

3.8.15 Humpback Whale (*Megaptera novaeangliae*)

Distribution and Abundance

Humpback whales are common in Alaska waters. Their historic summer range in the North Pacific Ocean encompasses coastal and inland waters around the Pacific Rim from California north to the GOA and the Bering Sea and west along the Aleutian Islands to the Kamchatka Peninsula (Johnson and Wolman 1984, Nemoto 1957, Tomilin 1967, Perry *et al.* 1999a). Through a variety of information sources (surveys, photo-identifications, genetics), it has become evident that at least three relatively separate populations exist in the U.S. EEZ. Each population migrates between its respective summer/fall feeding areas and its winter/spring calving and mating areas (Calambokidis *et al.* 1997, Baker *et al.* 1998). These apparent populations are considered as separate stocks for management purposes: the western North Pacific stock, central North Pacific stock, and the Washington-Mexico stock. The western and central North Pacific stocks are seasonally distributed in Alaskan waters. The western North Pacific stock winters in Japanese waters and probably migrates to the BSAI to feed in the summer (Berzin and Rovnin 1966, Nishiwaki 1966, Darling 1991). The central North Pacific stock winters in Hawaiian waters and summers in northern British Columbia, southeast Alaska, PWS, and west to at least Kodiak Island (Baker *et al.* 1986, Baker *et al.* 1990, Perry *et al.* 1990, Calambokidis *et al.* 1997).

The North Pacific population of humpbacks has been estimated at 15,000 animals before commercial whaling began in the late 1800s. By the time whaling was prohibited in 1966, there may have been only 1000 animals left (Rice 1978b). Baker and Herman (1987) estimated that the central North Pacific stock contained about 1,400 animals between 1980 and 1983. That estimate is questionable, however, due to the opportunistic nature of the survey methodology and the small sample size. A more recent abundance estimate was based on data collected by nine independent research groups that conducted photo-identification studies in the three wintering areas (Mexico, Hawaii, and Japan). Using photographs from 1991 to 1993, abundance estimates for the western North Pacific stock and the central North Pacific stock were calculated to be 394 (coefficient of variation = 0.084) and 4,005 (coefficient of variation = 0.095), respectively (Angliss *et al.* 2001; Calambokidis *et al.* 2001). There is no trend information for the western North Pacific stock. The central North Pacific stock appears to be increasing, although the rate of increase is unknown due to the uncertainty of the earlier estimate (Baker and Herman 1987, Hill and DeMaster 1999).

Trophic Interactions

Humpback whales exhibit site fidelity to feeding areas, and return year after year to the same feeding location (Baker *et al.* 1987, Clapham *et al.*1993). There is very little interchange between feeding areas (Baker *et al.* 1986, Calambokidis *et al.* 1996, 2000, 2001, Waite *et al.* 1999, Urban *et al.* 2000). Prey in the North Pacific and Bering Sea include small schooling fishes, euphausiids, and other large zooplankton (Nemoto 1959, Bryant *et al.* 1981, Dolphin and McSweeney 1983). Euphausiid prey include *Thysanoessa inermis. T. longipes, T. spinifera* and to a lesser extent *T. raschii* (Kawamura 1980, Tomilin 1957). Fish preference include Atka mackerel, pollock, herring, anchovy, eulachon, capelin, saffron cod, sand lance, Arctic cod, rockfish, and salmon species (Nemoto 1959, Tomilin 1957, Kawamura 1980). Atka mackerel ranging in size from 5.9 to 11.7 inches (15 to 30 cm) were considered the preferred prey of humpback whales in the Aleutian Islands west of Attu Island and south of Amchitka Island (Nemoto 1959). Distribution of whales in the inland waters of southeast Alaska appears to be determined primarily by distribution of their main prey: herring and euphausiids. Humpbacks use a variety of feeding behaviors to catch food including exhalation of columns of bubbles that concentrate prey, herding of prey, and lunge feeding. Humpbacks return year after year to the same feeding location with very little interchange between feeding areas (Baker *et al.* 1986, Calambokidis *et al.* 1996, Waite *et al.* 1999, Urban *et al.* 2000).

Management Overview

Humpback whales fall under the jurisdiction of the NOAA Fisheries PRD. They are listed as endangered under the ESA and are automatically considered a depleted and strategic stock under the MMPA. An ESA recovery plan has been written (NMFS 1991b). The primary goal of this plan is to assist humpback whale populations to grow and occupy areas where they were historically found. Critical habitat has not been designated for this species.

Past and Present Human Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Intensive commercial whaling took more than 28,000 humpbacks from the North Pacific during the 1900s (Rice 1978b). This is likely an underestimate because of under-reporting of Soviet catches (Yablokov 1994).

At the present time, the calculated PBR for the western North Pacific stock of humpbacks is less than one animal per year while PBR for the central North Pacific stock is 7.4 animals per year (Angliss *et al.* 2001).

Direct Mortality from Incidental Take in External Fisheries

Brownell *et al.* (2000) found records of six humpbacks taken as bycatch by Japanese and Korean fisheries between 1995 and 1999. In addition, two strandings were reported during this period that are assumed to be the result of fishery entanglement. Samples of whale meat sold in Japanese and Korean markets also indicate that humpbacks are being sold. Although there are questions regarding the nature of these mortalities, the data indicate a minimum incidental take of 1.1 to 2.4 humpbacks per year from the western North Pacific stock (Angliss *et al.* 2001).

A small proportion of various Hawaiian fisheries has also been monitored by independent observers. One humpback was observed entangled in longline gear in 1991 and is presumed to have died. Another humpback was taken in Hawaiian longline gear in 1993. In southeast Alaska, purse seine and drift gillnet salmon fisheries have reported incidental takes of humpbacks in 1989, 1994, and 1996. In addition, over 25 humpbacks were found stranded or swimming with entangled fishing gear in Hawaii and Alaska between 1994 and 1999. Some of the whales were freed, apparently uninjured, but others are considered to have died. All fishery-related takes in Alaska and Hawaii, excluding the federal groundfish fisheries, are estimated to average 3.1 whales per year. These mortality rates from both Hawaii and Alaska are considered to be minimums based on the small number of observers and the unreliability of self-reported data (Angliss *et al.* 2001).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the 1990 to 1999 BSAI and GOA groundfish trawl, longline, and pot fisheries. One humpback whale mortality was observed in the BSAI trawl fishery in 1998 and one in 1999, resulting in an extrapolated average mortality of 0.4 humpbacks per year during this period. It is not known whether these incidental takes derived from the western or central stocks so the takes are counted against the PBRs for both stocks (Angliss *et al.* 2001).

Direct Mortality from Ship Strikes

Ship strikes and interactions with vessels unrelated to fishing have also accounted for humpback mortality. In the central North Pacific stock, four ship strikes were recorded between 1995 and 1999 for an average of 0.8 humpback mortalities per year (Angliss *et al.* 2001).

Indirect Effects from Disturbance

Coincident to fishing activity, as well as vessel transit, is the routine use of various sonar devices. The sounds produced by these devices may be audible to baleen whales and suggest disturbance sources. Wintering humpback whales have been observed reacting to sonar pulses by moving away (Maybaum 1990, 1993), although few other reactions have been documented. There is concern that noise generated by vessels as well as for research (such as the U.S. Navy's Low Frequency Active sonar program and NOAA's Acoustic Thermometry of Ocean Climate program) may be impacting humpback whales throughout their range. Research on this issue is underway (Angliss *et al.* 2001).

Humpbacks are also subject to a growing whale-watching industry in both Hawaii and Alaska. Regulations concerning minimum approach distances and operation guidelines for whale-watching vessels have been established, but there is still concern that the whales may abandon preferred habitats to avoid persistent whale-watching activity (Angliss *et al.* 2001). This issue is attracting attention in certain popular visitor areas such as Glacier Bay National Park in Alaska.

Comparative Baseline

Humpback whales are listed as an endangered species under the ESA due to commercial whaling in the 1900s. Recent population estimates for the western and central North Pacific stocks are 394 and 4,005 respectively. Trends for the western stock are unknown. The central stock is thought to be increasing but at an unknown rate. Diets of humpback whales do not generally overlap with species taken by the groundfish fisheries. There have been numerous cases of incidental take related to commercial fisheries in the past ten years, including two observed mortalities from BSAI groundfish trawls since 1998 (Table 3.8-15).

Status for Cumulative Effects Analysis

Because of their endangered species status and their presence in the action area in summer, humpback whales will be considered in the analysis of Alternative FMPs in Chapter 4. However, although they interact frequently with commercial fisheries, and the effects among management alternatives would be difficult to discern from other baleen whales, humpback whales will be considered in the baleen whales species group.

3.8.16 Gray Whale (*Eschrichtius robustus*)

Distribution and Abundance

Gray whales (*Eschrichtius robustus*) occur across the coastal and shallow water areas of both the eastern and western reaches of the North Pacific Ocean, as well as the Bering, Chukchi, and Beaufort seas. Two stocks are recognized: the western Pacific or Korean stock, which is considered rare and endangered, and the eastern North Pacific stock, which was removed from the list of endangered wildlife in 1994 (Rugh *et al.* 1999). Only the eastern North Pacific stock is found in the BSAI and GOA groundfish management areas.

The eastern North Pacific Ocean population winters in the warm coastal waters of Baja California and the southern Gulf of California. From late February to May, the whales begin a northward migration, following the coast closely. They enter the Bering Sea, primarily through Unimak Pass, mostly in April and May, and continue moving along the coast of Bristol Bay. After passing Nunivak Island, they head toward St. Lawrence Island, arriving there in May or June. The whales disperse to spend the summer feeding in shallow waters (usually less than 200 ft deep) of the northern and western Bering Sea and the Chukchi Sea. Gray whales begin their southward migration in mid-October, passing through Unimak Pass between late October and early January. They arrive in Baja California mainly in December and January (Frost 1994).

Gray whales were nearly exterminated by commercial whaling in the 1800s and 1900s, and may have numbered only in the hundreds by the time whaling was prohibited in 1946 (Angliss *et al.* 2001). Since then, they have recovered to pre-exploitation abundance. The eastern North Pacific stock abundance has been estimated by conducting shore-based counts of whales migrating past the coast of California. For the 1997 to 1998 census period this estimate was 26,635 whales (coefficient of variation = 10 percent) (Hobbs and Rugh 1999). This estimate was significantly greater than the estimate from 1992 to 1993 (17,674). Some of the difference could be attributed to survey or migration pattern variations rather than real changes in population (Angliss *et al.* 2001). A recent estimate of the population trend calculated an annual rate of increase of 2.4 percent between 1967 and 1998 (Breiwick 1999). However, there are indications that this increase may have leveled off and is perhaps declining as this population reaches the carrying capacity of its environment, estimated to be between 20,000 to 28,000 animals.

On average, there have been about 38 reports of stranded gray whales per year from 1995 to 1998 (Norman *et al.* 2000). However, there were unusually high mortality rates of greater than 270 in 1999 (LeBoeuf *et al.* 2000; Norman *et al.* 2000) and greater than 300 in 2000 (NMML unpublished data[c]). Based on a 5 percent annual natural mortality level for gray whales (Wade and DeMaster 1996), estimated average mortality rates would likely be 800 to 1200 animals for a population of 22,000 to 26,000 (Norman *et al.* 2000). Because stranding reports reflect only a small portion of total mortality, the high rates observed in 1999 and 2000 probably indicate large die-offs in these two years. Reports of emaciated whales (LeBoeuf *et al.* 2000, Perryman and Lynn 2002) and low calf production (Perryman *et al.* 2002) are suggestive of a deterioration in available resources, such as benthic amphipods in primary feeding areas of the Bering and Chukchi seas. This may be associated with the high abundance of gray whales, which may be approaching their carrying capacity (Moore *et al.* 2001). But in 2000 and 2001, relatively few strandings were found, even though the search effort has increased in recent years. Migration counts during 2001 and 2002 resulted in a preliminary abundance estimate of about 17,500 whales. While this number is less than a few years before, scientists expect populations at carrying capacity to fluctuate as environmental conditions change, and the population experiences good years and bad years (NMFS 2002e).

Trophic Interactions

Gray whales are the only baleen whales that are mainly bottom feeders. They feed by sucking up sediment from the sea floor and filtering out food items with their baleen. Gray whales eat primarily benthic amphipods in the Bering and Chukchi seas, while other feeding locations may provide more opportunistic feeding (Nerini 1984). Several studies have found *Ampelisca macrocephala, Lembos arcticus, Anonyx nugax, Pontoporeia femorata, Eusirus* spp., and *Atylus* spp. to be the most dominant species in stomach contents (Zimushko and Lenskaya 1970, Rice and Wolman 1971, Tomilin 1957, Nerini 1984, Lowry *et al.* 1982). The ratio of each species varied between areas but one of the amphipod species usually accounted for 80 to 90 percent of the food intake for each meal. Other stomach contents included small percentages of sponges, ascidians, hydrozoans, anthozoans, polychaetes, priapulids, sipunculids, isopods, decapod crustaceans, gastropods, bivalves, holothuroidians, echinoderms, cumaceans, fish larvae, sand, mud, algae, wood fragments, silt, pebbles, and kelp, probably ingested incidental to bottom feeding (Zimushko and Lenskaya 1970, Rice and Wolman 1971, Tomilin 1957, Nerini 1984, Lowry *et al.* 1982). There were no significant differences found in prey species between immature and adult whales or between males and females. The total estimated food consumption by the population in the EBS is 271,500 mt, which included only a trace amount of fish (Perez and McAlister 1993). Concentrations of 12,000 to 20,000 amphipods per square yard have been found in the southern Chukchi Sea and northern Bering Sea where the whales feed. The estimated daily consumption of an adult gray whale is about 2,600 pounds. In the approximately five months spent in Alaska waters, one whale eats about 396,000 pounds of amphipod crustaceans (Frost 1994). Previous studies have reported estimates of annual food consumption in the Bering Sea region as 850,000 mt (Zimushko and Lenskaya 1970), 2,700,000 mt to 3,240,000 mt (Frost and Lowry 1981), and 571,000 mt to 1,674,000 mt (Nerini 1984). In general, gray whales feed little during their annual migration (Rice and Wolman 1971).

Management Overview

Gray whales fall under the jurisdiction of the NOAA Fisheries PRD, and are protected under the MMPA. Gray whales were originally listed as endangered under the ESA, but were delisted in 1994 (Rugh *et al.* 1999). The IWC sets an annual quota for subsistence take by aboriginal peoples but no other intentional take is permitted.

Past and Present Human Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

In the 1800s and early 1900s gray whales were heavily hunted. First on their calving grounds and later, with the advent of modern technology, in other areas. It is estimated that by the 1930s only a few hundred to a few thousand remained. In 1948 the International Convention for the Regulation of Whaling banned all hunting of gray whales except by aboriginal people (Frost 1994).

Subsistence hunters from Alaska and Russia have traditionally harvested whales from this stock. In Alaska, Native hunters took only two gray whales in the past decade, both in 1995 (Angliss *et al.* 2001). Russian subsistence hunters took an average of 76 gray whales per year between 1994 and 1998. The 1968 to 1993 average take for Russian and Alaska Natives combined was 159 whales per year (Angliss *et al.* 2001). In 1997, the IWC approved a 5-year quota of 620 gray whales (140 per year maximum) for these Native hunters. The calculated PBR for the eastern North Pacific stock is 575 whales per year (Angliss *et al.* 2001).

Direct Mortality from Incidental Take in External Fisheries

In state-managed and tribal gillnet fisheries along their migration corridor, small numbers of gray whales become entangled in the nets and are either lost or injured as a result. The total number of gray whale incidental takings averages about 6 per year, including about 4 per year that are found entangled in fishing gear that cannot be attributed to a specific fishery. These numbers are considered minimal estimates since these types of fisheries are not monitored by observers in most areas, including Canada and Alaska (Angliss *et al.* 2001).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take on the 1990 to 1998 BSAI and GOA groundfish trawl, longline, and pot fisheries. No gray whale mortalities were observed (Hill and DeMaster 1999).

Indirect Effects through Changes in Prey Availability

Bottom trawls on the EBS shelf operate during the summer when most of the eastern stock of gray whales uses that area as a feeding ground. The impact of bottom trawling activity on the availably of benthic prey, the primary food source for gray whales, is unclear. However, population-level impacts do not appear to have occurred in light of increasing gray whale populations concurrent to decades of bottom trawling on the EBS shelf (Rugh *et al.* 1999).

Comparative Baseline

Gray whales were once an endangered species under the ESA due to whaling but their population has been increasing, and they were delisted in 1994. They are rarely taken for subsistence by Alaska Natives, but are still hunted by Natives in Russian waters. Diets of gray whales do not overlap with species taken by the groundfish fisheries, and they do not appear to interact with the fleet on a regular basis (Table 3.8-16).

Status for Cumulative Effects Analysis

Because of their protected status under the MMPA and their residence in the project area in summer, gray whales will be considered in the analysis of Alternative FMPs in Chapter 4. However, since they interact so infrequently with the groundfish fisheries, gray whales will be considered in the "baleen whales" species group.

3.8.17 Northern Right Whale *(Eubalaena japonica)*

Distribution and Abundance

Right whales historically summered in Alaska waters, mostly between 50° and 60°N from April to September, with a peak in sightings in coastal waters in June and July (Maury 1852, Townsend 1935, Omura 1958, Klumov 1962, Omura *et al.* 1969). Important historical concentration areas in Alaska appear to have been located in the GOA, especially south of Kodiak Island (Rice and Wolman 1982), and in the eastern Aleutian Islands and southern Bering Sea shelf waters (Braham and Rice 1984, Scarff 1986). Migration and winter distribution patterns are unknown, but a few sightings have been made as far south as 27°N in the eastern North Pacific and near Hawaii. Data from the NMMLs POP (1997) include right whale sightings in Alaskan waters (from 1979 to 1997) during all seasons except winter. Vessel and aerial surveys conducted during July from 1997 to 2000 reported lone animals or small groups of right whales in western Bristol Bay (Perryman *et al.* 1999, Moore *et al.* 2000, LeDuc *et al.* 2000, Angliss *et al.* 2001).

The IWC currently recognizes two species of northern right whales: *Eubalaena glacialis* in the North Atlantic and *E. japonica* in the North Pacific (IWC 2000), based upon the findings of recent genetic analyses (Rosenbaum *et al.* 2000). Stock structure in the North Pacific is unknown, and there are insufficient data about where calving and breeding take place to confirm or deny the existence of more than one stock in the North Pacific (Perry *et al.* 1999a). The pre-exploitation population estimate for this stock was approximately 11,000 animals (NMFS 1991a). Only a few individuals are believed to have survived the period of commercial whaling (Rice 1974). There have been only 14 individuals photographed in 1998 to 2000 aerial surveys, and two of these were repeats. This mark-recapture ratio is consistent with a very small population (Angliss *et al.* 2001). A reliable estimate of current abundance for the North Pacific right whale stock is not available (but is expected to be very small), nor is there any estimate of population trend (Ferrero *et al.* 2000, Angliss *et al.* 2001).

Trophic Interactions

Right whales in the North Pacific are known to prey on a variety of zooplankton species including *Calanus marshallae, Euphausia pacifica, Metridia* spp., and copepods of the genus *Neocalanus* (Omura 1986). Zooplankton sampled near right whales seen in the EBS in July 1997 included *Calanus marshallae*, *Pseudocalanus newmani*, and *Acartia longiremis* (Tynan 1999).

Management Overview

Northern right whales fall under the jurisdiction of the NOAA Fisheries PRD. They are listed as endangered under the ESA and are automatically considered a depleted and strategic stock under the MMPA. The 1991 ESA Recovery Plan for northern right whales (NMFS 1991a) is currently undergoing revision to include recent findings. Critical habitat has not been designated for this species. However, in November of 2000, NOAA Fisheries received a petition from the Center for Biological Diversity to designate critical habitat for this species. The petitioners asserted that the southeast Bering Sea shelf from 55 to 60° N should be considered critical habitat. On June 1, 2001, NOAA Fisheries found the petition to have merit (66 FR 29773) and is considering whether the petition is warranted under the ESA (Angliss and Lodge 2002). In February 2002, NOAA Fisheries determined that the petition was not warranted, but agreed to reevaluate the petition after a review of 2002 right whale surveys and research. Currently, NMML and NOAA Fisheries Alaska Region are reviewing the data and will schedule a meeting with NOAA Fisheries Northeast Region to discuss appropriate criteria for critical habitat designation for the right whales in the Pacific and Atlantic Oceans. NOAA Fisheries reevaluation of the 2000 petition will commence soon afterwards.

Past and Present Human Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Right whales are large, slow-swimming, tend to congregate in coastal areas, and have a thick layer of blubber which enables them to float when killed. These attributes made them a preferred species for whaling, and their population was decimated by the late 1800s. Between 1835 and 1909, over 15,000 right whales were estimated to be taken by U.S. registered whaling vessels; most of these whales were taken before 1875 (Angliss *et al.* 2001). Since 1931, the northern right whale has been protected from commercial whaling internationally, first under the League of Nations Convention and since 1949 by the IWC. However, reports from Russia indicate that Soviet whalers continued to harvest northern right whales illegally until 1971 (Zemsky *et al.* 1995, Tormosov *et al.* 1998).

Direct Mortality from Incidental Take in External Fisheries

Two right whale deaths reportedly occurred in the Russian gillnet fishery, one in 1983 and one in 1989 (NMFS 1991a, Kornev 1994). No incidental takes of right whales have been reported in other North Pacific fisheries (Ferrero *et al.* 2000, Angliss *et al.* 2001). Ship strikes and entanglement in fishing gear are important sources of mortality in the Atlantic stock of northern right whales, but their rarity in the Pacific has made it impossible to assess the susceptibility of the North Pacific stock to vessel strikes (Angliss *et al.* 2001).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the 1990 to 1997 BSAI and GOA groundfish trawl, longline, and pot fisheries, but no mortalities or injuries of right whales were observed (Hill and DeMaster 1999). Any mortality incidental to commercial fisheries would be considered significant (Angliss *et al.* 2001).

Comparative Baseline

Northern right whales are listed as an endangered species under the ESA due to commercial whaling in the 1800s and early 1900s. A recovery plan was finalized in 1991 (NMFS 1991a). The goal of this plan is to assist in the recovery of this species to the point where it is appropriate to remove it from ESA listing. One of the objectives of this plan is to reduce or eliminate injury or mortality caused by fishing and fishing gear. Population trends and current status are unknown although the population is believed to be very small based on the infrequency of sightings. Diets of right whales do not overlap with species taken by the groundfish fisheries, and they do not appear to interact with the fleet on a regular basis. No incidental take from the groundfish fisheries has been reported (Table 3.8-17).

Status for Cumulative Effects Analysis

Because of their endangered species status and their presence in the action area in summer, northern right whales will be considered in the analysis of Alternative FMPs in Chapter 4. However, since they interact so infrequently with the groundfish fisheries, right whales will be considered in the baleen whales species group.

3.8.18 Bowhead Whale (*Balaena mysticetus*)

Distribution and Abundance

The IWC recognizes five stocks of bowhead whales. The western Arctic stock is the only stock found in U.S. waters and is widely distributed in the central and western Bering Sea in winter (November-April). Bowhead whales are generally associated with the marginal ice front and found near the polynyas of Saint Matthew and Saint Lawrence Islands and the Gulf of Anadyr (Moore and Reeves 1993). From April through June, these whales migrate north and east, following leads in the sea ice in the eastern Chukchi Sea until they pass Point Barrow, and reach the southeastern Beaufort Sea where most spend June to September (Shelden and Rugh 1995). By late October and November they arrive in the Bering Sea (Kibal'chich *et al.* 1986, Bessonov *et al.* 1990), where they remain until the following spring migration. Historically, there were many records of bowhead whales in the Bering and Chukchi seas in summer (Townsend 1935), but the area appeared to be abandoned after commercial whaling decimated the population (Bogoslovskay *et al.* 1982, Bockstoce 1986). Some recent sightings in these waters in summer are thought to be whales from the expanding western Arctic stock (Rugh *et al.* 2000).

The western Arctic stock originally numbered about 18,000 whales and was reduced to about 3,000 after commercial whaling ended in the early 1900s (Woodby and Botkin 1993, Breiwick *et al.* 1984). Since 1978, counts of bowheads have been conducted from the sea ice north of Point Barrow during spring migration and have been corrected for whales missed for various reasons. Recent improvements in acoustical sampling have improved the detection and reliability of estimates (Angliss *et al.* 2001). From 1978 to 1993, the western Arctic stock increased from approximately 5,000 to 8,000 whales, a rate of 3.1 percent (Raftery *et al.* 1995). In 1993, the population was estimated to be 8,200 animals (IWC 1997). The most recent estimate derived from spring 2001 census was about 9,860 bowheads (IWC 2003).

Trophic Interactions

Prey species identified from bowhead whale stomach contents have included crustacean zooplankton, particularly euphausiids and copepods, ranging in length from 3 to 30 mm, and epibenthic organisms, mostly mysids and gammarid amphipods. Benthic species were relatively rare in bowhead stomach contents (Lowry 1993). Studies of stable isotope ratios in bowhead baleen suggest that the Bering and Chukchi seas are the preferred feeding habitats, rather than the Beaufort Sea (Lee and Schell 1999).

Management Overview

Bowhead whales fall under the jurisdiction of the NOAA Fisheries PRD. Bowheads are listed as endangered under the ESA and are listed as a depleted and strategic stock under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. In 1994, an amendment to the MMPA included provisions for the development of cooperative agreements between the USFWS, NOAA Fisheries, and Alaska Native organizations to conserve and co-manage marine mammals taken in subsistence hunts, including bowheads. The Alaska Eskimo Whaling Commission, representing ten whaling villages in northwestern Alaska, has signed a co-management agreement with NOAA Fisheries. Quotas for the bowhead hunts are established annually by the IWC.

Past and Present Human Effects and Management Actions

<u>Direct Mortality: Harvest and Other Intentional Take</u>

Bowheads have been a favored whale for hunting for at least 2,000 years because they produce large quantities of oil, baleen, meat, and muktuk (skin with blubber). They are also slow, non-aggressive, and float when they are killed. Bowheads are the most important subsistence animal, both culturally and nutritionally, for most northwestern Alaska Inupiaq and Yupik people. Alaska Eskimo whalers use handheld weapons and skin boats propelled by paddles to pursue bowheads during the spring hunt and motor-driven boats during the fall (Carroll 1994). The IWC has authorized Alaska Natives to strike up to 67 bowheads per year since

1978 but actual strikes have been less than the quota. The calculated PBR for this stock is 77 animals per year (Angliss *et al.* 2001).

As noted above, commercial whaling had a devastating impact on bowhead whale populations, including the western Arctic stock. Between 1848 and 1919, over 20,000 bowheads were estimated to have been harvested from pelagic and shore-based whaling operations in the Bering Sea (Woodby and Botkin 1993). The demand for baleen products, however, decreased dramatically in the early 1900s, largely due to changes in fashion. Fur trading and freighting voyages took the place of whaling ventures. In 1908, the baleen market collapsed, and by 1921, the last bowhead whale was taken at sea (Bockstoce and Burns 1993).

Direct Mortality from Incidental Take in External Fisheries

There are no Observer Program records of bowhead whale mortality incidental to commercial fisheries in Alaska (Hill and DeMaster 1999). However, there have been several cases of entanglements recorded (Philo *et al.*1992). These included three harvested bowheads that had scars attributed to rope entanglements, one bowhead found dead entangled in ropes similar to those used with fishing gear in the Bering Sea, and one bowhead with ropes on it that were attributed to rigging from a commercial offshore fishing pot, most likely a crab pot. There have been two other recent reports of bowheads with gear attached or marks that likely were from crab gear (J.C. George, North Slope Borough, personal communication). Aerial photographs in at least two cases have shown ropes trailing from the mouths of bowheads (NMFS unpublished data).

Indirect Effects through Oil Development

Increasing oil and gas development in the Arctic leads to increasing risk of various forms of pollution and noise from higher levels of boat traffic as well as exploration and drilling operations. There is evidence that bowheads are sensitive to noise from offshore development activities and that they will actively avoid seismic operations during their fall migration (Richardson *et al.* 1995, Davies 1997). In a recent ESA Section 7 consultation regarding the impact of the proposed Liberty oil development project in the Beaufort Sea, NOAA Fisheries acknowledged these impacts, but noted that the bowhead whale population was increasing and concluded that the development was not likely to jeopardize the continued existence of the bowhead whale (NMFS 2002f).

Comparative Baseline

Bowhead whales are an endangered species due to commercial whaling in the 1800s and early 1900s, but their population has been increasing in the project area since commercial whaling was stopped. They are an important subsistence resource for northern Alaska Natives. Diets of bowheads do not overlap with species taken by the groundfish fisheries, and they do not appear to interact with the fleet on a regular basis (Table 3.8-18).

Status for Cumulative Effects Analysis

Because of their "endangered" status under the ESA and their residence in the project area, bowhead whales will be considered in the analysis of Alternative FMPs in Chapter 4. However, since they interact so infrequently with the groundfish fisheries, bowhead whales will be considered in the baleen whales species group.

3.8.19 Sperm Whale (*Physeter macrocephalus*)

Distribution and Abundance

The sperm whale is one of the most widely distributed of any marine mammal species with their northernmost boundary at approximately 62°N in the Bering Sea (Leatherwood *et al.* 1982, Omura 1955). They are a pelagic species, known to dive deeper than 1,000 m and remain submerged for an hour or more. Females and young sperm whales usually remain in tropical and temperate waters year-round while males are thought to move north in the summer to feed in the BSAI and GOA area (Rice 1989).

For management purposes, the IWC has divided sperm whales in the North Pacific into eastern and western stocks. However, this division is not based on genetic or morphological differences, and the movement patterns of sperm whales are poorly known (Angliss *et al.* 2001). For stock assessment purposes, NOAA Fisheries has divided the North Pacific population into three management stocks (Angliss *et al.* 2001), only one (the Alaska stock) of which is considered relevant to this review. Sperm whales inhabit deeper pelagic waters as well as the broad continental shelf of the eastern Bering Sea, and nearshore environs in the eastern Aleutian Islands, GOA, and southeast Alaska (Rice 1989). Current and historic estimates of abundance, and therefore population trends, are considered unreliable. The abundance of sperm whales in the North Pacific, including whales from the separate California/Oregon/Washington stock, was reported to be 1,260,000 prior to whaling in the early 1900s, which was reduced to 930,000 whales by the late 1970s (Rice 1989). The number of sperm whales occurring within Alaskan waters is unknown.

Trophic Interactions

Sperm whales feed primarily on mesopelagic squid, but also consume octopi, other invertebrates, and fish (Tomilin 1967, Berzin 1971). Fish consumption becomes more evident near the continental shelf break and along the Aleutian Islands (Okutani and Nemoto 1964). Diet of sperm whales in the Bering Sea is comprised of 70-90 percent squids and 10-30 percent fish (Kawakami 1980). Fish eaten in the North Pacific included salmon, lantern fishes, lancetfish, Pacific cod, pollock, saffron cod, rockfishes, sablefish, Atka mackerel, sculpins, lumpsuckers, lamprey, skates, and rattails (Tomilin 1967, Kawakami 1980, Rice 1986a). Food consumption rates were calculated to be 3 percent of their total body weight per day in smaller sperm whales (mostly females and juvenile males) that weighed less than 13.6 mt (Lockyer 1981). Larger males weighing more may eat 3.5 percent of their total body weight per day. This number also increases sharply for pregnant and lactating females. Sperm whales consuming 2 to 4 percent of their total body weight per day equals0.9 to 2.7 mt for a 13 to 14 m animal (Kawakami 1980). The total estimated annual food consumption by the EBS population is 952,800 mt, of which 171,500 mt is fish (Perez and McAlister 1993). This estimate assumes: 1) about 15,000 adult male sperm whales summer in the EBS and Aleutian Islands region, 2) an average body mass of 26 mt, and 3) a diet of 82 percent cephalopods (mostly squid) and 18 percent fish (Perez 1990).

Management Overview

Sperm whales fall under the jurisdiction of the NOAA Fisheries PRD, and are protected under the ESA and the MMPA. Sperm whales are listed as endangered under the ESA and are listed as depleted and strategic under the MMPA. Although abundance estimates for this stock are not available, the species is considered unlikely to be in danger of extinction in the foreseeable future (Angliss *et al.* 2001). There are no critical habitats designated for this species.

Following reauthorization of the MMPA, with its emphasis on direct takes of marine mammals, NOAA Fisheries determined the approximate number of lethal takes each fishery imposed on ESA-listed species and issued exemption certificates for those with minimal impacts. The issuance of the certificates was a federal action subject to Section 7 consultation under the ESA. NOAA Fisheries issued a BiOp concerning the issuance of MMPA exemptions for all commercial fisheries (including the MSA groundfish fisheries) and concluded that the BSAI and GOA groundfish fisheries were not likely to jeopardize the continued existence and recovery of any listed species under the purview of NOAA Fisheries (NMFS 1979). The BiOp contained nine conservation recommendations, including monitoring of interactions.

Past and Present Human Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 (Perry *et al.* 1999a). However, this number may be negatively biased by as much as 60 percent due to under-reporting by Soviet whalers (Brownell *et al.* 1998). In particular, the Bering Sea population of sperm whales (consisting mostly of males) was severely depleted (Perry *et al.* 1999a). Catches in the North Pacific continued to climb until 1968, when 16,357 sperm whales were harvested, after which catches declined, in part through limits imposed by the IWC (Rice 1989). Sperm whales have been protected from commercial harvest by the IWC since 1985, although the Japanese continued to harvest sperm whales in the western North Pacific until 1988 after filing a formal objection with the IWC (Rice 1989, Reeves and Whitehead 1997). Sperm whales have never been reported to be taken by subsistence hunters (Rice 1989).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take of marine mammals in the 1990 to 1999 BSAI and GOA groundfish trawl, longline, and pot fisheries. Sperm whale interactions with longline fisheries operating in the GOA are known to occur and may be increasing in frequency. In 1996, NOAA Fisheries received reports from observers on commercial fishing vessels that sperm whales were preying on sablefish caught on commercial longline gear in the GOA. Three entanglements have been reported in the GOA longline fishery; one in 1997, 1999, and 2000. In two cases (1997 and 2000), the whales were released without serious injury; although the whale entangled in 1999 was alive when released, the extent of injuries to the whale is not known (Angliss *et al.* 2001, NMFS 2000b). Several observer reports have noted efforts by fishermen to deter sperm whales from their lines, including yelling at the whales and throwing seal bombs in the water. A pilot project using fishery observers in 1997 and 1998 was initiated to determine the extent of the interactions between sperm whales and the commercial longline fishery in Alaska (Hill *et al.* 1999).

Indirect Effects through Changes in Prey Availability

Sperm whale diets overlap with commercial fisheries harvests more than any other species of toothed whales, but the degree of overlap is at least partly because of direct interactions with longline gear. In addition to consuming primarily medium- to large-sized squids, sperm whales also consume some fish and have been observed feeding off longline gear targeting sablefish and halibut in the GOA. The interactions with commercial longline gear do not appear to have an adverse impact on sperm whales. Much to the contrary, the whales appear to have become more attracted to these vessels in recent years (Angliss *et al.* 2001).

Comparative Baseline

Sperm whales are divided into several stocks in U.S. waters, including the North Pacific stock that regularly inhabits Alaskan waters, but population estimates are considered unreliable. Sperm whales are listed as endangered under the ESA. No incidental take of sperm whales has been observed or reported in commercial fisheries, including the MSA groundfish fisheries, although there have been reports of fishermen trying to deter sperm whales from their longline catches in the GOA. NOAA Fisheries has issued a BiOp that concludes the groundfish fisheries do not jeopardize the recovery or survival of endangered sperm whales (Table 3.8-19).

Status for Cumulative Effects Analysis

Because of their endangered status under the ESA, sperm whales will be considered in the analysis of Alternative FMPs in Chapter 4. However, since they interact so infrequently with the groundfish fisheries, sperm whales will be considered in the toothed whale species group in the analysis of Alternative FMPs in Chapter 4.

3.8.20 Beaked Whales

- Baird's beaked whale (*Berardius bairdii*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Stejneger's beaked whale (*Mesoplodon stejnegeri*), also known as the Bering Sea beaked whale

Distribution and History

Baird's beaked whales inhabit the North Pacific Ocean and adjacent seas, particularly in areas with submarine escarpments and seamounts (Kasuya and Ohsumi 1984, Ohsumi 1983). In the eastern North Pacific Ocean, the species range extends north into the Bering Sea at least as far as Saint Matthew Island and the Pribilof Islands, where stranded individuals have been found (Hanna 1920, Rice 1986b). An apparent break in distribution occurs in the eastern GOA, but there are sighting records from the mid-gulf to the Aleutian Islands and in the southern Bering Sea (Kasuya and Ohsumi 1984). According to Tomilin (1957), Baird's beaked whales arrive in the Okhotsk and Bering seas in April and May and are especially numerous in summer months. Baird's beaked whales are migratory, arriving in continental slope waters during summer and fall months when surface water temperatures are the highest (Dohl *et al.* 1983, Kasuya 1986). Baird's beaked whales are the most commonly observed beaked whales in their range, perhaps because they are relatively large and gregarious, traveling in schools composed of a few to several dozen animals (Balcomb 1989).

Cuvier's beaked whales are distributed in all oceans and most seas and range as far north as the Aleutian Islands (Moore 1963, Rice 1986b). No seasonal changes in distribution are apparent from stranding records, and morphological evidence is consistent with a single panmitic population from Baja California to Alaska (Barlow *et al.* 1997, Mitchell 1968).

Stejneger's beaked whales are rarely observed at sea, and distribution has been inferred from stranded animals (Loughlin and Perez 1985, Mead 1989). They are endemic to the cold temperate waters of the North Pacific Ocean, ranging from the coast of California north through the GOA and Aleutian Islands and into the Bering Sea as far as the Pribilof Islands and Commander Islands (Loughlin and Perez 1985). Stejneger's beaked whales are believed to inhabit deeper waters of the continental slope (Moore 1963, Morris *et al.* 1983) and frequent the Aleutian Basin and Aleutian Trench rather than the shallow waters of the northern or eastern Bering Sea (Mead 1989). This species is not known to enter the Arctic Ocean and is the only species of *Mesoplodon* in Alaskan waters (Loughlin and Perez 1985). Loughlin *et al.* (1982) reported that Stejneger's beaked whales sighted in the central Aleutian Islands were in groups of 5 to 15 individuals.

Due to the rarity of beaked whale sightings at sea, there are no reliable estimates for the number of Baird's, Cuvier's, or Stejneger's beaked whales in Alaska waters (Hill and DeMaster 1999). The abundance of Baird's beaked whales off the Pacific coast of Japan is about 5,000 animals (Kasuya *et al.* 1997, Miyashita 1986, Miyashita and Kato 1993), but it is unclear whether these animals mix with whales in Alaska waters.

Trophic Interactions

Prey species of Baird's beaked whales include benthic and epibenthic creatures such as squid, skate, grenadier, rockfish, and octopus (Pike 1953, Tomilin 1957), as well as pelagic species such as Atka mackerel, sardines, and Pacific saury (Nishiwaki and Oguro 1971). Judging by the benthic habits of their prey species, these whales routinely dive to depths of 1,000 m. Typical dives are 25 to 35 minutes in duration and dives of 45 minutes are not unusual (Balcomb 1989).

Squid are considered to be the primary prey of Cuvier's beaked whales, although few stomach samples have been analyzed. Fiscus (1997) reviewed the prey species identified in the stomach contents of animals found stranded on Amchitka Island and Kodiak Island (Foster and Hare 1990) and concluded that, in Alaskan waters, Cuvier's beaked whales feed mainly on cephalopod species that inhabit mesopelagic and deeper depths in the open ocean. However, he also noted that some of these squid species (mostly gonatids) have been taken in surface gillnets (Fiscus 1997, Fiscus and Mercer 1982, Kubodera *et al.* 1983).

The primary food of Stejneger's beaked whale is probably squid (Moore 1963, Tomilin 1957). Mead (1989) found trace quantities of squid beaks, but no fish in the stomachs of two stranded animals. Stomach samples collected from eleven animals stranded on Adak Island, Alaska, contained primarily cephalophods of the families Gonatidae and Cranchiidae (Walker and Hanson 1999).

Management Overview

All three species of beaked whales fall under the jurisdiction of the NOAA Fisheries PRD, and are protected under the MMPA. The Alaska stocks of Baird's, Cuvier's, and Stejneger's beaked whales are not listed as threatened or endangered under the ESA, nor are they considered depleted or strategic under the MMPA. Since there are no reliable estimates of population size, no values for PBR have been calculated (Hill and DeMaster 1999).

Past and Present Human Effects and Management Actions

Direct Mortality: Harvest and Other Intentional Take

There are no known subsistence hunts for any beaked whales in Alaska. Japanese whalers reportedly took an average of 54 Baird's beaked whales per year from 1992 to 1997, but it is not known whether these whales came from the Alaska stock (Angliss and Lodge 2002).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries observers monitored incidental take in the 1990 to 1997 BSAI and GOA groundfish trawl, longline, and pot fisheries, and no mortalities or serious injuries of Baird's, Cuvier's, or Stejneger's beaked whales were observed (Hill and DeMaster 1999). No other interactions between commercial fisheries and beaked whales have been recorded in Alaska.

Comparative Baseline

Three species of beaked whales are present in the project area but their ecology and population dynamics are very poorly known. There appears to be essentially no direct impacts of the groundfish fishery on these species. The past/present effect on beaked whales are summarized in Table 3.8-20.

Status for Cumulative Effects Analysis

Because they do not appear to interact directly with the groundfish fisheries, the three species of beaked whales will be considered as part of the toothed whales species group in the analysis of Alternative FMPs in Chapter 4.

3.8.21 Pacific White-Sided Dolphin (*Lagenorhychus obliquidens*)

Life History and Distribution

Pacific white-sided dolphins are found throughout the temperate North Pacific Ocean north to the GOA and west to Amchitka in the Aleutian Islands, but are rarely encountered in the southern Bering Sea. They are mostly pelagic but also occur occasionally on the continental shelf (Dahlheim and Towell 1994, Ferrero and Walker 1996, Hobbs and Jones 1993). These gregarious dolphins are found in groups of 5 to 100 individuals but can also occur in large schools of up to 1000 during migration (Evans 1977).

Of two stocks recognized in the North Pacific Ocean, the North Pacific stock is present in the BSAI and GOA management areas (Angliss *et al.* 2001). The most complete population abundance estimate for Pacific white-sided dolphins was calculated from line transect analyses applied to the 1987 to 1990 central North Pacific marine mammal sightings survey data (Buckland *et al.* 1993). That abundance estimate, 931,000 animals, more closely reflects a rangewide estimate rather than one that can be applied to either of the two management stocks off the west coast of North America. However, the portion of the Buckland *et al.* (1993) estimate derived from sightings north of 45°N in the GOA (26,880) can be used as the population estimate for this area. At present, there are no reliable data to estimate population trends for this species (Angliss *et al.* 2001).

Trophic Interactions

Prey of the Pacific white-sided dolphin include a variety of small schooling fish, such as sauries and lanternfish, and also squid, which they feed on at night (Walker and Jones 1993).

Management Overview

Pacific white-sided dolphins fall under the jurisdiction of the NOAA Fisheries PRD, and are protected under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. The calculated PBR for this species is 294 animals per year (Angliss *et al.* 2001). They are not listed as depleted or strategic under the MMPA.

Past and Present Effects and Management Measures

Direct Mortality from Incidental Take in External Fisheries

Between 1978 and 1991, thousands of Pacific white-sided dolphins were killed annually in the high seas driftnet fisheries (Angliss *et al.* 2001). However, these fisheries have been outlawed by international agreement since 1992. Self-reported records from state-managed salmon gillnet fisheries indicate a take of approximately two dolphins per year. However, data on these interactions are incomplete and most likely underestimate actual take (Angliss *et al.* 2001). Records of toothed whale entanglement in derelict fishing gear are almost entirely absent (Laist 1997).

Direct Mortality from Incidental Take in Groundfish Fisheries

Incidental take in the BSAI and GOA groundfish trawl, longline, and pot fisheries was recorded by NOAA Fisheries-certified observers from 1990 to 1998. One dolphin was taken in that time period in the BSAI trawl fishery and one in the BSAI longline fishery (Angliss *et al.* 2001). No dolphins were reported from any other fishery.

Comparative Baseline

The Pacific white-sided dolphin is a fairly common seasonal resident of the BSAI and GOA. There is very little overlap between their prey and species taken in the groundfish fisheries. Incidental take in the groundfish fisheries or other current fisheries is rare. The past/present effects on Pacific white-sided dolphin are summarized in Table 3.8-21.

Status of Cumulative Effects Analysis

Based on the lack of interaction between the groundfish fisheries and the Pacific white-sided dolphin, the low level of effect in other fisheries, and its lack of status under the MMPA or ESA, this species will be discussed only as part of the toothed whales species group in the analysis of FMP alternatives in Chapter 4.

3.8.22 Killer Whale (*Orcinus orca*)

Distribution and Abundance

Killer whales occur in stable social groups called pods. Three types of pods have been identified based on differences in behavior, ecology, and morphology (Bigg *et al.* 1987, Heyning and Dahlheim 1988). Resident pods are seen throughout much of the year in certain areas and concentrate on eating fish. Transient pods appear to move over broad areas and concentrate on marine mammal prey. A third type of killer whale, termed the offshore type, has been observed in southeast Alaska but is found in more southern waters (Angliss *et al.* 2001). Whales from the different pod types are genetically distinct and do not appear to interact with each other.

Killer whales have been observed in all oceans and seas of the world (Leatherwood *et al.* 1982) and are present throughout the BSAI and GOA area (Braham and Dahlheim 1982). They occur primarily in coastal waters, although they have been sighted well offshore (Heyning and Dahlheim 1988). Five stocks of killer whales have been recognized in U.S. Pacific waters, two of which are regularly found in Alaska. The eastern North Pacific northern resident stock (hereinafter referred to as the resident stock) occurs from British Columbia north and west through all Alaskan marine waters. The eastern North Pacific transient stock (hereinafter referred to as the transient stock) occurs from Washington north and west through all Alaskan marine waters (Angliss *et al.* 2001).

During the 1980s, photoidentification techniques were used for the first time in southeast Alaska and in PWS to determine the number of individuals and pods of killer whales occurring in those two areas. Following the EVOS, these studies were expanded and carried out on a more systematic basis. As a result of this research, 216 resident whales have been identified in British Columbia as of 1998; 99 have been identified in southeast Alaska as of 1999; and 362 resident whales have been identified in PWS and Kenai Fjords as of 1998. An additional 68 whales that have ties to other resident pods reside in waters west of Seward and are considered part of the resident stock (745 total known residents). Some whales that have only been studied through photographs have been provisionally determined to be residents, including 241 whales observed in waters west of Seward, so the total resident stock size in Alaska should be considered a minimum value. At present there are no reliable data on resident whale population trends (Angliss and Lodge 2002).

The number of transient killer whales in Alaska waters includes 219 that traverse British Columbia and southeast Alaska, 11 in PWS, and 21 in the eastern GOA (251 total known transients). An additional 14 whales in southeast Alaska and 53 whales in waters west of Seward have been provisionally identified as transients (based on morphological characteristics visible in photographs), so the total transient stock size in Alaska should be considered a minimum value. At present there are no reliable data on transient whale population trends (Dahlheim 2001, Angliss and Lodge 2002).

Trophic Interactions

Resident killer whales appear to feed primarily on a wide variety of fish such as salmon, herring, halibut, and cod. Transient killer whales are opportunistic feeders and have been observed to prey on virtually any large marine animal available (Jefferson *et al.* 1991). Killer whales also have been observed to prey on river otters, squid, and several species of birds. Killer whales may briefly leave the water to grab seals and sea lions from the shore. Animals within a pod often feed cooperatively. When preying on large animals such as gray or humpback whales, the killer whales may attack as a pack, tearing away at the prey animal from several angles. When preying on schooling fish, smaller killer whales may swim close to the beach to drive the fish from shallow waters out to the rest of the pod. Large groups of killer whales are often involved in hunting schools of fish. Smaller groups (two to eight animals) are more often used when preying on marine mammals such as seals or porpoises (Baird 2000).

Killer whales frequently take fish directly from commercial fishing gear as it is retrieved. Interactions with commercial longline fisheries are well-documented throughout the BSAI. Depredation rates of bottomfish by killer whales on longline catches, based on four different methods of calculation, suggested that whales took 14 to 60 percent of the sablefish, 39 to 69 percent of the Greenland turbot, and 6 to 42 percent of the arrowtooth flounder caught in commercial gear (Yano and Dahlheim 1995). Depredation rates can be so high in some areas that fishermen have abandoned particular fisheries even when they are still open.

Management Overview

Killer whales fall under the jurisdiction of the NOAA Fisheries PRD, and are protected under the MMPA. The resident stocks are not considered depleted or strategic, however, in 2003, NOAA Fisheries proposed to designate the AT1 group of killer whales as a depleted stock of marine mammals pursuant to the MMPA and is based on biological evidence that indicates that the group is a depleted population stock as defined by the MMPA (68 FR 206 [60899-60903] 2003). The MMPA established a moratorium on the taking of all marine mammals in the U.S. Killer whales are not taken for subsistence use by Alaska Natives. Because population estimates for killer whales are considered minimums and do not include provisionally classified whales, the calculated values for PBR are considered to be conservative estimates. For the resident stock (including 216 whales resident in British Columbia), the PBR is 7.2 whales per year, and for the smaller transient stock, the PBR is 2.8 whales per year (Angliss *et al.* 2001).

Past and Present Human Effects and Management Actions

<u>Direct Mortality: Harvest and Other Intentional Take</u>

Killer whales have not been targeted by commercial whalers or subsistence hunters.

Direct Mortality from Incidental Take in External Fisheries

Canadian fisheries that are most likely to interact with killer whales are not generally covered by independent observers. In 1994, the salmon gillnet fishery reported one killer whale hitting salmon gillnet gear but not becoming entangled. No killer whale mortalities have been reported in Canadian or state-managed fisheries (Angliss *et al.* 2001). Records of toothed whale entanglement in derelict fishing gear are almost entirely absent (Laist 1997).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries-certified observers monitored incidental take in the 1990 to 1999 BSAI and GOA groundfish trawl, longline, and pot fisheries. Incidental mortality of killer whales occurred in the BSAI groundfish trawl (including four observed takes and one during an unobserved trawl) and longline fisheries (including one observed take and two during unobserved hauls). For the most recent 5-year period, 1995 to 1999, the mean annual estimated mortality is 0.6 killer whales in the BSAI trawl and 0.8 whales in the BSAI longline fisheries. No killer whale mortality was observed in the pot fisheries. The combined mortality from the observed groundfish fisheries was therefore 1.4 whales per year (Angliss *et al.* 2001). While whales interacting with fisheries are most likely from resident pods (since they eat fish), no genetic testing has been done on whales incidentally taken in the groundfish fisheries to ascertain whether they were from resident or transient stocks. Because of this uncertainty, NOAA Fisheries counts the mortality from fisheries against the PBR for each of the stocks in its annual MMPA stock assessments (Angliss *et al.* 2001).

Direct Mortality from Vessel Strikes

In addition to mortalities caused by entanglement, killer whales are also susceptible to injury or mortality through vessel strikes. Several observers have reported large groups of killer whales following trawl vessels in the BSAI, sometimes for days at a time, in order to consume fish-processing wastes (Angliss *et al.* 2001). One killer whale was reported to be killed when it struck the propeller of a BSAI groundfish trawl vessel in 1998 (Angliss and Lodge 2002).

Direct Mortality from Illegal Shooting

Killer whales interact with longline fisheries in the BSAI and GOA where predation on catch, especially sablefish and Greenland turbot, occurs periodically as gear is being retrieved (Dahlheim *et al.* 1996). During the 1992 killer whale surveys in the BSAI and western GOA, 9 of 182 individual whales (4.9 percent) had evidence of bullet wounds, presumably from irate fishermen. Under provisions of the MMPA, it is illegal to shoot or injure killer whales. The relationship between wounding due to shooting and survival is unknown (Angliss *et al.* 2001). In PWS, the pod responsible for most of the fishery interactions experienced a 59 percent decline in its members (from 37 to 15) between 1986 and 1991. These whales are believed to have died but the cause of death, whether from gunshot wounds, the EVOS, or some other factor, is unknown (Dahlheim and Matkin 1994).

Indirect Effects through Changes in Prey Availability

Many factors may affect the abundance and distribution of the various fish species consumed by resident killer whales, including directed fisheries on those species and oceanographic fluctuations. Given the ability of whales to eat a variety of fish species and to hunt over large areas of water, it seems unlikely that resident whales find food limited. However, the large decline in the western stock of Steller sea lions over the past 20 years has led to concerns that transient killer whales may be experiencing a relative shortage of this preferred prey and have been switching to less preferred prey such as harbor seals, northern fur seals, and sea otters. The decline of all these species at the same time has led to concern about possible cascading effects of commercial fishing on predator-prey relationships. However, recent surveys of transient killer whales in PWS, outer Kenai Peninsula and Kodiak indicates the number of killer whales feeding off Steller sea lions is likely quite low (possibly <30). Additional data is needed to determine the actual contribution to the decline or recovery of Steller sea lions (Matkin *et al.* 2003).

Comparative Baseline

Killer whales are divided into two stocks that regularly inhabit Alaskan waters, the eastern North Pacific northern Resident stock (745 known residents) and the eastern North Pacific northern transient stock (251 known transients). Population estimates are made by identifying individual whales through photographic analysis but a substantial numbers of provisional identifications are not included in the estimates, so they should be considered minimums. Resident whales feed on various fish species and are likely the type that interacts directly with the fisheries through depredation of longline catches, incidental take in trawl and longline gear, and other effects. Transient whales concentrate on marine mammal prey and are being investigated for their potential role in the decline of Steller sea lion populations as well as other marine mammal species. The past/present effects on killer whales are summarized in Table 3.8-22.

Status for Cumulative Effects Analysis

Because of their frequent interaction with the groundfish fisheries and their possible role in the decline of several marine mammal species, killer whales will be considered as a separate species in the analysis of Alternative FMPs in Chapter 4.

3.8.23 Beluga Whale (*Delphinapterus leucas*)

Distribution and Abundance

Belugas are distributed throughout seasonally ice-covered arctic and subarctic waters of the northern hemisphere and are closely associated with open leads and polynyas in ice-covered regions (Gurevich 1980, Hazard 1988). Five stocks are recognized in Alaskan waters: Beaufort Sea, eastern Chukchi Sea, EBS, Bristol Bay, and Cook Inlet. The first four stocks winter in the drifting ice of the Bering Sea and segregate into four discrete stocks in the spring, with concentrations in Bristol Bay, Norton Sound, Kotzebue Sound, and Kasegaluk Lagoon (Hazard 1988, O'Corry-Crowe *et al.* 1997, O'Corry-Crowe and Lowry 1997). The Cook Inlet population occurs in the inlet and Shelikof Strait region, although wanderers have been seen east to Yakutat Bay and to Kodiak Island (Angliss and Lodge 2002).

Belugas can move long distances. Some migrate over 1,500 miles from the Bering Sea to the Mackenzie River estuary in Canada. In Bristol Bay, they sometimes swim over 100 miles per day. It is not unusual for belugas to ascend large rivers such as the Yukon, and they seem to be unaffected by salinity changes. Belugas are very vocal animals, producing a variety of grunts, clicks, chirps, and whistles which are used for navigating, finding prey, and communicating. Because of this, they have sometimes been called "sea canaries" (Lowry 1994).

Since belugas are closely associated with ice flows, aerial survey counts of whales must account for the number of animals under the ice or otherwise undetectable during surveys by multiplying actual counts by a correction factor. For belugas, this correction factor typically ranges between 2.5 and 3.27 (Frost and Lowry 1995). The most recent aerial survey of the Beaufort Sea stock was conducted in July 1992 and yielded a corrected estimate of almost 40,000 whales. This stock is considered to be stable or increasing (Hill and DeMaster 1999). Aerial surveys of the Chukchi stock in 1989 to 1991 yielded a corrected estimate of 3,710 whales. Based on comparisons of this data with more recent but less comprehensive surveys, this stock appears to be stable (Hill and DeMaster 1999). Aerial surveys of the eastern Bering stock were conducted yearly between 1992 to 1995 and yielded a corrected estimate of about 8,000 whales. Aerial surveys of Norton Sound were also conducted in 2000. Preliminary analysis of this data yielded a corrected estimate of 18,142 belugas in the eastern Bering stock (Angliss and Lodge 2002). This major difference in population estimates may be more of an artifact of differences in survey routes and conditions between years rather than an actual population change, but it does indicate that the population is at least stable or increasing (Angliss and Lodge 2002). Based on a series of aerial surveys, the corrected abundance estimate for the Bristol Bay stock was 1,555 in 1994, 2,133 in 1999, and 1,642 in 2000. These estimates are at or above the high end of estimates made in the 1950s and in 1983, suggesting that the Bristol Bay stock is at least stable and may be increasing (Angliss and Lodge 2002).

The Cook Inlet population has declined significantly from historic levels. A comprehensive aerial survey conducted in 1979 yielded a corrected estimated population of 1,293 whales (Hill and DeMaster 2000). This stock has been surveyed annually since 1994 and has shown a 50 percent decline from 1994 to 1999. The corrected estimate for this stock was 375 whales in 1999 and 435 whales in 2000 (Angliss and Lodge 2002). Offshore sightings of belugas in upper Cook Inlet have declined since 1994 and sightings in lower Cook Inlet have been dramatically reduced (Angliss and Lodge 2002).

Trophic Interactions

Alaskan belugas feed primarily on a variety of schooling and anadromous fishes that are sequentially abundant in coastal zones (e.g., herring, capelin, smelt, eulachon, cod, and salmon) during the spring and summer. Octopus, squid, shrimps, crabs, and clams are eaten occasionally. Fall and winter diets are not known (Frost and Lowry 1981, Lowry *et al.* 1985). Most feeding is done over the continental shelf and in nearshore estuaries and river mouths. In the shallow waters of Alaska, most feeding dives are probably to depths of 6 to 30 m and last two to five minutes. In captivity, beluga whale food consumption rates were found to vary with age, sex, and season. On average, the larger the animal the smaller the relative food intake; therefore, belugas at 200 kg consumed about 4.5 percent of their body weight per day while belugas at 1,400 kg needed only 1.2 percent (Kastelein *et al.* 1994).

Natural predators of belugas include polar bears and killer whales. They are also a traditionally significant part of Alaska Native subsistence hunts in some coastal communities.

Management Overview

Beluga whales fall under the jurisdiction of the NOAA Fisheries PRD, and are protected under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. In 1994, an amendment to the MMPA included provisions for the development of cooperative agreements between USFWS, NOAA Fisheries, and Alaska Native organizations to conserve and co-manage marine mammals. NOAA Fisheries has signed agreements with the Alaska Beluga Whale Committee for co-management of the four western Alaska beluga stocks and with the Cook Inlet Marine Mammal Commission (CIMMC) for co-management of that population.

The Cook Inlet population has declined significantly from historic levels and has become the subject of intensive co-management actions. NOAA Fisheries decided that listing the population under the ESA was not warranted (64 FR 38778) but did designate the population as depleted and strategic under the MMPA in May 2000 (65 FR 34590). Subsistence hunting was determined to be the immediate cause of the decline, and this activity has been essentially halted until the stock improves (Mahoney and Shelden 2000). None of the other stocks are listed as depleted under the MMPA.

Past and Present Human Effects and Management Actions

<u>Direct Mortality: Harvest and Other Intentional Take</u>

Belugas are harvested by Alaska Natives living in coastal villages from Cook Inlet to Barter Island. Belugas are principally used for human consumption, either as meat or muktuk, which consists of skin and the outer layer of blubber. The oil is used for cooking and for fuel. Belugas are hunted in spring as they travel northward through channels of water through the ice, as well as during the summer and autumn open-water period.

Data on subsistence harvest of beluga whales are provided by the Alaska Beluga Whale Commission. The annual subsistence harvest of beluga whales from the Beaufort Sea stock (1996 to 2000) includes an average of 68 whales per year by Alaska Natives and 109 whales per year by Canadian Natives (Angliss and Lodge 2002). The total average take is thus 177 belugas per year, well below the calculated PBR of 649 animals in this stock (Angliss and Lodge 2002). The annual subsistence harvest of beluga whales from the Chukchi stock (1996 to 2000) averages 60 animals per year. The calculated PBR for this stock is 74 animals per year (Angliss and Lodge 2002). The annual subsistence harvest of beluga whales from the EBS stock (1996 to 2000) averages 164 animals per year. The calculated PBR for this stock is 298 animals per year (Angliss and Lodge 2002). The annual subsistence harvest of beluga whales from the Bristol Bay stock (1996 to 2000) averages 15 animals per year. The calculated PBR for this stock is 32 animals per year (Angliss and Lodge 2002).

As noted above, the decline of the Cook Inlet beluga population is thought to have been the result of subsistence harvests by Alaska Natives. Between 1993 and 1998, the numbers of belugas that were reported to be taken ranged from 21 to 123 animals per year, not including an apparently large number of whales that were struck and lost. Beginning in 1999, subsistence harvest of belugas in this area was prohibited under the MSA, unless a co-management agreement between hunting communities and CIMMC was established. Since 1999, such agreements have been made for the strike of beluga whales by hunters from the Native Village of Tyonek and for Cook Inlet community hunters. In 2001, Native Village of Tyonek hunters harvested one beluga. Cook Inlet community hunters took one in 2002. Future agreements under MMPA allow for one strike for Native Village of Tyonek in 2003 and 2004, and one strike for Cook Inlet community hunters in 2004. The co-management agreements are for strikes only, regardless of whether or not the animal is retrieved (NMFS and CIMMC 2002). The PBR for this stock is calculated to be 2.2 animals per year (Angliss and Lodge 2002).

Direct Mortality from Incidental Take in External Fisheries

Commercial salmon gillnet fisheries in the Bristol Bay area are not subject to any observer program, but are required to self-report interactions with marine mammals. Between 1990 to 2000 there were two reports of beluga mortality in fishing gear. Self-reports are likely to under estimate interactions. In 1983, ADF&G documented 12 beluga whale mortalities in Bristol Bay related to drift and set gillnet fishing (Hobbs *et al.* 2000). State-managed personal use and subsistence salmon fisheries also occur in coastal waters used by belugas, but there are no reporting requirements for these fisheries. However, one beluga was reported to be taken from the eastern Bering stock in 1996, and seven were reported taken in Bristol Bay in 2000. The extent of these non-commercial fishery interactions is unclear given the lack of reporting requirements. It is likely that belugas taken in subsistence nets were themselves used for subsistence purposes by Alaska Natives and may have been counted in subsistence harvest data (Hobbs *et al.* 2000).

In 1999 and 2000, observers were placed on Cook Inlet commercial salmon set and drift gillnet vessels because of the potential for incidental take of belugas. No belugas were observed to be taken in these fisheries in either year or self-reported in the fisheries between 1990 to 2000 (Angliss and Lodge 2002).

Direct Mortality from Incidental Take by MSA Groundfish Fisheries

NOAA Fisheries-certified observers monitored incidental take in the 1990 to 1998 BSAI groundfish trawl, longline, and pot fisheries. No mortality or serious injuries to belugas were observed incidental to these fisheries (Hill and DeMaster 1999). Three different commercial fisheries that could have interacted with beluga whales in Bristol Bay and the EBS were monitored by fishery observers for incidental take during 1990 to 1999: BSAI groundfish trawl, longline, and pot fisheries. Observers did not report any mortality or serious injury of beluga whales incidental to these groundfish fisheries (Angliss *et al.* 2001). A review of all cetacean surveys conducted in the GOA from 1936 to 1999 discovered only 31 sightings of belugas among 23,000 sightings of other cetaceans, indicating that very few belugas occur in the GOA outside of Cook Inlet (Laidre *et al.* 2000) and are therefore unlikely to interact with the GOA groundfish fishery.

Direct Mortality from Strandings

In 1996, 60 belugas were stranded in Turnagain Arm (Cook Inlet), causing at least four deaths. In 1999, another 60 belugas were stranded in Turnagain Arm with five whales subsequently found dead. There was no indication that the strandings were related to any human activity (Moore *et al.* 2000, Angliss and Lodge 2002).

Comparative Baseline

Beluga whales are divided into five stocks including four stocks that winter in the Bering Sea and one that resides year round in Cook Inlet. Population estimates are made by aerial surveys corrected for sightability of the whales. The four Bering Sea stocks appear to be stable or increasing. The Cook Inlet stock declined substantially in the last ten years because of excessive subsistence harvests and was recently listed as depleted under the MMPA. The stock is now under a co-management agreement that greatly controls subsistence harvest. Belugas feed on a variety of fish species, but prefer to forage near coastal waters or near the pack ice. No belugas have been reported to be taken in the groundfish fisheries, but they are infrequently taken in state-managed salmon fisheries. The past/present effects on beluga whales are summarized in Table 3.8-23.

Status for Cumulative Effects Analysis

Because of their infrequent interaction with the groundfish fisheries, beluga whales will be considered as part of the toothed whales species group in the analysis of Alternative FMPs in Chapter 4.

3.8.24 Harbor Porpoise (*Phocoena phocoena*)

Life History and Distribution

Harbor porpoises are found all along the coasts of the BSAI and GOA area and their range extends both north and south of these waters. They occur primarily in coastal waters, but are also found where the shelf extends offshore (Gaskin 1984, Dahlheim *et al.* 2000).

Differences found in genetic samples from California, Washington, British Columbia, and Alaska (Rosel *et al.* 1995) and studies of contaminant levels from California to Washington (Calambokidis and Barlow 1991) show that harbor porpoises do not move or interbreed over great distances. Because regional populations are believed to exist, it was considered prudent to establish three management units within Alaska: southeast Alaska, GOA, and BSAI stocks. Based on aerial surveys corrected for undetected animals and unsurveyed habitat, the most recent estimates of harbor porpoise numbers in these 3 stocks include 10,508 porpoises in southeast Alaska (1997 survey), 21,451 in the GOA (1998 survey), and 10,946 in just the Bristol Bay portion of the BSAI stock (1991 survey). No surveys have been conducted in the Aleutians or in the Bering sea north of Bristol Bay. The GOA survey in 1998 was considerably different than the previous surveys in 1991 to 1993, both in overall area covered and in the specific areas sampled. Largely due to this change in sampling, the corrected estimate from the earlier surveys (8,271) was much less than the 1998 survey (21,451). The 1998 survey is thought to be much more representative of the GOA stock size because it included more of the inshore habitat commonly used by harbor porpoise. No reliable information on abundance trends exists for any of these stocks (Angliss *et al.* 2001).

Trophic Interactions

No prey studies have been conducted in Alaska. However, prey studies in Washington and British Columbia found the diet of harbor porpoise to include cephalopods and a wide variety of fish, including Pacific herring, smelt, eelpout, eulachon, pollock, Pacific sand lance, and gadids (Gearin *et al.* 1994, Walker *et al.* 1998).

The total estimated annual food consumption by the population during summer in the EBS is 1,000 mt, of which 800 mt (85 percent) is fish (based on the estimated average pelagic abundance of 1,500 animals) (Perez and McAlister 1993). Captive, non-lactating harbor porpoises of various age and sex classes were found to consume between 750 and 3,250 grams of fish per day (equivalent to 4 to 9.5 percent of their body weight) (Kastelein *et al.* 1997). Rates of consumption depended on the caloric content of the fish as well as the age, body weight, exercise level, and individual basal metabolic rates. Wild harbor porpoises are expected to need more energy for thermoregulation and locomotion than did the animals in this study.

Management Overview

Most marine mammals, including porpoises, fall under the jurisdiction of the NOAA Fisheries and are protected under the MMPA. Harbor porpoise are not considered a strategic stock under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. However, there is no subsistence harvest of harbor porpoise (Angliss *et al.* 2001).

Past and Present Human Effects and Management Measures

Direct Mortality: Incidental Take in Groundfish Fisheries

The NOAA Fisheries observers monitored incidental take on the 1990 to 1998 BSAI and GOA groundfish trawl, longline, and pot fisheries. During this period, 21 to 31 percent of the GOA longline catch occurred within the range of the southeast Alaska harbor porpoise stock (Angliss *et al.* 2001). No incidental mortalities were recorded by observers, and logbook data for the GOA and Bering Sea harbor porpoise stocks. For all three stocks, a reliable mortality estimate rate incidental to commercial fisheries was considered unavailable because of the absence of observer placements in several fisheries.

Direct Mortality from Incidental Take in External Fisheries

An annual mean take of harbor porpoise is 3 mortalities documented from logbook records from the southeast Alaska salmon drift-gillnet fishery (1990 to 1998). No other fisheries report incidental take of this porpoise.

Comparative Baseline

Harbor porpoise is a common species in the BSAI and GOA but has little interaction with the groundfish fisheries. There is little competitive overlap between the ground fisheries and harbor porpoise prey. Annual incidental take in the groundfish fisheries rarely, if ever, occurs. This species is not classified as a strategic stock under the MMPA and is not an ESA-listed species. The past/present effects on harbor porpoise are summarized in Table 3.8-24.

Status of Cumulative Effects Analysis

The low level of interaction between the harbor porpoise and the groundfish fisheries and lack of incidental take, harbor porpoise will not be considered as a separate species in the analysis of Alternative in Chapter 4, but would be address with the toothed whale groups.

3.8.25 Dall's Porpoise (*Phocoenoides dalli*)

Life History and Distribution

Dall's porpoises are endemic to the northern North Pacific Ocean and adjoining seas, inhabiting both pelagic and nearshore habitats. The species is common along the entire coast of North America as far south as 32°N (Morejohn 1979). In the Bering Sea, sightings are infrequent north of 62°N (Nishiwaki 1966). They are present in the BSAI and GOA area all year round although there may be some seasonal onshore-offshore movements.

One stock of Dall's porpoise is recognized in Alaskan waters (Hill *et al.* 1997), although a separate Bering Sea stock has been suggested, based on differences in reproductive timing and parasite associations (Amino and Miyazaki 1992, Kasuya and Ogi 1987, Walker 1990, Walker and Sinclair 1990) and preliminary genetics analyses (Winans and Jones 1988). The Alaska stock of Dall's porpoise is estimated at 417,000. This number, however, may be overestimated as much as fivefold because of vessel attraction behavior (Hill *et al.* 1997, Turnock and Quinn 1991). There is no reliable data on population trends for this species (Angliss *et al.* 2001).

Trophic Interactions

Food habits data from the western Aleutian Islands suggest a diet composed primarily of cephalopods and myctophid fishes (Crawford 1981). The total estimated annual food consumption by the population during summer in the EBS is 169,000 mt, of which 84,500 mt (50 percent) is fish (Perez and McAlister 1993).

Management Overview

Most marine mammals, including porpoises, fall under the jurisdiction of the NOAA Fisheries and are protected under the MMPA. The MMPA established a moratorium on the taking of all marine mammals in the U.S. except for subsistence use by Alaska Natives. There is no subsistence take of Dall's porpoise by Alaska Natives. Dall's porpoise are not considered a strategic stock under the MMPA nor are they listed as threatened or endangered under the ESA.

Past and Present Human Effects and Management Actions

<u>Direct Mortality from Incidental Take by Groundfish Fisheries</u>

Six different commercial fisheries operating within the range of the Alaska stock of Dall's porpoise were monitored for incidental take by NOAA Fisheries observers during 1990 to 1998. No mortalities were observed in pot fisheries or in the GOA longline fishery. The mean annual (total) mortality was 6.0 for the Bering Sea groundfish trawl fishery, 1.2 for the GOA groundfish trawl fishery, and 1.6 for the Bering Sea groundfish longline fishery (Angliss and Lodge 2002).

Direct Mortality from External Fisheries

The Alaska Peninsula/Aleutian Island salmon drift gillnet fishery took an estimated 28 porpoises in 1990. Other state-managed salmon gillnet fisheries have low occurrences of incidental take but these data are based on limited self-reports and are considered unreliable for quantitative estimates (Angliss and Lodge 2002).

Comparative Baseline

Dall's Porpoise is a common species in the BSAI and GOA and interacts with the groundfish fisheries on a regular basis. Annual incidental take in the groundfish fisheries is relatively low for the large populations size in this region. There is little overlap between the prey of Dall's porpoise and the fish targeted by the groundfish fisheries. This species is not classified as a strategic stock under the MMPA and is not an ESA-listed species. The past/present effects on Dall's porpoise are summarized in Table 3.8-25.

Status of Cumulative Effects Analysis

Considering the low level of incidental take in the groundfish fisheries and their very limited overlap in prey species, Dall's porpoise will not be carried forward as separate species in analysis of Alternatives in Chapter 4 but will be grouped with the toothed whale group.

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3.9 Social and Economic Conditions

This section of this Programmatic SEIS provides an overview of the human environment associated with the groundfish fisheries managed by the NOAA Fisheries under the BSAI groundfish FMP and under the GOA FMP. The overview of the human environment is presented in eight sections as described below.

Historical Overview

The introduction and overview section provides a brief history of the groundfish fisheries in the North Pacific from as far back as the 1800s to today. This history includes a discussion of the groundfish fisheries as they evolved from traditional fisheries to commercial fisheries. This information provides a historical link to how the fisheries of the current day have formed. It includes a discussion of important influences from foreign exploitation to technological advances and provides a brief discussion of major amendments and initiatives that have had a significant influence on the domestic groundfish fisheries. This includes management regulations from before the enactment of the 1976 Fishery Conservation and Management Act (renamed the Magnuson-Stevens Fishery Conservation and Management Act [MSA] when amended in 1996) to today. The overview also provides information on fisheries dominated by large offshore foreign fishing and processing vessels, through the days of the joint venture fisheries, to the modern era characterized by U.S.-owned fishing and processing vessels and processing plants located in the coastal regions of Alaska.

Harvesting and Processing Sector Profiles

The harvesting and processing sector profiles section contains summary profiles of nine classes of catcher vessels, five classes of catcher processors, seven classes of inshore processors, and motherships. The sector profiles provide information on each class' involvement and dependence on Alaska groundfish fisheries and link fishing and processing activities to communities and regions in Alaska, Washington, and Oregon. The separate profiles are preceded by an overview of the activities of catcher vessels, catcher processors, inshore processors, and motherships in Alaska groundfish fisheries between 1992 and 2001. The summary profiles are condensed versions of more detailed regional profiles in *Sector and regional Profiles of the North Pacific Groundfish Fisheries—2001* (Northern Economics, Inc. and EDAW, Inc. 2001), with the addition of data for 2001.

Regional Socioeconomic Profiles

The regional socioeconomic profiles section contains summary profiles of six regions in Alaska, Washington, and Oregon that have particular interest in the harvesting and processing of North Pacific groundfish. Four of the regions are in Alaska and cover the coastal areas: the Alaska Peninsula and Aleutian Islands, Kodiak, southcentral Alaska, and southeast Alaska. A single region in Washington State is defined that includes counties bordering the state's inland marine waters. The final region includes three coastal counties in Northwest Oregon. The summary profiles are condensed versions of more detailed regional profiles in *Sector and Regional Profiles of the North Pacific Groundfish Fisheries—2001* (Northern Economics, Inc. and EDAW, Inc. 2001), with additional data for 2001.

Community Development Quota Program

The CDQ Program section provides a brief history of the development and qualifications of the community development quota program. This section covers the communities involved in the groundfish fisheries, as well as their purpose and accomplishments. The summary profile of CDQ communities is condensed from the detailed profile in *Sector and Regional Profiles of the North Pacific Groundfish Fisheries—2001* (Northern Economics, Inc. and EDAW, Inc. 2001), with additional data for 2001.

Subsistence

The subsistence section provides a summary of existing conditions and activity levels for the regionally important groundfish communities of the Alaska Peninsula and Aleutian Islands, Kodiak, southcentral Alaska, and southeast Alaska. It covers the subsistence use of Steller sea lions in relation to the central role Steller sea lion population dynamics have played in recent groundfish fishery management strategies and on some future management approaches. Lastly, this section includes other relevant subsistence activities including subsistence salmon fisheries, and joint production opportunities.

Environmental Justice Existing Conditions

The environmental justice existing conditions section provides an overview of the regulatory context and how it applies to this Programmatic SEIS. This section covers Alaska groundfish communities that have substantial environmental justice implications including communities with the highest level of engagement in and dependence upon groundfish-related activities, demographics of the workforce, population attributes, subsistence, and CDQ issues.

Market Channels and Benefits to U.S. Consumers

This section first provides a summary of the primary products derived from the Alaska groundfish fisheries and a brief overview of secondary processing and product distribution activities. Next, the difficulties of tracking the movement of groundfish products to their final point of sale are examined. Lastly, available data are used to summarize the product flows and markets for pollock, Pacific cod, sole, and rockfish.

Non-Market Goods and Services

The non-market goods and services section provides a discussion of possible non-market goods and services that may be directly or indirectly affected by the Alaska groundfish fisheries. The categories of economic values subsection outlines possible values that individuals attribute to market or non-market goods and services. The next three subsections examine these categories of values as they relate to three particular resources: groundfish, the Steller sea lion and the marine ecosystems of the BSAI and GOA. The alternative value paradigms section discusses values that lie outside the categories of values subject to economic investigation but that may be relevant to decision-making. These values are presented by their proponents as moral imperatives and, thus, do not lend themselves to analyses of economic tradeoffs.

3.9.1 Historical Overview

Development of North Pacific Fisheries (All Species)

<u>1800s to 1930s</u>

The development of the North Pacific fisheries began with the discovery of fisheries for subsistence use. Aboriginal reliance on fish for food and trade existed long before the first Asian and European explorers and exploiters arrived off the shores of Alaska. These Native subsistence fisheries have traditionally focused on nearshore species such as salmon, herring, shellfish (molluscan and crustacean), and a few demersal or groundfish species such as cod, halibut, and rockfish. These subsistence fisheries account for small amounts of fish relative to the commercial fisheries, both of which continue in the present day.

The economic development of Alaska was based on Russian exploitation of fur seals, otters and other fur bearing animals. The first small-scale fishing enterprise began in 1785 at the Karluk River on Kodiak Island to provide dried salmon to the Russian fur traders. Cod is the first commercial fishery reported in 1864 with a catch of nine tons from Bristol Bay by the American vessel *Alert*. In the 1860s, the commercial potential of salmon was discovered and a technique for large-scale canning of salmon was developed. The first salmon canneries were built in Alaska in 1878. In 1882, the Kodiak Island salmon cannery was built. In 1911, the commercial halibut fishery began in southeast Alaska off the south end of Baranof Island. The market demand for halibut grew as the development of ice makers enabled fishermen to preserve the halibut long enough to make it available to markets in the east and midwest U.S.

As more and more fisheries were discovered it became essential to achieve conservation of fishery resources and equitable distribution of their benefits. This became obvious when, after Alaska was purchased from Russia in 1867, it allowed American fishermen to use the common-pool approach and to fish for cod without interference from the Russians. However, the few fisheries management regulations that existed in the early 1900s were focused on salmon fisheries. As the Alaska salmon industry developed, government agents began collecting taxes on processed salmon products. The U.S. Commission of Fish and Fisheries was created in 1871 to determine whether and to what extent commercial marine food fishes of the northeast had declined in abundance. The Commission was also to report to Congress the necessary measures to remedy this decline. It wasn't until 1904, during the Theodore Roosevelt administration, that the Commission's work concerned Alaska. Roosevelt ordered an investigation of the Alaska salmon fishery due to reported inadequacies of existing conservation measures and recommended laws and regulations. In 1924, Congress passed the White Act, which declared congressional intent that not less than 50 percent of the salmon should be allowed to escape the fishery. The White Act gave the Secretary of Commerce broad powers to regulate fisheries in Alaska's territorial waters.

In the late 1800s and early 1900s, Pacific cod, halibut, and to a lesser extent sablefish, were the targeted fisheries. Market demand and the ability to transport fish products to market from remote Alaskan locations at reasonable cost determined whether a specific fishery would develop, rather than the abundance or availability of a particular species to fishermen.

As Canada and the U.S. fished Pacific halibut from northern California through Alaska shortly before World War I, fishery officials, fishermen, and dealers from both countries began to express concern about increasing amounts of gear and decreasing catch per unit of gear. Around 1913, Canadian and U.S. officials began to discuss the possibility of an international research and management agency. On March 2, 1923, the two nations finally ratified a halibut conservation treaty (Browning 1980). This treaty established a four-person International Fisheries Commission, granting it limited regulatory powers and a principal-in-charge to conduct halibut fisheries research. The new Commission imposed an annual closure of the fishery from November 16 to February 15 to protect spawning halibut (Browning 1980). The treaty was renegotiated in 1930 and 1937 to enhance the Commission's regulatory power, and in 1953 a treaty revision changed the name to the IPHC.

Development of Groundfish Fisheries (Dominated by Foreign Fisheries)

1940s-mid 1970s

The increased catching power of trawl gear, coupled with the advent of powered refrigeration and gear-handling equipment, electronic navigation, and other technologies, first posed a threat to the traditional Alaska fisheries for Pacific salmon, Pacific cod, sablefish, and halibut. However, these technologies eventually opened fisheries for lower-valued groundfish species, such as flatfish and pollock, because the trawl gear allowed harvesting of larger volumes of fish. This is reflected in the early fisheries regulations.

The State of Alaska has management authority for fishery resources within state territorial waters (3 miles offshore) by virtue of the Submerged Lands Act of 1953. Prior to statehood in 1959, all regulations affecting the groundfish fisheries were federal and implemented by the Bureau of Commercial Fisheries. These federal regulations focused on implementing licensing and reporting requirements, but also limited the type of gear that could be used at certain times and in certain areas.

A very robust foreign groundfish fishery operated off Alaska long before the MSA was passed in 1976. Japan fished the Bering Sea for pollock from 1933 to 1937, for yellowfin sole during 1940 and 1941, and for flatfish in the early 1950s. Japan also fished the GOA for Pacific ocean perch in 1960 and for flatfish in 1963. The Soviet Union sent exploratory fleets to the Bering Sea in 1958 and commenced commercial operations in 1959 on yellowfin sole and red king crab, and then expanded into Pacific ocean perch and herring in 1960. The Soviets moved into the GOA in 1964 and decimated Pacific ocean perch stocks before moving onto new fishing grounds off Washington and Oregon. The Republic of Korea (South Korea) began fishing in the Bering Sea in 1967 and in the GOA in 1972. Poland sent one stern trawler to fish briefly in the GOA and Bering Sea in late 1973. Taiwan commenced operations off Alaska in 1974 and 1975, trawling for Pollock and gillnetting for salmon in the central and EBS, and longlining for sablefish off southeast Alaska. The late 1960s to the early 1970s represents a period of unregulated overfishing of groundfish resources off Alaska plus gear conflicts between foreign trawl fisheries and domestic pot fisheries for crab and longliner fisheries for halibut.

In the early 1960s, the U.S. had fisheries authority to only 3 miles off Alaska's coast; even within this 3 miles, waters were only closed to all foreign fishing. The U.S. thus had little leverage to restrict large offshore Japanese and Soviet operations during their initial build-up. Exchange of fisheries research and information was initially conducted with Japan and Canada under the auspices of the INPFC. However, the INPFC focused primarily on salmon interception issues.

Other than the limited regulations imposed by the State of Alaska, however, the U.S. had virtually no authority to impose restrictions beyond its territorial sea. The Truman Proclamation of 1945 asserted the nation's right to adopt conservation measures and to require foreign nations to comply with them. However, the U.S. did not extend its jurisdiction over fisheries beyond its 3-mile-wide territorial limit until 1966, when enactment of Public Law 89-658 extended the exclusive jurisdiction of the U.S. over fisheries from 3 miles to 12 miles offshore (Miles *et al.* 1982). Although the establishment of the 9-mile contiguous fishery zone (CFZ) under this law was a harbinger of the ultimate fisheries jurisdiction claim of 200 miles ten years later with the MSA, it was relatively ineffective in controlling the growth of foreign fishing capacity and groundfish harvests off the coast of Alaska.

Transition to Joint Venture Vessels

<u>Mid 1970s-late 1980s</u>

The 1976 Magnuson Fishery Conservation Management Act (renamed the MSA when amended in 1996) established a mechanism to Americanize the off-shore fishery. The MSA assigned the NOAA Fisheries and the regional fishery management councils the responsibility of managing the fisheries in the Fishery Conservation Zone now called the U.S. EEZ that extends out 200 miles from the seaward boundaries of all coastal states. In the North Pacific, NOAA Fisheries and NPFMC took over management of a groundfish fishery that was largely unmanaged and open to all who wished to participate. Americanization of the groundfish fisheries was enhanced by actions of NPFMC and NOAA Fisheries that provided domestic harvesters and processors a priority over foreign interests. The development of the domestic groundfish fishing and processing industries was a high priority of Congress and NPFMC and therefore of NOAA Fisheries. To achieve this, NPFMC developed two FMPS authorized by the MSA. The groundfish FMP for the GOA was approved by NPFMC and adopted and implemented by NOAA Fisheries in 1978. It established broad management goals and principles. The FMP provided regulations that defined groundfish species and prohibited species, and established a process for determining OY and setting harvest guidelines. A similar FMP for the BSAI was approved in 1982.

Figure 3.9-1 dramatically demonstrates the magnitude of the foreign fisheries in the EEZ off Alaska and provides an indication of the development of domestic fishing and processing infrastructure that would be necessary to fully Americanize the groundfish fisheries off Alaska. It shows the total harvests of all major Alaska fisheries by the domestic fishing and processing industry from 1975 through 1980. Domestic harvests were minimal for groundfish during this period compared to salmon and crab, accounting for less than 6,000 of the 262,000 mt harvested in the domestic fisheries. The value of groundfish harvests is estimated to have accounted for only 0.2 percent of the total value of domestic fisheries in Alaska in 1980. Figure 3.9-2 shows the same data for the years 1977-1980, but adds harvests of groundfish in the EEZ by foreign fishing vessels.

From 1976 until the late 1980s, a variety of federal laws and programs were developed to promote the "Americanization" of fisheries inside the U.S. EEZ, especially the rich groundfish resources of the Bering Sea (NMFS 2002g). A start toward this was made in the early 1980s with the advent of what was known as the "Fish-and-Chips" policy. Fish-and-Chips tied foreign fishing privileges in the EEZ to commitments by the foreign entities to purchase the products of the U.S. seafood industry. A parallel program sponsored by NOAA Fisheries, the Fisheries Obligation Guarantee Program, guaranteed more than $150 million worth of loans between 1977 and 1996 for the construction of U.S. catcher processors and inshore floating processors. This program lowered capital investment costs relative to competitive market rates, thereby encouraging capital investment in the North Pacific groundfish fisheries and other U.S. fisheries.

The time period of 1978 to 1990 became a transition period to JV. The MSA enhanced the management actions of NPFMC and NOAA Fisheries. Domestic processors were surveyed in the fall each year. The survey results assisted in allocating the domestic annual processing (DAP) for the year, which was estimated by the total allowable level of foreign fishing (TALFF). Domestic processors were allocated the DAP if it was less than the total allowable harvest. The DAP directly reduced the TALFF. In addition to domestic processing priority, a DAH was created. If U.S. fishing vessels wished to participate in groundfish fisheries, they were also given a priority over TALFF regardless of whether domestic processors were involved. The creation of the DAH led to joint venture processing operations between U.S. fishing vessels and foreign motherships. Under these incentives, the Alaska groundfish fishery transitioned from almost entirely foreign to joint ventures to a completely domestic fishery in 1991, with 100 percent of groundfish harvested and processed by U.S.-owned vessels or shorebased processing plants in Alaskan communities. This dramatic expansion of the domestic fishery was financed, in large part, by a flood of foreign capital into new vessels and processors. (After the passage of the Commercial Fishing Industry Vessel Anti-Reflagging Act of 1987, fishing and processing vessels were required to have at least 50 percent U.S. ownership, but no similar ownership requirements were imposed on shore-based processors—all shorebased processors on Alaskan soil were considered domestic regardless of the actual ownership of the facility).

As shown in Figure 3.9-3, the transition from foreign fishing and processing to U.S. fishing and foreign processing with JV processors occurred in the early 1980s. JV processors operations peaked in 1987 and TALFFs were eliminated by 1988. In 1986 the transition to domestic processing began to accelerate, and by 1989 DAPs exceeded JV processors. The last JV processors operations occurred in 1990.

Much of the early development of domestic processing came in the form of U.S.-owned catcher processors and offshore motherships. In 1990, nearly 1.37 million mt of groundfish were processed at sea by domestic catcher processors and motherships, compared to 0.44 million mt processed by shorebased processing facilities. By 1991, the amount of groundfish handled by domestic processors was nearly 10 times greater than the amount of salmon, crab, halibut, and other species combined. The peak groundfish catch during that year occurred, in part, because blend estimates of catch and bycatch were not yet used to monitor most quotas. If they had been, several fisheries would have been closed earlier in the year (Hiatt *et al.* 2001).

The growth and relative importance of the domestic processing of groundfish is demonstrated in Figure 3.9-4. Between 1992 and 2000, groundfish accounted for approximately 85 percent of the total volume of fishery resources harvested in the commercial fisheries of Alaska. Figure 3.9-5 shows the growth and relative importance of the domestic groundfish fisheries in terms of wholesale product value. From 1977 through 2000, groundfish has developed to be the single most valuable resource for domestic processors, accounting for more than 45 percent of total wholesale value of all Alaska fishery resources.

As noted above, foremost within the overall rapid development of the groundfish fishery was the at-sea processing, or factory trawl fleet (NMFS 2002g). Other sectors, including onshore processing plants and harvesting vessels, existed prior to the development of the domestic pollock fishery, but they were involved in other fisheries. By 1990, there were more than 50 factory trawlers participating in the BSAI pollock fishery, along with several motherships and four major shoreside plants. The new domestic factory trawler fleet alone brought enough capacity to the BSAI pollock fishery to catch and process considerably more pollock than allowed under the TAC. The inshore processing industry, supplied by smaller, mostly independent catcher vessels, also had considerable excess capacity. Estimates of harvesting and processing capacity in the pollock fishery suggested that perhaps two or three times more capacity existed in the fishery than would be required to "efficiently" harvest and process the TAC (NMFS 2002g). Nearly a year-round fishery in the early to mid-1980s, the pollock fishery shrank to less than 60 days by 1992, in the face of a steady, or slightly increasing, quota.

Domestic Fishery and Management Objectives

Early 1990s-Present

During the transition, NPFMC and NOAA Fisheries became increasingly aware that managing a largely foreign fishery and allocating fishery resources among foreign and domestic interests were much easier than managing a purely domestic fishery and allocating fishery resources among competing U.S. interests. When fishery managers impose regulations that may have negative economic consequences for one sector while providing positive economic consequences for another, it becomes difficult to allocate resources between domestic users. The fisheries became fully domestic under a democratic allocation system, a process developed by NPFMC. It was becoming increasingly clear that rapid expansion of the domestic fleet under open access was creating conditions that led to a race for fish. Under TALFF and JV processors fisheries, open access and the race for fish was not a problem. From the perspective of NOAA Fisheries, the foreign fishery was essentially managed with individual quotas, and a race for fish did not exist. Following the NPFMC decision to implement IFQs in the sablefish and halibut longline fisheries and allocate pollock between inshore and offshore processors, they realized that the rapid Americanization of groundfish had created an overcapitalized, open access fishery that generated a profusion of fishery management issues. Some of these issues include allocation conflicts, gear conflicts, deadloss due to ghost fishing by lost or abandoned gear, excessive bycatch and discards, excess harvesting capacity, reduced product quality as reflected in prices, poor safety, lack of economic stability for fishery participants and communities, and a lack of rural coastal community development (NPFMC 1991). The IFQ program for halibut and sablefish was intended to address these issues. The IFQ is one means to limit entry in order to reduce overcapitalization and the wasteful practices that occur under other systems.

As part of the inshore/offshore pollock allocation, the first CDQ program to be implemented was recommended by NPFMC in 1992 (NPFMC 1992a). The NPFMC had previously adopted (in 1991) a CDQ allocation for the Pacific halibut and sablefish fixed-gear fisheries as part of the IFQ program for these fisheries but this was not implemented until 1995. The first CDQ pollock harvests were made in December 1992. Initially 7.5 percent of the BSAI pollock TAC was allocated to the CDQ program. The overall allocations are divided among the communities based on recommendations of the State of Alaska. In 1995, the program was expanded by the NPFMC to include allocations for king crab, Tanner crab, and other groundfish species. The expanded multi-species CDQ program was authorized by Congress in 1996 and fully implemented in 1998 (see Section 3.9.4).

In October 1998, Congress enacted the AFA which has had a profound effect on the management of groundfish fisheries in the BSAI and, to a lesser extent, the groundfish fisheries in the GOA. The AFA subsumed NPFMC action in June 1998 to change the inshore/offshore allocation. After increasing the CDQ allocation of BSAI pollock to 10 percent of the TAC and providing for bycatch amounts in other fisheries, the AFA shifted just over 10 percent of the BSAI pollock TAC from motherships and factory trawlers to inshore processors, which include processing plants on land and floating processors anchored near shore. A profound change brought by the AFA was the creation of a pollock factory trawlers cooperative called the Pollock Conservation Cooperative (PCC). A group of catcher vessels that delivered fish to these factory trawlers also was able to form a separate cooperative. The formation of these cooperatives allowed the factory trawlers, and catcher vessels that deliver to them, to allocate among themselves the offshore factory trawler sector's share of the pollock TAC each year until December 31, 2004.

In response to the rapid Americanization, NPFMC initiated a Comprehensive Rationalization Program in 1992. The NPFMC's main concern was to "maintain the health of the marine ecosystem to ensure the long-term conservation and abundance of the groundfish and crab resources. In addition, NPFMC must address the competing and oftentimes conflicting needs of the domestic fisheries that have developed rapidly under open access, fisheries which have become over capitalized and mismatched to the finite fishery resources available".

In the years following Americanization of the fisheries and initiation of the Comprehensive Rationalization Program, several amendments were approved that have resulted in limiting the number of participants and the types of activities in which they engage.

The ban on roe stripping (Amendment 19 to the GOA FMP and Amendment 14 to the BSAI FMP) and allocation issues would soon become increasingly bitter disputes. The first hint of these consequences occurred with the allocation of sablefish among gear types in the GOA under Amendment 14.

A moratorium on new harvesting vessels entering the groundfish fisheries was implemented through GOA Amendment 28 and BSAI Amendment 23. The moratorium reduced the possibility of significant increases in the number of large-capacity harvesting vessels activity participating in the groundfish fisheries.

Allocations of pollock between inshore and offshore sectors were approved and implemented in 1992. Amendment 18 to the BSAI FMP set aside one half of the pollock reserve (7.5 percent of the BSAI pollock TAC) for CDQ harvest, allocated 35 percent of the remaining BSAI pollock TAC to vessels catching pollock for processing by the inshore component and 65 percent of the remaining BSAI pollock TAC to vessels catching pollock for processing by the offshore component. Amendment 18 also established a catcher vessel operational area in which catcher processors and motherships were prohibited from engaging in directed fishing for pollock during the B Season (September 1 to November 1). Amendment 23 to the GOA FMP allocated 100 percent of the GOA pollock TAC to vessels catching pollock for processing by the inshore component. Amendment 23 also allocated 90 percent of the GOA Pacific cod TAC to vessels catching Pacific cod for processing by the inshore component, and 10 percent of the GOA Pacific cod TAC to vessels catching Pacific cod for processing by the offshore component. The inshore and offshore allocations reduced the possibility that processing by one sector (inshore or offshore) could negatively affect harvesting and processing by the other sector. However, open access conditions and excess capacity continued in both the inshore and offshore sectors resulting in intense competition and potential economic instability.

An allocation of the BSAI Pacific cod harvests between jig, fixed gear, and trawl fisheries was implemented through BSAI Amendment 24. This amendment was reauthorized in 1996 (Amendment 46) with changes in the allocation and an additional split between TCVs and trawl catcher processors. Amendment 64, approved in 1999, further subdivided the fixed gear portion of the BSAI Pacific cod fishery among longline catcher processors, longline catcher vessels (LCV), and pot gear vessels. The Pacific cod allocations in the BSAI provided trawlers and fixed gear vessels a fixed percentage of the fishery, and eliminated the threat that the harvesters of one gear group would impinge on the harvests of the other.

The NPFMC groundfish LLP was approved in 1995, further reducing the number of vessels eligible to participate in the groundfish fisheries. The LLP also added the remaining groundfish species in the BSAI to the CDQ program. Amendments in 1998 and 2000 have placed additional restrictions and qualification criteria on licenses. The CDQ portion of the LLP was implemented in 1998 and first licenses were issued in 2000. The LLP removed additional amounts of the groundfish harvest from the open access fishery and further reduced the possibility of an increase in harvesting capacity that could erode the expectations of currently participating vessels.

With the approval and implementation of the AFA of 1998, the open access nature of the pollock fishery in the BSAI was virtually eliminated. The number of vessels and processors allowed to participate in the fishery was fixed, and each provided access to a fixed portion of the pollock resource through a cooperative. The possibility that an AFA vessel or processor can have negative impacts on the ability of another AFA vessel or processor to participate in the BSAI Pollock fishery was minimized.

Summary of Historical Overview

The enactment of the MSA in 1976 established NPFMC and gave it authority to recommend to the Secretary of Commerce fishery management policies. By 1988, participation in the North Pacific groundfish fishery in the EEZ was limited to domestic fishing vessels and plants and foreign processor vessels in joint venture operations with American-owned catcher vessels. Joint venture operations were then phased out leaving the fishery fully "Americanized" by 1991. However, by 1988 domestic capacity was sufficient to harvest the groundfish TAC and was still expanding rapidly. This led to the race for fish. In 1996, NPFMC enacted the LLP, a more restrictive form of limited access. This in turn allowed in more vessels than were necessary to prosecute the fisheries, leading to several amendments to the BSAI and GOA groundfish FMPs. Amendments to FMPs and the race for fish led NPFMC to focus on limiting catches to sustainable levels and the various user groups to focus on securing shares of the TAC. Table 3.9-125 summarizes the effects of past/present events and actions on the harvesting and processing sectors. This information is also referred to as the comparative baseline.

The FMP amendments have included direct allocations of quotas for particular species or species groups to groups of vessels as delineated by gear type, vessel size, mode of operation, etc.

3.9.2 Harvesting and Processing Sector Profiles

This section presents data that summarize various aspects of the economic status of the groundfish fisheries in the U.S. EEZ off Alaska. Generally, data are presented for the harvesting and processing sectors of the groundfish fisheries for 1992 through 2001. The primary source of the economic information presented here is the document, *Sector and Regional Profiles of the North Pacific Groundfish Fisheries – 2001* (Northern Economics, Inc. and EDAW, Inc. 2001).

Section 3.9.2 is divided into four subsections:

1. Section 3.9.2.1 describes the key indicators used in this analysis to assess economic conditions in the harvesting and processing sectors.

2. Section 3.9.2.2 provides an overview of the major causes of economic change in the harvesting and processing sectors.

3. Section 3.9.2.3 describes the primary sources of economic data used in this analysis.

4. Section 3.9.2.4 presents profiles of the harvesting and processing sector classes identified for this analysis. Specifically, this subsection describes the activities of 1) various classes of catcher vessels — vessels that harvest groundfish and deliver their catch to processors; 2) various classes of catcher processors—vessels that both harvest and process groundfish; and 3) other types of processors—shore-based processors, floating inshore processors (FLP), and motherships that take deliveries of groundfish from catcher vessels.

3.9.2.1 Key Indicators of Economic Conditions in the Harvesting and Processing Sectors

The profiles of the harvesting and processing sectors describe the economic status of the Alaska groundfish fisheries in terms of various quantitative measures of economic activity and output using estimates of the size and composition of the groundfish fleet, the number and type of processing facilities, vessel and plant ownership, the amount of groundfish caught and retained, the ex-vessel value of groundfish landed, the quantity and value of groundfish seafood products, the number of people employed, and the payments to labor (also called labor income). Ex-vessel value is equal to the quantity of fish retained for processing multiplied by the ex-vessel (dockside) per unit price. This value represents both the gross revenues earned by harvesters and the costs of raw fish paid by processors. Gross product value is equal to the quantity of processed product multiplied by the wholesale product price after primary processing. This value represents the gross revenues earned by processors.

Other economic and social indicators examined in this analysis are described in more qualitative terms. These indicators include product quality, product utilization rate, harvesting and processing capacity, and safety of human life at sea. The analysis also includes a qualitative discussion of changes in average costs in the harvesting and processing sectors. However, the firm-level cost data required to estimate changes in net revenues (gross revenues less variable and fixed costs) are unavailable.

It is also important to note that a number of the indicators described above can serve as indicators for economic variables that are difficult to measure directly. For example, an estimate of labor payments is a surrogate measure of the contribution of the groundfish fisheries to a community's employment levels. Similarly, total and groundfish ex-vessel values by region of landing are subject to local and state taxes and, therefore, are indicators of the fishery-generated tax revenue that accrues to local and state governments. They are also a measure of the demand for shoreside support services by the groundfish fisheries.

3.9.2.2 Internal and External Factors Affecting Economic Conditions in the Harvesting and Processing Sectors

The economic performance of the Alaska groundfish fisheries is influenced by a variety of factors. For the purposes of this analysis, the conservation and management measures that regulate the fisheries are considered to be internal factors. As described in Section 3.9.1, certain management measures have dramatically affected economic conditions in the domestic groundfish fisheries as a whole or segments of those fisheries. These management measures include those implemented to prevent overfishing of groundfish stocks and to protect ecosystems as well as those measures designed to allocate the groundfish quota among various user groups and to enhance the economic efficiency of the fisheries.

The economic performance of the Alaska groundfish fisheries is also significantly affected by factors external to the regulatory regime. These factors include the domestic and foreign demand for groundfish products, economic conditions in other Alaska fisheries, the costs of harvesting and processing inputs—such as fuel and labor—and changes in fishing technology. Foreign and domestic demand, in turn, is a function of such factors as consumer preferences, the supply of competing products, foreign exchange rates, international trade agreements, demographics, and national income levels (Kinoshita *et al.* 1993).

The single most important of these demand-related factors is the food preferences of consumers. Shifting tastes in domestic and foreign markets can have a profound effect on the harvesting and processing decisions of fishery participants and the economic health of the industry as a whole. Among U.S. consumers, for example, the increased demand for seafood products that resulted from reports of the health benefits of eating fish and shellfish had a marked positive economic impact on certain segments of the domestic fishing industry, including harvesters and processors of Alaska groundfish. On the other hand, markets for Alaska groundfish thought to be stable and dependable—such as exports of pollock surimi to Japan—may change significantly in the future. One fish buyer interviewed for this analysis suggested that the demand for certain surimi-based products in Japan appears to be declining along with the demand for other traditional foods.

Another especially important variable in the market for Alaska groundfish products is the pollock harvest in Russian waters (NMFS 2001b). Russia has accounted for more than half of total world harvest of pollock, and vessels of other nations fishing in Russian waters also catch significant volumes. These foreign harvests compete directly with U.S. harvests in international markets for Alaska pollock products. In the past several years the TAC in Russia has been reduced each year. However, there is general consensus that the Russian stock of Alaska pollock has been overfished. Adding to this is financial difficulty in the Russian fishing industry. It is likely that harvests from Russian waters will decline even further before they stabilize; one estimate suggests it may be at least 2005 before stocks recover from overfishing The declining trend of harvests from Russian waters suggests a favorable market outlook for pollock from the EEZ off Alaska over the next few years due to tightening world supply.

A third important exogenous factor related to markets for groundfish is foreign exchange rates. With the large amount of groundfish that is exported from the fisheries off Alaska to Japan, the strength of the Japanese yen relative to the U.S. dollar can be a powerful force in the market for groundfish and other Alaska seafood products. The major collapse of the economy in southeast Asia during the late 1990s led to an economic slowdown in Japan, which caused Japanese consumer demand to slow (NMFS 2001b). The yen weakened significantly, and the exchange rate dropped to a low of 144 yen per dollar in August 1998. The weak yen and slackened demand placed great pressure on Alaska producers. The economy has since recovered somewhat, and the Japanese yen has strengthened against the dollar.

The economic status of the Alaska groundfish fisheries is also heavily influenced by other Alaska fisheries. These fisheries may provide fishing opportunities to vessels and processors participating in the groundfish fisheries, intercept or otherwise affect groundfish stocks and harvest quotas, and provide other sources of employment and tax revenue for local communities. The fisheries that have the greatest potential effects are crab (tanner and king), salmon, halibut, and state groundfish fisheries. Several classes of catcher vessels and inshore processors (shore-based processors and FLPs) currently rely to a certain degree on the harvest from these fisheries. In some communities the processing sector handles a range of products (e.g., groundfish, crab, and salmon), while in other communities the processors are more specialized. Fisheries other than those occurring near Alaska, such as the Pacific whiting fishery off Oregon and Washington, are also important for several catcher vessels, catcher processors, and motherships.

Finally, the economies of the communities in which processors are located or from which harvesters operate also have an effect on economic conditions in the Alaska groundfish fisheries. The economic development activities that have the greatest potential effect are State of Alaska and federal oil and gas exploration/ production, defense industry projects, tourism and the construction and operation of marine or air-related transportation facilities. Non-fishing economic activities within coastal communities may compete with the groundfish industry for labor, services, and facilities. Alternatively, they can provide supplementary employment and income-generating opportunities for fishermen, processors, and others involved in the fishing industry.

3.9.2.3 Data Sources and Methodology

The fisheries data collection system used to monitor the groundfish fisheries has changed significantly over the past twenty-five years. When the MSA was implemented in 1976, the groundfish fisheries were dominated by foreign catcher processors and motherships. To monitor fishing activity, NOAA Fisheries required the vessel operators to record activities in logbooks. U.S. observers on the vessels reported catch estimates and logbook entries weekly. This system of reporting continued into the 1980s, when much of the groundfish catch was harvested by domestic catcher vessels and delivered to foreign processing vessels in joint venture operations. Deliveries by domestic catcher vessels to inshore processors were reported by means of ADF&G groundfish fish tickets.[1] Catcher processors were also required to submit fish ticket reports of groundfish catches to the ADF&G, but these vessels could stay at sea for long periods, and thus did not report as frequently as catcher vessels. With the rapid expansion of the domestic catcher processor fleet, it became apparent that a mechanism for timely reporting of catches by this fleet was needed. By 1987, NOAA Fisheries required weekly reports of groundfish caught in the EEZ and processed at sea from all catcher processors and motherships regardless of how long their catch was retained before landing. Currently, both at-sea and inshore processors are required to report estimates of all harvests and deliveries on a weekly basis using the Weekly Production Report (WPR).

In 1990, the groundfish FMPs for the GOA and EBS were amended to establish mandatory observer coverage requirements for vessels and plants involved in the groundfish fisheries. With some exceptions, those amendments require vessels 125 feet or longer to carry an observer 100 percent of the time while fishing for groundfish; vessels 60-124 ft long to carry an observer during 30 percent of their fishing days in each calendar quarter of the year in which they fish more than 10 days; plants processing 1,000 or more metric tons in a month to have an observer in the plant each day they process groundfish; and those processing 500-1,000 mt to have observers 30 percent of the days. Since 1992, NOAA Fisheries has based all estimates of catch in the groundfish fisheries on a blend of observer data and WPR data.

Estimates of total catch for the processor profiles presented in this analysis were derived from the NOAA Fisheries blend data. NOAA Fisheries WPR data were used to derive final product estimates. The product

[1] Fish tickets record landed weight and value by species. A fish ticket is considered a legal document and requires the signature of the permit holder (captain or operator) and the receiver (buyer).

price information provided by NOAA Fisheries was based on data collected by the State of Alaska in the Commercial Operators Annual Reports.

Data for catcher vessels that delivered to inshore processors are primarily from fish tickets collected by ADF&G. Analysts from NPFMC parsed the fish ticket records such that only records of deliveries to inshore processors were included. These data were available for 1988 through 2001.[2] Data for the years before 1988 were not available because it was not feasible to adequately parse the data voluntarily submitted by catcher processors and motherships. Including such information could result in double counting errors.

Fish ticket data do not fully account for fish that have been discarded. To provide a consistent set of information only harvests retained by inshore processors have been included in the catcher vessel profiles. The fish ticket information provided by NPMFC included estimates of the ex-vessel value of each delivery.

While deliveries to inshore processors are recorded on ADF&G fish tickets, at-sea deliveries to motherships are monitored by observers. However, these observers do not routinely record the species composition of deliveries made by individual catcher vessels. To estimate the species composition of deliveries to motherships, observer data for individual catcher vessels were combined with NOAA Fisheries blend data for motherships. The blend data were used to estimate the monthly average species composition for each mothership, while the observer data were used to estimate the monthly catch delivered by each catcher vessel. The average species composition of each mothership was assigned to the catch of each of its catcher vessels so that the sum of the amount of each species delivered by all of the catcher vessels equaled the total quantity of fish received by the mothership.

The ex-vessel value of at-sea deliveries must be estimated. Unlike data for deliveries to inshore processors, there is no regularly collected information on prices paid for deliveries at sea prior to 2000.[3] To estimate at-sea ex-vessel value this analysis used the following formulaic approach validated by industry sources in June and July 2000:

- The at-sea ex-vessel price of pollock and Pacific cod is 87.5 percent of the price paid for deliveries inshore. Payments are only for that portion of the catch retained by the mothership.

- The at-sea ex-vessel price of all other species is 40 percent of the first wholesale value of the mothership's final product. Other than pollock and Pacific cod, few groundfish species were retained by motherships between 1991 and 2001.

Vessel ownership and address information from Commercial Fisheries Entry Commission (CFEC) vessel registration files and NOAA Fisheries Federal permit data was used to assign income and employment estimates from the groundfish fisheries to regions in Alaska, Oregon, and Washington. Processor ownership and address information from NMFS Processor Permit data and from ADF&G Alaska Seafood Processor and Exporter License and Permit data was used to assign processors to regions. Because of inconsistencies in the

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[2] The catcher vessel profiles use ADF&G fish ticket data from 1992 to 2001 in order to be consistent with processor profiles.

[3] Beginning in 2000, at-sea deliveries by catcher vessels were required to be reported on ADF&G fish tickets.

ownership data in early years, the analysis assigned processors to the region indicated in the most recent CFEC vessel registration or Federal permit data available.

The catch data sets contain many instances of incidental groundfish catch reported by catcher vessels and processors participating in non-groundfish fisheries. Vessels fishing for halibut, for example, are required to land incidental catches of Pacific cod and rockfish. In an effort to focus the analysis on harvesting and processing operations with a significant involvement in the groundfish fisheries, threshold limits were established for catcher vessels and catcher processors. The threshold limits varied by gear and vessel length. Vessels that had landings below these limits were excluded from this analysis. In addition, inshore processors that acted as buying stations or were not associated with a given port were excluded. Unidentified vessels or catcher vessels that made catches below threshold limits accounted for approximately 0.6 percent of the value of the groundfish fisheries from 1992 through 2001.

Employment estimates for catcher processors and motherships are collected by NOAA Fisheries in WPR. For this analysis NOAA Fisheries provided information on the average crew size for each vessel and the number of weeks that each vessel was active between 1993 through 2000. Multiplying crew size by the number of active weeks provided an estimate of the number of crew member weeks for each vessel. Assuming a work year of 52 weeks, crew member weeks were translated into an estimate of Full Time Equivalent (FTE) employment. These estimates were increased by five percent to account for corporate office staff.

Employment estimates for inshore processors were derived in a different manner. WPR provided information on the volume of processed product for each inshore processor. These values were summed to obtain totals for each inshore processor class. The product volumes were then multiplied by coefficients representing the average tonnage of each product type that could be produced per labor hour.[4] The result is the number of labor hours to produce the product volumes. Using 2,080 hours as a standard work year (because many plant employees do not qualify for vacations and work on holidays), the FTE employment for each inshore processor class was estimated. The FTE employment estimates were increased by five percent to account for corporate office staff.

Inshore processing plant employment was assigned to the region in which the plant is located, with corporate office staff allocated to the region of the plant owner's address as indicated in permit files. Catcher processor, mothership, and catcher vessel total employment (vessel and corporate office staff) was allocated to the regions indicated in the CFEC vessel registration or federal permit data. This method of assigning employment to regions is similar to that used by state and federal agencies. Insufficient information exists to provide a more accurate account of regional employment patterns in the groundfish fisheries. The method of assigning employment to regions used in this analysis does not attempt to account for the formal or legal residency of employees.

[4] The coefficients originated in the Fisheries Economic Assessment Model for Alaska (Jensen and Radtke 1990). They were first updated by Northern Economics, Inc. as part of a Fisheries Industry Model (FIM) prepared for the U.S. Department of Interior, Minerals Management Service (Northern Economics, Inc. 1990 and 1994). The coefficients were updated again by Northern Economics, Inc. in unpublished reports prepared for the City of Unalaska and City of King Cove that provided a revenue forecasting system for each community. The coefficients represent averages for processing facilities throughout the state, and substantial variation can occur across processor classes.

Estimates of employment on catcher vessels were derived from previous studies of crew-size for various vessel types and from interviews with industry representatives. Estimates of employment for a particular vessel class were made by multiplying the crew-size estimate by the number of active vessels in the class during each month. Crew member months were converted to crew member hours by assuming that crew members work an average of 16 hours per day for an average of 15 days in every month their vessel is active. The total number of estimated crew member hours was then divided by 2,080 hours to obtain an estimate of FTE employment.

Payments to labor for both offshore and inshore processors were estimated by multiplying total wholesale production value by the percent of that value accounted for by processing labor. Studies by Northern Economics, Inc. (1990 and 1994) indicated that processing labor accounts for 20 to 30 percent of total wholesale production value for the various processor classes. The estimated payments to processing labor were increased by 10 percent to account for the salaries of corporate office staff. Payments to labor for catcher vessels were estimated assuming that labor costs are equal to 40 percent of ex-vessel value. Payments to labor for inshore processors, catcher processors, motherships, and catcher vessels were regionally distributed in the same manner as described above for employment.

3.9.2.4 Sector Profiles

Profile Categories

The groundfish fisheries support a wide array of harvesting and processing operations. This analysis has grouped these operations into three groups representing 1) catcher vessels; 2) catcher processors; and 3) shore-based processors, FLPs, and motherships. These groups have been further subdivided into twenty-one classes as follows:

- Nine classes of catcher vessels defined on the basis of fishing activities in a given year and vessel size.

- Five classes of catcher processors defined on the basis of the predominant product type or gear type associated with these vessels.

- Seven classes of shore-based, floating inshore, and mothership processors defined on the basis on the regional location of the facilities.

More detailed descriptions of each of these categories are presented in Table 3.9-1.

To further facilitate the organization and presentation of fisheries data, groundfish species were aggregated into four main groups, as shown in Table 3.9-2. Grouping species allows the analysis to provide a relatively uniform description of activities by vessel class and to report as much catch data as possible without violating NOAA Fisheries restrictions pertaining to release of confidential data .[5] In addition, seven geographic regions were defined to enhance the presentation of information on the linkages between groundfish harvesting and

[5] NOAA Fisheries and State of Alaska policies regarding the protection of confidential data require that fisheries operations data be aggregated to include information from at least four individual operations. Because of the limited activity of some types of vessels in some regions, disclosure of less aggregated species data would have violated this confidentiality limitation.

processing operations and coastal communities. These regional classes are presented in Table 3.9-3. Section 3.9.3 provides details on the socioeconomic relationship between the groundfish industry and communities and regions in Alaska, Washington, and Oregon.

Overview of Activities in Alaska Groundfish Fisheries

Economic conditions within the harvesting and processing sectors of the Alaska groundfish fisheries have undergone major changes over the past three decades. This section examines the historical context of economic conditions in the Alaska groundfish fisheries, as well as the possible agents of change. The description of historical trends is divided into two time periods. The period of 1977 to 1991 corresponds to the era of rapid development of domestic fishing and processing capacity following the enactment of the MSA. The years 1992-2001 follow the modification of the fisheries data collection system. All catch data reported after 1991 are based on the blend estimates of total catch which are used by NOAA Fisheries to monitor groundfish and prohibited species catch quotas during each fishing year. In addition, it is during this period that allocation issues among domestic fishery participants and the effects of the groundfish fisheries on the marine ecosystem received greater attention.

The availability and consistency of data limits the ability to analyze historical change in indicators of the economic condition of the Alaska groundfish fisheries, particularly during the years immediately following the implementation of the MSA. This analysis is also limited by the difficulty of delineating the cause-and-effect relationships between multiple factors and the resultant economic effects. As noted in Section 3.9.2.2, many factors substantially affect the economic status of the Alaska groundfish fisheries. Changes in markets, biological conditions and fishery management regulations can result in changes in the revenues and operating costs of firms participating in the fisheries as well as changes in fleet size and composition. Isolating the effects of a single factor is seldom possible, especially when data are presented for the groundfish fisheries as a whole. The effects of various factors are more easily discerned when the activities of individual catcher vessel and processor classes are described later in this section.

<u>1977 to 1991</u>

As discussed in Section 3.9.1, the MSA was designed to promote the development of a U.S. offshore fleet through an allocation system that favored domestic vessels over foreign vessels and joint venture operations. During the 1980s, the groundfish fisheries in the U.S. EEZ off Alaska changed from being primarily foreign fisheries to fully domestic fisheries. Foreign fishing ended in 1987, and JV processing operations peaked in the same year. In 1986, the transition to domestic processing began to accelerate, and by 1989 allocations to domestic processors exceeded allocations to joint ventures. The last JV processing operations occurred in 1990.

Much of the early development of domestic processing came in the form of U.S.-owned catcher processors and offshore motherships. Trawls, longlines, pots, and other types of fishing gear were used in the domestic groundfish fishery. Annual catch for virtually every gear group, area, and species increased dramatically from 1982 to 1990. However, vessels using trawl gear to harvest pollock in the BSAI area accounted for most of the total groundfish landings. Catch for offshore processing was the largest and fastest growing component of catch. The number of domestic catcher processors increased from only three in 1986 to 50 in 1991. By 1990, nearly 1.37 million mt of groundfish were processed offshore by domestic catcher processors and motherships, compared to 0.11 million mt in 1986. The catch processed by shore-based facilities increased from 61,500 mt in 1986 to 463,400 mt in 1991. The relative catch of these two types of operations varied by area and species (Kinoshita *et al.* 1993). In the BSAI the catch processed offshore exceeded that processed by inshore facilities for each species. The opposite was true in the GOA, with the exception of rockfish and flatfish.

The majority of the total groundfish catch was harvested by vessels with addresses listed in CFEC vessel registration or Federal permit data that indicated that they were based outside of Alaska. Much of the early development of domestic harvesting processing of groundfish resources came in the form of catcher processors and offshore motherships based in Seattle.[6] However, the percentage of catch taken by vessels registered by Alaska residents or corporations was greater when measured in terms of ex-vessel value rather than in terms of weight. This is because vessels registered by Alaska residents or corporations caught a larger proportion of higher priced species such as sablefish.

By 1991, the amount of groundfish handled by domestic processors was nearly 10 times greater than the amount of salmon, crab, halibut, and other species combined. Also, groundfish replaced salmon as the highest value commercial fishery off Alaska in 1991. The peak groundfish catch during that year occurred, in part, because blend estimates of catch and bycatch were not yet used by NOAA Fisheries to monitor most quotas. If they had been, several fisheries would have been closed earlier in the year (Hiatt *et al.* 2001).

<u>1992 to 2001</u>

Table 3.9-4 summarizes domestic harvesting and processing activity in the groundfish fisheries off Alaska from 1992 to 2001. More detailed information about each sector and region is contained in later subsections.

From 1992 through 2001, an average of 1,083 catcher vessels made landings of groundfish above threshold levels each year. In the same period, an average of 107 catcher processors and 68 motherships and inshore processors annually participated in the groundfish fisheries. The number of participants in the groundfish fisheries decreased substantially during the ten-year period. The cause of the decline is likely a combination of several factors, including the implementation of a vessel moratorium and license limitation program, quota allocations among participants in the groundfish fisheries, mandated vessel retirements under the AFA, and changes in global markets for groundfish products.

Between 1992 and 2001, processors received groundfish with an average annual ex-vessel value of $244 million. Total groundfish harvests ranged from a high of 2.3 million mt in 1992 to a low of 1.6 million mt in 1999. Pollock accounted for approximately 66 percent of total reported harvests during the ten-year period. About 86 percent of total reported groundfish harvests were in the BSAI.

For the domestic groundfish fisheries as a whole, 94 percent of the 2001 catch was made by vessels with addresses listed in CFEC vessel registration or Federal permit data that indicated that they were based outside of Alaska (Hiatt *et al.* 2002). The catches of Alaska and non-Alaska vessels were much closer to being equal in the GOA where Alaskan vessels accounted for the majority of the Pacific cod and sablefish catch.

An average of 580 thousand mt of product were produced from groundfish per year between 1992 and 2001. This equated to an average utilization rate (product tons divided by reported harvest tons) of 29 percent. The

[6] Most of the shoreside pollock processing capacity was built and owned by Japanese seafood companies.

estimated average annual wholesale value of production was $1.2 billion between 1992 and 2001. During this period, the groundfish fishing and processing industry generated an estimated yearly average of 4,700 FTE jobs in Alaska and 5,300 FTE jobs in the Washington inland waters (WAIW) region, with an estimated total average payment to labor of $589 million.

Overview of Other Indicators of Conditions in the Alaska Groundfish Fisheries

The preceding discussion examined historical conditions in the Alaska groundfish fisheries in terms of various quantitative measures of economic activity and output. This section provides an overview of three additional variables that are discussed in more qualitative terms: harvesting and processing capacity, average costs, and safety of human life at sea.

Harvesting and Processing Capacity

A detailed discussion of the issue of harvesting and processing capacity in the Alaska groundfish fisheries is provided in the qualitative analysis of overcapacity. A summary of portions of that analysis is presented here.

In simple terms, fishing capacity is the ability of a vessel or fleet of vessels to catch fish (NMFS 1999c). This ability is a function of such factors as the number of fishing vessels in the fleet; the size of each vessel; the technical efficiency of each vessel (determined by factors such as on-board gear and equipment, fishermen's knowledge and techniques, and the size of the crew); and the time spent fishing (National Fisheries Conservation Center undated). Loosely speaking, overcapacity in a fishery occurs when the ability to catch fish exceeds what is needed to harvest sustainable yields. This condition can lead to intense fishing pressure on stocks, poor economic performance within the fishing industry, and inefficient use of labor and capital.

The rapid expansion of U.S. participation in the Alaska groundfish fisheries during the 1980s and early 1990s led to excess capacity in a number of these fisheries. The NPFMC responded in 1992 by initiating a comprehensive rationalization program. In the years following the initiation of the program, NPFMC and NOAA Fisheries, whether intentionally or unintentionally, progressively limited the number of participants in the Alaska groundfish fisheries and the types of activities in which they can engage. Major regulatory actions that affected capacity in the groundfish fisheries included the following management programs.

The sablefish and halibut longline fishery IFQ program was approved by NPFMC in 1991 and implemented by NOAA Fisheries in 1995. Quota shares were allocated within separate management areas and for specific vessel size classes. Shares are marketable but can be sold or traded only within each management area, within the same vessel size category, and with restrictions on the total amount and type of quota held. In 2002, NPFMC amended the IFQ program to allow fishing villages in the GOA with fewer than 1,500 people to acquire quota shares for sablefish and halibut. The measure allows 42 villages to buy quota shares and lease them to resident fishermen.

The western Alaska CDQ program was created to provide fishermen who reside in western Alaska communities an opportunity to participate in the BSAI groundfish fisheries, to expand their participation in nearshore fisheries, and to help alleviate the poor economic conditions within these communities. Initially, the western Alaska CDQ program relied on an allocation of the annual pollock TAC in the Bering Sea. In

1993, NPFMC extended the community development quota to halibut and sablefish. The multi-species CDQ allocations, adding all remaining BSAI groundfish, prohibited species and crab, were implemented in 1998.

A moratorium on new harvesting vessels entering the groundfish fisheries was implemented in 1995. The moratorium reduced the possibility of significant increases in the number of large-capacity harvesting vessels actively participating in the groundfish fisheries.

Final implementing rules for NPFMC's groundfish North Pacific LLP were published in 1998, and the first licenses were issued in 2000. The LLP superceded the moratorium and further reduced the number of vessels eligible to participate in the groundfish fisheries. The LLP also established groundfish area and gear endorsements. Licenses under the LLP are generally transferable, but endorsements are not severable from the license. Licensed vessels can be replaced, but increases in the length of licensed vessels are limited in vessels under 125 ft and prohibited in larger vessels.

In 1998, Congress passed the AFA which, among other things, limited the number of harvesting and processing vessels that would be allowed to participate in the BSAI pollock fishery. Only harvesting and processing vessels that met specific requirements, based on their participation in the 1995-1997 fisheries, are eligible to harvest BSAI pollock. The AFA also established the authority and mechanisms by which the remaining pollock fleet can form fishing cooperatives. Within each cooperative, each member company is contractually allocated a percentage share of the total cooperative allocation based on its historical catch (or processing) levels. In practice, the cooperative system is similar to an IFQ system. However, the distribution of fishing privileges and the system for trading, selling or enforcing them is decided by the members of the separate cooperatives.

These measures have, at least in part, limited excess harvesting and processing capacity in the Alaska groundfish fisheries. As shown in Table 3.9-4, the number of participants in the groundfish fisheries has decreased substantially since 1992. Yet, as indicated by recent problem statements prepared by NPFMC, the measures have not been successful in eliminating excess capacity as one of the major management problems for these fisheries. A recent report by Felthoven *et al.* (2002) supports NPFMC's position that significant excess capacity remains in several Alaska groundfish fisheries. Under the current management regime, these fisheries are expected to continue to generate an important share of the total ex-vessel value of all domestic commercial fisheries. However, the use of the race for fish to allocate TACs and PSC limits and the high levels of excess harvesting and processing capacity in many of the groundfish fisheries are expected to significantly decrease the net benefits to the Nation from these fisheries.

Average Costs

The costs of operating a fishing boat include fuel, repairs and maintenance, wages of skipper and crew, protection and indemnity insurance, food and consumable supplies, bait, and ice. Because these expenses change with changes in the quantity of output produced they are referred to as variable costs. For some fishing vessels, fuel is the single largest variable cost. It is estimated that these costs represent approximately 10 to 15 percent of the variable cost (Pacific States Marine Fisheries Commission [PSMFC] 2003).

Crew members are paid on a share system, so labor costs depend on the quality and market value of the fish and the number of people receiving a portion of the proceeds. The share agreement can differ from boat to boat. Some fishermen receive a share of the profits, while others receive a share of the gross earnings of the boat. This traditional payment method produces strong economic incentives for maximizing catches and minimizing costs.

Repair and maintenance costs can change substantially from one year to the next. In a particularly bad year these expenses could account for 20 percent of variable costs (PSMFC 2003). Protection and indemnity insurance accounts for approximately 5 percent of variable costs. Unlike hull insurance, which most operators treat as a fixed cost, protection and indemnity insurance is a variable cost. Its price is primarily dependent on three factors: expected numbers of days at sea, number of crew, and the loss history of the vessel or company (PSMFC 2003). Food and consumables make up about 2 percent of an at-sea operation's total variable costs. This category includes food as well as galley supplies, cleaning products, linens, miscellaneous hardware, etc.(PSMFC 2003).

Major operating expenses for fish processing facilities include raw fish, labor, fuel, shipping, utilities, permits, and packaging supplies. Some processing facilities also purchase food additives. For example, pollock surimi additives such as sorbital, sugar and phosphates account for about 5 percent of the variable costs (PSMFC 2003). Shipping costs account for approximately 12 to 15 percent of variable costs. The majority of fish products are shipped via commercial carriers to intermediate or final destinations. Wage rates vary from one plant to another and among locations. While some floating processors pay minimum wage ($7.15 per hour), the average pay, when room and board is not provided, is about $7.50 per hour (Alaska Department of Labor and Workforce Development 2003). A few plants operate only for a short five to six week season and may pay $8 or $9 an hour. In addition to wages, some Alaska fish processing companies offer other benefits to employees, such as free lodging and meals and transportation to and from Alaska if employees fulfill their contractual obligations. The seafood processing industry in Alaska has become very competitive, and employee benefit costs are major expenses. Few corporations willingly settle for lower profits, and no one wants to shut down, so many seafood processing workers' wages and benefits have been cut in recent years.

Other significant operating costs for certain shore-based processors and fishing vessels are those associated with deployment of observers.[7] The fishing industry must bear these costs, which are about $355 per deployment day, not including food costs.

In addition to variable costs, the operators of fishing vessels and processing facilities must meet fixed costs, i.e., expenses that do not vary with level of production, such as the interest on the debt incurred in purchasing a boat, processing facility, license, or other fishing- or processing-related assets.

At present, there is insufficient data on operating costs to comprehensively assess economic conditions in the groundfish fisheries. The types of economic data that would be necessary include disaggregated cost and employment information from harvesting and processing firms. No data on the costs of production and little

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[7] With some exceptions, observer regulations require vessels 125 ft or longer to carry an observer 100 percent of the time while fishing for groundfish; vessels 60-124 ft long to carry an observer during 30 percent of their fishing days in each calendar quarter of the year in which they fish more than 10 days; plants processing 1,000 or more metric tons in a month to have an observer in the plant each day they process groundfish; and those processing 500-1,000 mt to have observers 30 percent of the days.

data on employment levels are routinely collected.[8] Without information about costs, it is not possible to determine the profitability of harvesting and processing operations.

NOAA Fisheries and NPFMC have recognized the increasing need to collect economic data on a regular basis. To help meet this need, the Fisheries Economics Data Program was established as a cooperative data collection program by NOAA Fisheries and PSMFC with the assistance of NPFMC and Pacific Fishery Management Council. On-going economic data collection efforts by the program include a monthly survey of fuel docks at selected ports on the West Coast and in Alaska to create a marine fuel price index. Data are currently available for the period 1999-2002.

Safety of Human Life at Sea

The high risks faced by fishermen at sea and the effects of fishery regulations on those risks are recognized broadly. The MSA National Standard 10 highlights the issue of fishing vessel safety, stating that conservation and management measures must, to the extent practicable, promote the safety of human life at sea. The harsh sea and weather conditions in the Bering Sea and GOA make fishing in Alaska one of the most dangerous occupation in the U.S. (Barrett 2000). Lincoln and Conway (1999) of the National Institute of Occupational Safety and Health (NIOSH) estimate that, from 1991 to 1998, the occupational fatality rate in commercial fishing off Alaska was 116/100,000 (persons/full time equivalent jobs), or about 26 times the national average of 4.4/100,000.[9] Statistics indicate that 536 individuals suffered severe injuries in commercial fishing related incidents in Alaska during 1991-1997 (Lincoln *et al.* 2002), and 120 Alaska fishermen died between 1989 and 1999 (Cullenberg 2002). Over 90 percent of these deaths were due to drowning following vessel sinkings (Lincoln *et al.* 2002). Fatality rates were highest for the Bering Sea crab fisheries. Groundfish fatality rates, at about 46/100,000 were the lowest for the major fisheries identified by Lincoln and Conway. Even this relatively lower rate was about ten times the national average.[10]

Lincoln and Conway (1999) note, however, that during most of the 1990s commercial fishing in Alaska actually appeared to become safer. While annual vessel accident rates remained relatively stable, annual fatality per incident rates (case fatality rates) dropped. The result was an apparent decline in the annual occupational fatality rate. From 1991 to 1994, the case fatality rate averaged 17.5 percent a year; from 1995 to 1998 the rate averaged 7.25 percent a year. Lincoln and Conway (1999, p. 694) described their view of the source of the improvement in the following quotation:

> *"The impressive progress made during the 1990s in reducing mortality from incidents related to fishing in Alaska has occurred largely by reducing deaths after an event has occurred, primarily by keeping fishermen who have evacuated, capsized or sinking vessels*

[8] Most fishermen are considered self-employed and as a result are not included in Alaska Department of Labor and Workforce Development employment statistics.

[9] The rates in the NIOSH study are based on an estimate of 17,400 full time employees active in the fisheries. This estimate of the employment base was assumed constant over the time period. However, various factors may have affected this base, including reductions in the size of the halibut and sablefish fleets due to the introduction of individual quotas. These estimates must therefore be treated as rough guides.

[10] With an average fatality rate of approximately 28 fatalities per 100,000 FTE workers since 1990, the BSAI pollock fishery has enjoyed a relatively solid safety record for the past decade (Woodley 2002).

afloat and warm (using immersion suits and life rafts), and by being able to locate them readily, through electronic position indicating radio beacons."

There could be many causes for the lower number of deaths following vessel sinkings. Lincoln and Conway (1999) and van Amerongen (2002) point to provisions of the Commercial Fishing Industry Vessel Safety Act (CFIVSA) of 1988 that were implemented in the early 1990s. This law required the U.S. Coast Guard to issue new regulations for safety equipment and operating procedures for fishing, fish tender and fish processing vessels. It also increased casualty reporting requirements. As a result of this legislation vessels are better equipped with Emergency Position Indicating Radio Beacons (EPIRBs), life rafts, side-band radios, and survival suits. Moreover, emergency drill instructor training and mandatory monthly drills are required of all fishing vessels. Following the passage of the CFIVSA, vessels throughout Alaska have had the opportunity to obtain a Voluntary Dockside Examination (VDE) by the Coast Guard or Coast Guard Auxiliary (Medlicott 2002). If they pass the inspection they are issued a Vessel Safety Inspection Decal, valid for two years. Since a VDE is currently voluntary, the NPFMC initiated a regulation in 1998 that made the VDE or some other documentation of compliance with Coast Guard regulations mandatory for all vessels carrying observers (Cullenberg 2002).

In response to a surge in commercial fishing related deaths and vessel losses in 1999 (17 Alaska fishermen lost their lives in that year), the Seventeenth Coast Guard District increased the focus on commercial fishing vessel safety. One of the items developed was the "Ready for Sea" program (Page 2002). This is a list of the top ten safety items to which mariners should pay particular attention in order to mitigate known risks and help ensure a vessel's safe return to port. The checklist focuses on items that could prevent an incident and how to be prepared to respond if one does occur.

The Coast Guard receives support for maintaining fishing vessel safety from the North Pacific Fishing Vessel Owners' Association (NPFVOA), a non-profit, membership based organization. The NPFVOA and Coast Guard produced the Vessel Safety Manual in 1985 and collaborated on a core safety program and set of safety training videos. The core program consists of survival at sea training, first aid and CPR training, fire fighting, and stability training and the Safety at Sea video series includes four videos titled Safety Equipment and Survival Procedures, Fire Prevention and Control, Medical Emergencies at Sea, and Fishing Vessel Stability. After the passage of the CFIVSA, the NPFVOA developed a course to teach individuals how to conduct emergency drills. Since it was first organized, the NPFVOA has trained over 22,000 fishermen.

The IFQ program for the halibut and sablefish longline fishery and the establishment of cooperatives in the BSAI pollock fishery under the AFA have contributed to the improved safety record in the Alaska groundfish fisheries by slowing the pace of fishing. For example, the elimination of the race for fish in these fisheries provide captains with the opportunity to wait out a storm without negative economic consequences (van Amerongen 2002). A 1995 report from Marine Safety Reserve, a liability pool, noted a substantial decline in the longline vessel accident rate (injuries per fishing day) following implementation of the IFQ program (Buck 1995). Safety statistics compiled by the U.S. Coast Guard show that, as the IFQ program progressed, a substantial drop in search and rescue missions for the sablefish and halibut fisheries occurred (Hartley and Fina 2001a, Woodley 2002). Furthermore, a survey of sablefish fishermen revealed that more than 90 percent reported weather as an important factor in determining when to fish quota (Knapp and Hull 1996). Similar benefits in vessel safety have resulted from the operation of the AFA pollock cooperatives. While the slowing down of the BSAI pollock fishery and the flexibility offered by the quota systems has not had an impact upon fatality rates (the fatality rate has remained at zero since 1995), vessels from several of the Pollock

Conservation Cooperative companies have reported an approximately 50 percent reduction in processing-crew injuries (Woodley 2002).

Catcher Vessels

This section provides brief profiles of the nine classes of groundfish catcher vessels that participate in the groundfish fisheries off Alaska. As is the case with the profiles of the offshore and inshore processors that follow, the information on catcher vessels provided here is an abridged version of the detailed profiles in *Sector and regional Profiles of the North Pacific Groundfish Fisheries – 2001* (Northern Economics, Inc. and EDAW, Inc. 2001). Each catcher vessel profile reports generally the same types of information to ease comparisons among classes. The remainder of this introductory section describes the features that distinguish the various classes from each other and provides an overview of the catcher vessel activities from 1992-2001.

Catcher vessels harvest groundfish by using various gear types and deliver their catch to inshore processing plants or motherships. Catcher vessels can be divided into two general categories: trawl vessels and fixed gear vessels. This analysis creates five classes of trawl vessels based on participation patterns and vessel length. Four classes of fixed gear vessels are defined based on primary gears and vessel length. Each vessel with participation in the groundfish fisheries above threshold levels was assigned to one of these classes during a given year according to its fishing activities in that year and its size. The classes were developed specifically for use in this analysis to enhance the differences and similarities among the catcher vessels that participate in the groundfish fisheries.

Catcher vessels harvest a number of species, including both groundfish and non-groundfish. In an effort to provide a relatively uniform description of the activities of each of the nine types of catcher vessels and to report as much catch data as possible under NOAA Fisheries data confidentiality restrictions, this analysis aggregated the groundfish species into the four main groups (A-R-S-O, FLAT, PCOD and POLL) presented in Table 3.9-2. Further, catcher vessels operate in different regions of Alaska, and their owners and crew reside in communities located in or out of the state. The geographic regions that were identified for this analysis are presented in Table 3.9-3.

Table 3.9-5 provides a comparison of the relative level of activities of the different classes. Table 3.9-6 summarizes the operations of the nine catcher vessel classes in 2001.

The vessels in the first two trawl catcher vessel (TCV) classes (TCV Bering Sea pollock [BSP] ≥ 125 and TCV BSP 60-124) are all eligible to harvest the directed fishing allowance under Section (b)(1) of the American Fisheries Act and focus almost exclusively on BSP. The two classes differ in that the larger vessels can carry significantly more fish in their holds and are able to fish much farther from shore. In 2001, these two classes of catcher vessels accounted for more than half of the total catcher vessel ex-vessel value and payments to labor.

The third class of TCV (TCV Diversified-AFA) are also AFA-eligible, but they generate less gross revenue in the BSAI pollock fisheries than they do in other trawl fisheries, such as those occurring in the GOA. This class generally consisted of vessels between 60 and 124 ft in LOA, but in some years included one or two vessels longer than 124 ft. The fourth class of TCV (TCV Non-AFA) are not AFA-eligible and therefore do not have access to the lucrative BSAI pollock fisheries. Instead, these vessels focus their fishing effort in the GOA. These vessels are all greater than 60 ft long. The final class of trawl vessels (< 60) are all less than

60 ft in length and fish almost exclusively in the GOA. Most of these vessels also participate in Alaska salmon fisheries with purse seine gear. State regulations prohibit the use of vessels longer than 58 ft in salmon seine fisheries.

Pot catcher vessels (PCV) traditionally have focused on crab fisheries. Recently, these vessels have developed a secondary source of income between crab fishing seasons by using pot fishing techniques to harvest Pacific cod. Longline catcher vessels concentrate their fishing effort in sablefish and halibut IFQ fisheries. Although the groundfish harvests of Longline catcher vessels are substantially less than those of TCV, the value of their harvests are significant because of the relatively high ex-vessel value of sablefish. All vessels in the PCV and LCV classes are 60 ft or longer.

There are far more vessels in the class comprised of fixed gear catcher vessels from 33 to 59 ft in length (Fixed Gear Catch Vessels 33-59) than in any other class. Most of these vessels participate in groundfish fisheries to augment their earnings from Alaska salmon fisheries. However, because this class is so large it has the third highest ex-vessel value of groundfish among the catcher vessel classes. These vessels obtain most of their groundfish revenues from harvests of Pacific cod and high-value species in the A-R-S-O group, primarily sablefish and rockfish.

Fixed gear catcher vessels less than or equal to 32 ft in length (fixed gear catcher vessels ≤ 32) have limited activity in groundfish fisheries, as most of these vessels were constructed specifically to harvest salmon. They often harvest higher-value groundfish such as Pacific cod, rockfish and sablefish when not engaged in salmon fisheries. Vessel size restricts the effectiveness of the fixed gear catcher vessels ≤ 32 class in groundfish fisheries.

Overview of Catcher Vessel Activities

Table 3.9-6 summarizes the activities of catcher vessels in the Alaska groundfish fisheries during the 1992-2001 period. Major findings presented in the table are as follows:

- The number of catcher vessels in the groundfish fisheries declined from 1,374 in 1992 to 917 in 2001. However, the quantity of groundfish landed by catcher vessels and retained by processors remained relatively steady, fluctuating between a high of 970 thousand mt in 1997 and a low of 772 thousand mt in 1993. The harvest was stable in comparison to the number of participating vessels because most of the vessels that exited the fisheries were small fixed gear vessels (fixed gear catcher vessel 33-59 and fixed gear catcher vessel ≤ 32) that tend to harvest less fish. Furthermore, total groundfish catch depends less on the number of vessels than on the allowable harvest levels and allocations among fishery participants established by NOAA Fisheries and NPFMC.

- During the 1992-2001 period most of the catcher vessels were registered by individuals or companies in the southcentral Alaska and southeast Alaska regions. However, the number of vessels from these regions decreased, while the number of vessels from the WAIW region increased.

- In some years non-groundfish species were nearly as important as groundfish to catcher vessels as a whole in terms of ex-vessel value. Between 1992 and 2000, non-groundfish accounted for about half of the ex-vessel value of the landings of all catcher vessels.

- As a result of the high ex-vessel value of Pacific cod and species in the A-R-S-O complex, which includes sablefish and rockfish, the ex-vessel value of landings of these species approached or exceeded that of pollock in some years. In 1996, for example, pollock accounted for 47 percent of total ex-vessel value of groundfish landings, while the A-R-S-O group and Pacific cod accounted for 29 and 22 percent, respectively. However, pollock has accounted for most of the ex-vessel value of catcher vessels in recent years.

- Between 1992 and 2001, the BSAI accounted for 51 to 63 percent of the ex-vessel value of catcher vessel landings. It is in this area that large trawlers harvest pollock. The GOA is a major source of Pacific cod and A-R-S-O species.

- In 2001, the WAIW region accounted for about 40 percent of the total FTE groundfish employment on catcher vessels and approximately 60 percent of the total payments to labor. The difference is due to fact that most of the boats and employment came from smaller, Alaska-based vessels with generally lower groundfish revenues, while the larger vessels with higher groundfish revenues per crew were mainly based in Washington.

Drawing on information in *Sector and Regional Profiles of the North Pacific Groundfish Fisheries – 2001* (Northern Economics, Inc. and EDAW, Inc. 2001), the remainder of this subsection presents summary profiles of the nine catcher vessel classes. Each catcher vessel class profile provides a description of the class in terms of the size and number of vessels; an overview of participation by the class in groundfish and other Alaska fisheries; a more detailed look at the Alaska groundfish fisheries important to the class; estimates of employment and payments to labor in the Alaska groundfish fisheries; and patterns of vessel ownership.[11] Each profile also includes a table showing number of active vessels, vessel registration by region, groundfish landings retained, ex-vessel value of groundfish and non-groundfish retained, ex-vessel value of groundfish retained by species group, ex-vessel value of groundfish retained by FMP subarea, and groundfish employment and payments to labor by region.

<u>Bering Sea Pollock Trawl Catcher Vessels ≥ 125 ft in Length (Trawl Catcher Vessel BSP ≥ 125)</u>

Synopsis

Large vessels that are AFA-eligible and rely almost exclusively on pollock harvested in the Bering Sea. Nearly all of the catch of these vessels is delivered to Bering Sea pollock shoreplants (BSP-SPs) (Table 3.9-7).

Description of the Class

This catcher vessel class includes all vessels for which trawl catch accounts for more than 15 percent of total catch value, the value of BSP catch is greater than the value of the catch of all other species combined, vessel length is greater than or equal to 125 ft, and the total value of groundfish catch is greater than $5,000. All

[11] While it is known that many of the large inshore processing plants have full or part ownership of many of the catcher vessels that deliver to them, detailed information regarding ownership linkages within the fishing industry is absent. Vessel registration and permit information do not necessarily reveal the true ownership of vessels. Consequently, this analysis did not attempt to provide a detailed description of vessel ownership patterns.

of these vessels fishing after 1998 are AFA-eligible. In 2000, vessels in the TCV BSP ≥ 125 class had an average length of 153 ft, an average horsepower rating of about 2,475, an average gross tonnage of approximately 310 tons, and an average hold capacity of 13,500 cubic ft.

Participation in Groundfish Fisheries

The number of vessels in this class reached a peak of 36 in 1997. In 1999, the most recent year for which landings data for all non-groundfish species are available, about 93 percent of all ex-vessel value generated by the class came from groundfish fisheries. Some of these vessels also participate in the summer Pacific whiting fishery off the coasts of Oregon and Washington. During June and July, some vessels in this category may tender salmon or undergo maintenance if they are not engaged in the whiting fishery. The bimodal distribution of groundfish activity of this vessel class is a function of the two primary regulatory seasons for pollock—the roe season in the winter and spring and the non-roe season in the summer and fall. Because of the class's reliance on the pollock resource, the Bering Sea FMP subarea is clearly the most important fishing area. In recent years this area accounted for more than 98 percent of the total ex-vessel value of the groundfish landed by this vessel class. Nearly all of the groundfish was delivered to BSP-SPs.

Groundfish Landings by Species

Pollock is clearly the most important fishery for the class, accounting for nearly all of the retained groundfish landings and ex-vessel value. Pacific cod has been the second most important species in terms of volume and value since 1988. From 1992 to 2001, the volume of groundfish retained for the class varied between 206 thousand mt and 383 thousand mt. In the same period, groundfish ex-vessel value ranged from a high of $100 million in 1997 to a low of $35 million in 1993.[12]

Employment, Payments to Labor, and Ownership

Normally, a vessel in the TCV BSP ≥ 125 class carries four to five crew members (including the skipper) when fishing for pollock and other groundfish. In addition to the fishing crew, one or more people must be responsible for accounting, correspondence, record keeping, and other business requirements. The vessel owner may fill this role or hire a person or firm to complete these tasks. Payments to labor for this vessel class have varied widely as a result of fluctuations in ex-vessel value. In 2001, Washington residents or companies registered all vessels in this class except one. The one exception was a vessel registered by a resident of the Other regions.

Bering Sea Pollock Trawl Catcher Vessels 60 to 124 ft in Length (Trawl Catcher Vessel BSP 60-124)

Synopsis

These are large- or medium-sized vessels that are AFA-eligible and rely almost exclusively on pollock harvested in the Bering Sea. Many of the vessels deliver their catch to motherships or catcher processors (Table 3.9-8).

[12] After the enactment of the American Fisheries Act in 1998, ex-vessel prices may have been more closely tied to the quality of fish delivered, particularly for roe-bearing pollock harvested in the A Season. Higher A Season prices were noted in payments to TCV from motherships.

Description of the Class

This catcher vessel class includes all vessels for which trawl catch accounts for more than 15 percent of total catch value, the value of BSP catch is greater than the value of the catch of all other species combined, vessel length is 60 ft to 124 ft, and the total value of groundfish catch is greater than $5000. All of these vessels fishing after 1998 are AFA-eligible.

Vessels in this class are similar to vessels in the TCV BSP ≥ 125 class. The key difference between the two classes is vessel size. Because of their relatively small fish-hold sizes, many of the vessels in this class cannot carry enough pollock to be cost-effective in the high-volume, shore-based pollock fishery. Therefore, many vessels deliver their pollock to motherships or to catcher processors. In 2000, over 42 percent of the total value of deliveries in the TCV BSP 60-124 class was generated by at-sea deliveries. In that year vessels in the TCV BSP 60-124 class had an average length of 113 ft, an average horsepower rating of about 1,330, and an average hold capacity of 7,763 cubic ft.

Participation in Groundfish Fisheries

The number of vessels in this class has fluctuated, reaching a peak of 63 in 1995 and declining to a low of 42 in 1999. The vessels in this class focus their fishing effort in the BSAI pollock fishery. The primary pollock fishing periods extend from mid-January through the end of April and from August through November, with variations due to regulatory changes. Some of these vessels also participate in the summer Pacific whiting fishery off the coasts of Oregon and Washington. During June and July, some vessels in this category may tender salmon or undergo maintenance if they are not engaged in the whiting fishery. In 1999, the most recent year for which complete landings data for non-groundfish species are available, about 88 percent of all ex-vessel value generated by the class came from groundfish fisheries. Because of reliance on pollock, the Bering Sea FMP subarea is the most important fishing area for the class and accounted for about 97 percent of the total ex-vessel value of groundfish retained in 2001. In 2000, roughly 56 percent of the ex-vessel value was generated from deliveries to Bering Sea pollock-shoreplants, while motherships accounted for 40 percent of the class's groundfish revenues.

Groundfish Landings by Species

In 2000, pollock accounted for 94 percent of harvest volume and 87 percent of total ex-vessel value. From 1992 to 2001, the volume of groundfish retained for the class varied between 254 thousand mt and 424 thousand mt. In the same period, groundfish ex-vessel value ranged from a high of $95 million in 1992 to a low of $43 million in 1998.

Employment, Payments to Labor, and Ownership

Four- to five-person crews, including the skipper, are typical on vessels in the TCV BSP 60-124 class, although it is likely that the AFA will result in a reduction in crew size for some vessels. Since 1992, the estimated FTE groundfish employment for this class has fluctuated widely, from a low of 128 in 1999 to a high of 290 in 2001. Estimated payments to labor have also varied widely as a result of fluctuations in ex-vessel value. In 2001, vessels registered in WAIW accounted for about two-thirds of the vessels in this class, and Oregon residents or companies registered about 22 percent of the fleet. In recent years, a few vessels have been registered by individuals or companies in Kodiak.

Diversified AFA-Eligible Trawl Catcher Vessels Greater than or Equal to 60 ft in Length (Trawl Catcher Vessel Div. AFA)

Synopsis

These are medium-sized vessels that are AFA-eligible but participate in the GOA pollock fishery and BSAI and GOA Pacific cod fisheries as well as the Bering Sea pollock fishery (Table 3.9-9).

Description of the Class

This catcher vessel class includes all vessels that are AFA-eligible for which trawl catch accounts for more than 15 percent of total catch value, the value of Bering Sea pollock catch is less than value of catch of all other species combined, vessel length is equal to or greater than 60 ft, and the total value of groundfish catch is greater than $5,000.

Vessels in the TCV Div. AFA class are more diversified in fishing effort than vessels in the TCV BSP ≥ 125 and TCV BSP 60-124 classes, but they are also eligible under AFA to participate in the BSAI pollock fisheries. In 2000, vessels in the TCV Div. AFA class had an average length of 92 ft, an average horsepower rating of about 995, an average gross tonnage of approximately 170 tons, and an average hold capacity of 4,866 cubic ft.

Participation in Groundfish Fisheries

The number of vessels in this class varied between 19 and 34 during the 1992-2001 period. In 1999, the most recent year for which complete landings data for non-groundfish species are available, about 93 percent of all ex-vessel value generated by the class came from groundfish fisheries. In addition to Bering Sea pollock, vessels in the TCV Div. AFA class have significant participation in the GOA pollock fisheries and the Pacific cod fisheries in both the BSAI and GOA. Some vessels in the class also participate in the Pacific whiting fishery off the coasts of Oregon and Washington. In recent years, GOA fisheries were more important for this class than BSAI fisheries in terms of ex-vessel value of groundfish retained. In 2000, roughly 46 percent of the ex-vessel value was generated from deliveries to Kodiak shoreplants, while 36 percent of the ex-vessel value was from Bering Sea processing facilities.

Groundfish Landings by Species

Pollock is the single most important species for the TCV Div. AFA class in terms of harvest volume and ex-vessel value. Pacific cod is the second most important species. Overall, ex-vessel value peaked in 1992 as the groundfish fisheries changed from joint venture fisheries to domestic processing operations. In 1993, gross revenues dropped significantly due primarily to lower ex-vessel prices rather than smaller harvests. From 1992 to 2001, the volume of groundfish retained for the class varied between 48 thousand mt and 111 thousand mt. In the same period, ex-vessel value ranged from a high of $33 million in 1992 to a low of $12 million in 1996.

Employment, Payments to Labor, and Ownership

Four person crews, including the skipper, are typical on vessels in the TCV Div. AFA class. Payments to labor have varied widely as a result of fluctuations in ex-vessel value. In 2001, vessels registered in Washington accounted for 45 percent of the vessels in this class, while individuals or companies in Oregon accounted for 20 percent of the vessels. The percentage of vessels registered by Kodiak residents or companies has declined over the years, but this region still accounted for one-fifth of the fleet in 2001.

<u>Non-AFA Trawl Catcher Vessels Greater than or Equal to 60 ft in Length (Trawl Catcher Vessel Non-AFA)</u>

Synopsis

These are medium-sized vessels that participate in the GOA groundfish fisheries and may also participate in halibut IFQ fisheries using longline gear (Table 3.9-10).

Description of the Class

This class includes all vessels that are not AFA-eligible for which trawl catch accounts for more than 15 percent of total catch value, the value of Bering Sea pollock catch is less than the value of catch of all other species combined, vessel length is greater than or equal to 60 ft., and the total value of groundfish catch is greater than $5,000. In 2000, vessels in the TCV Non-AFA class had an average length of 83 ft, an average horsepower rating of about 660, an average gross tonnage of approximately 140 tons, and an average hold capacity of 3,550 cubic ft.

Participation in Groundfish Fisheries

Participation peaked at 48 vessels in 1992, and then dropped back to a more stable level between 32 and 40 vessels. The annual cycle of operations of vessels in the TCV Non-AFA class differs from that of AFA-eligible TCV s. Differences include the reliance of the TCV Non-AFA fleet on the GOA groundfish fishery and the participation of several vessels in this class in the halibut IFQ fisheries using longline gear. Because these vessels are longer than 60 ft, they are ineligible to participate in Alaska commercial salmon fisheries with seine gear. In 1999, the most recent year for which complete landings data for non-groundfish species are available, about 84 percent of all ex-vessel value generated by the class came from groundfish fisheries. The central GOA has been the most important FMP subarea for the class. The importance of the Bering Sea peaked in 1997. After that year, vessels in the TCV Non-AFA class were unable to fish for BSAI pollock as a result of enactment of the AFA. However, the non-pollock harvest restrictions on AFA trawl vessels may encourage non-AFA trawl vessels to increase their participation in the BSAI Pacific cod fishery. In 2000, deliveries to Kodiak shoreplants accounted for 74 percent of gross revenues, while deliveries to Alaska Peninsula and Aleutian Islands shoreplants (APAI-SP) accounted for 11 percent.

Groundfish Landings by Species

As with AFA eligible TCV s, pollock is the primary species in terms of retained tonnage for vessels in the TCV Non-AFA class. However, the ex-vessel value of Pacific cod exceeded that of pollock in every year except 1998 and 2001. From 1992 to 2001, the volume of groundfish retained for the class varied between

33,000 and 55,000 mt. In the same period, ex-vessel value ranged from a high of $22 million in 1997 to a low of $9 million in 1994.

Employment, Payments to Labor, and Ownership

Vessels in the TCV non-AFA class typically carry a crew of four, including the skipper. One crew member usually functions as the engineer in addition to filling a position on deck. One person may function as the cook, or that role may be shared among crew members. Payments to labor have varied widely as a result of fluctuations in ex-vessel value. A fairly stable ownership pattern by Alaska residents or companies is evident for vessels in this class. Between 11 and 15 of the vessels were registered to individuals or companies in Kodiak between 1992 and 2001. Other Alaska residents or companies were the registered owners of another three to eight vessels. Individuals or companies in Washington and Oregon were the registered owners of most of the remaining vessels.

<u>Trawl Catcher Vessels Less than 60 ft in Length (Trawl Catcher Vessel < 60)</u>

Synopsis

These are small trawlers that participate in the GOA groundfish fisheries and may also participate in salmon fisheries using purse seine gear (Table 3.9-11).

Description of the Class

This catcher vessel class includes all vessels for which trawl catch accounts for more than 15 percent of total catch value, vessel length is less than 60 ft, and the total value of groundfish catch is greater than $2,500. The TCV < 60 fleet is treated as a distinct class because of differences between these vessels and larger TCVs. In particular, vessels in the TCV < 60 class are allowed to participate in the State of Alaska commercial seine fisheries for salmon. Alaska's limited entry program for salmon fisheries established a 58-foot length limit for seine vessels entering these fisheries after 1976. Many TCVs less than 60 ft in length were built to be salmon purse seine vessels, while others were designed to function as both trawlers and seiners.

Vessels in the TCV < 60 class are distinct from fixed gear vessels greater than 32 ft and less than 60 ft because of their ability and propensity to use trawl gear. Vessels in the TCV < 60 class have larger engines, more electronics, larger fish holds, and the necessary deck gear and nets to operate in the trawl fisheries. Similar-sized fixed gear vessels that participate in commercial salmon fisheries with purse seine gear have not made the necessary investment to participate in the trawl fisheries.

Participation in Groundfish Fisheries

The number of vessels in this class increased steadily from 1989 through 1993. This increase coincided with the development of domestic shore-based fisheries in the western GOA and central GOA FMP subareas of the GOA, where most of these vessels participate. From 1994 through 2001, the number of vessels in the TCV < 60 class remained between 44 and 61. Vessels in the TCV < 60 class participate in multiple fisheries and generally take full advantage of locally available fishery resources. These resources can differ significantly across different fishery management areas. Salmon harvesting is important to the economic viability of most vessels in this class. A significant percentage of the vessels also participate in the sablefish and halibut longline IFQ fisheries. In 1999, the most recent year for which complete landings data for non-groundfish species are available, about 55 percent of all ex-vessel value generated by the class came from groundfish fisheries. The decline in non-groundfish revenues after 1995 was primarily the result of a drop in salmon landings. The western GOA and central GOA are by far the most important fishing areas for the class, accounting for about 90 percent of the ex-vessel value in 2001. Vessels in the TCV < 60 class are increasingly relying on APAI-SPs. In 2000, they received 82 percent of their gross revenues from these plants, up from 70 percent in 1998. Processors in Kodiak are becoming less important to the TCV < 60 class, accounting for 34 percent of the ex-vessel value in 1995 and 6 percent in 2000.

Groundfish Landings by Species

Vessels in the TCV < 60 class focus their effort on Pacific cod in the western GOA and central GOA FMP areas of the GOA. Pollock is also an important trawl species, while sablefish (a component of the A-R-S-O species aggregation) harvested with longline gear makes a substantial contribution to the gross revenues of the class. From 1992 to 2001, the volume of groundfish retained for the class varied between 19,800 and 39,800 mt. In the same period, ex-vessel value ranged from a high of $14 million in 1997 to a low of $7 million in 1993.

Employment, Payments to Labor, and Ownership

The crew size on vessels in the TCV < 60 class typically ranges from three to four, including the skipper, depending on the fishery. Usually these crew members are employed in other fisheries as well. Since 1992, total estimated groundfish employment in the TCV < 60 class has varied between 91 and 129. About 75 percent of the vessels were registered by Alaska residents or companies in 2001, and the remainder were registered predominantly by individuals or companies in Washington. Individuals or companies in the Alaska Peninsula and Aleutian Islands region have consistently had the highest number of vessels in this class during the past decade, with most based in King Cove and Sand Point.

<u>Pot Catcher Vessels (PCV)</u>

Synopsis

These are medium-sized vessels that rely mostly on crab fisheries but also participate in Pacific cod fisheries primarily in the Bering Sea and central GOA (Table 3.9-12).

Description of the Class

This catcher vessel class includes all vessels that are not TCVs for which the value of pot catch is greater than15 percent of total catch value, vessel length is greater than or equal to 60 ft, and the total value of groundfish catch is greater than $5000. The vast majority of vessels in this class focus on crab fisheries and participate in groundfish fisheries only as a secondary activity. This class is distinct from other fixed gear vessels because all vessels in the class have crab endorsements under the BSAI groundfish and crab fisheries LLP, primarily use pots rather than longline or jig gear, and are longer than 60 ft. These differences in vessel size, gear type, and relevant regulations result in operational and financial differences between PCVs and other fixed gear catcher vessels. However, many PCVs have substantial landings with longline gear. In 2000, vessels in the PCV class had an average length of 105 ft, an average horsepower rating of about 825, an average gross tonnage of approximately 185 tons, and an average hold capacity of 7,475 cubic ft.

Participation in Groundfish Fisheries

The number of PCVs that have made more than incidental landings of groundfish varied widely between 1992 and 2001. During the early part of this period, many vessels experimenting with pot fishing for Pacific cod could not make enough money to justify continued participation. In 1995, harvests in the opilio tanner crab fishery, which had become the mainstay of the crab fleet, reached the lowest levels in a decade, and crab fishers sought other fisheries to generate needed revenues. The number of PCVs with substantial groundfish landings jumped to 101. Between 1995 and 2000, participation first declined as opilio harvests increased but then sharply increased to 158. In 1999, the most recent year for which complete landings data for non-groundfish species are available, about 13 percent of all ex-vessel value generated by the class came from groundfish fisheries. The crab fishery is the mainstay of the PCV class. The Pacific cod fishery is a way to keep crew members employed for longer periods and possibly make additional marginal contributions to the financial bottom line. The Bering Sea FMP subarea is the most important fishing area for the PCV class, followed by the central GOA. Bering Sea shoreplants are the largest buyers of groundfish harvests of PCVs, accounting for approximately 40 percent of gross revenues. Processors in Kodiak account for about 30 percent of PCV ex-vessel value.

Groundfish Landings by Species

Pacific cod has been the most important groundfish species for this class in terms of harvest volume and total ex-vessel value, and pollock has been the least important groundfish species. The A-R-S-O aggregation also accounts for a relatively large share of ex-vessel value, reflecting the fact that between 10 and 17 vessels in this class have participated in the high-value sablefish fisheries over the years. From 1992 to 2001, the volume of groundfish retained for the class varied between 7,000 and 27,000 mt. In the same period, ex-vessel value ranged from a high of $21 million in 2000 to a low of $4 million in 1993.

Employment, Payments to Labor, and Ownership

Pot vessels harvesting groundfish have an average of four to five crew members, including the skipper. Since 1992, total estimated FTE groundfish employment in the PCV class has varied between 72 in 1993 to 329 in 2000. During the 1992-2001 period, about half of the vessels in this category were registered by Alaska residents or companies, on average. However, in recent years the percentage of vessels registered by Washington residents or companies has substantially increased. Among the regions in Alaska, Kodiak has generally had the most vessel owners in this class.

<u>Longline Catcher Vessels Greater than or Equal to 60 ft in Length</u>

Synopsis

These are medium-sized vessels that target halibut and higher-priced groundfish such as sablefish and rockfish mainly in the eastern and central GOA (Table 3.9-13).

Description of the Class

This catcher vessel class includes all vessels that are not TCVs or PCVs for which vessel length is greater than or equal to 60 ft and the total value of groundfish catch is greater than $2,000, excluding halibut and state water sablefish. A large majority of the vessels in this class operate solely with longline fixed gear, focusing on halibut and relatively high-value groundfish such as sablefish and rockfish. Their operating parameters are influenced primarily by regulations for fixed gear fisheries targeting these species. The reliance of LCVs on groundfish fisheries sets them apart from smaller fixed gear catcher vessels, which are much more likely to operate in Alaska salmon fisheries with multiple gear types. The use of 60 ft as the minimum length for vessels in this class reflects the fact that regulations for State of Alaska salmon fisheries limit participating vessels to 58 ft. Thus, by definition vessels in the LCV class are generally precluded from operating in Alaska salmon fisheries. The LCVs reliance on longline gear sets them apart from the other large fixed gear vessels that use pots and have crab endorsements under the Crab LLP. In 2000, vessels in the LCV class had an average length of 72 ft, an average horsepower rating of about 395, an average gross tonnage of approximately 90 tons, and an average hold capacity of 4,688 cubic ft.

Participation in Groundfish Fisheries

The number of LCVs increased from 89 in 1988 to 121 in 1994. The general decline in the number of vessels in this class since 1994 may be the outcome of the IFQ program. In 1999, the most recent year for which complete landings data for non-groundfish species are available, about 34 percent of all ex-vessel value generated by the class came from groundfish fisheries. The eastern GOA and central GOA FMP subareas are the most important fishing areas for the LCV class. In 2000, LCVs received 37 percent of their gross revenues from processors in southcentral Alaska and 31 percent from processors in southeast Alaska. The relative importance of processors in Kodiak increased from 10 percent of the ex-vessel value in 1999 to 19 percent in 2000.

Groundfish Landings by Species

A-R-S-O were the most often landed groundfish species for the LCV class during the 1992-2001 period, whereas pollock was the least. From 1992 to 2001, the volume of groundfish retained for the class varied between 4,200 and 18,400 mt. In the same period, ex-vessel value ranged from a high of $39 million in 1997 to a low of $8 million in 1993. Low prices in 1998 and 1999, due to primarily the Asian economic crisis, had a major negative impact on gross revenues.

Employment, Payments to Labor, and Ownership

The LCV class is one of the most labor-intensive of the groundfish catcher vessel classes due to the need to handle each fish and piece of fishing gear individually. Longline catcher vessels typically carry between three and six deckhands and a skipper who also works the deck, although the number of crew members has decreased since 1995 with implementation of the IFQ system. The actual number of deckhands on LCVs generally depends on the fishery and the experience and productivity of the captain and crew. Total estimated FTE employment in groundfish fisheries in the LCV class declined from its high in 1995 (215 FTE) to 169 FTE in 2000. Labor payments per FTE position varied considerably over the 1992-2001 period. Prior to implementation of IFQs in 1995, FTE labor payments were relatively low, but they increased to a peak at $79,213 in 1997. In 1998 and 1999, payments declined due primarily to low prices resulting from the Asian economic crisis. In 2001, about half of the vessels in this category were registered by Alaska residents or companies, and the remainder were registered mainly by Washington residents or companies. Southeast and southcentral Alaska have had the largest number of registered vessel owners in this class among the Alaska regions since the late 1980s. The number of registered owners in southeast Alaska has been stable over the years compared to the number of owners from other Alaska regions. The percentage of registered owners in southcentral Alaska declined from 27 in 1994 (the year before IFQs) to 9 in 1999. Post-IFQ changes in other regions do not appear to be as significant.

Fixed Gear Catcher Vessels Greater than 32 and Less than 60 ft in Length

Synopsis

These are small vessels that focus on salmon, halibut, and higher-priced groundfish using a mix of gear types mainly in the eastern and central GOA (Table 3.9-14).

Description of the Class

This catcher vessel class includes all vessels that are not TCVs for which vessel length is 33 to 59 ft, and the total value of groundfish catch is greater than $2000. The larger size of these vessels in comparison to vessels in the smaller fixed gear class results in greater capacity and fishing efficiency. Consequently, this class accounts for a large portion of the total harvest of fixed gear vessels. The vessels in this class employ a mix of gear types, with smaller vessels typically using longline and jig gear, and larger vessels typically employing longline and pot gear. This class was established because these vessels were typically designed for, and participate in, a greater number of fisheries than smaller fixed gear vessels do, and vessels in this class use more gear types than larger fixed gear vessels use. The length of these vessels (< 60 ft) also means they can participate in almost all Alaskan salmon fisheries with the notable exception of fisheries in Bristol Bay. In 2000, vessels in the fixed gear catcher vessel 33-59 class had an average length of 47 ft, an average horsepower rating of about 313, an average gross tonnage of approximately 36 tons, and an average hold capacity of 2,395 cubic ft.

Participation in Groundfish Fisheries

From 1994 through 2001, the number of vessels in the fixed gear catcher vessel 33-59 class fluctuated between 514 and 860. The significant decline in vessel numbers after 1994 is assumed to be a result of the implementation of IFQs in sablefish and halibut fisheries. The activities of this vessel class have focused on salmon, halibut, and groundfish. Groundfish harvests decline significantly when these vessels switch to harvesting salmon and halibut. In 1999, the most recent year for which complete landings data for non-groundfish species are available, about 29 percent of all ex-vessel value generated by the class came from groundfish fisheries. From 1992 to 2001, the eastern GOA and central GOA FMP subareas accounted for almost all of the value of groundfish retained by this class. Processors in southeast Alaska accounted for approximately 45 percent of the ex-vessel value generated by the fixed gear catcher vessel 33-59 class. Processors in Kodiak and southcentral Alaska both contributed about 20 percent of the total ex-vessel value of the class. The relative importance of Kodiak processors increased following implementation of IFQs in 1995.

Groundfish Landings by Species

Landing volumes were significantly greater for A-R-S-O than for the other species during the entire 1992-2001 period, and pollock and flatfish had the lowest landings. High-value sablefish has been the most important species. Pacific cod has been the second most important species in terms of volume, but is a much smaller component in terms of ex-vessel value. From 1992 to 2001, the volume of groundfish retained for the class varied between 15,000 and 27,000 mt. In the same period, ex-vessel value ranged from a high of $48 million in 2000 to a low of $30 million in 1998.

Employment, Payments to Labor, and Ownership

This analysis assumed an average crew size of 3.5, including the skipper, for this type of vessel. The actual number of crew depends on a number of factors such as the type of gear, the presence of automatic baiting machines, the size of the vessel, and the amount of sablefish IFQ shares owned by the skipper and crew. Since 1992, total estimated FTE employment in groundfish fisheries in the fixed gear catcher vessel 33-59 class has varied between 1,119 and 724. In 2001, about 81 percent of these vessels were registered by Alaska residents or companies, and most of the remainder were from Washington. Individuals or companies in southeast Alaska have had the largest number of vessels in this class among the Alaska regions since the late 1980s. The data reveal that there has been a marked decline in participation of vessels from southcentral and southeast Alaska, while participation by other Alaska regions has remained relatively stable or increased. The regional differences may be due to the opportunistic nature of participation by small boats in groundfish and other fisheries. Residents of southcentral and southeast Alaska have relatively more non-fishing income-generating opportunities than residents of Kodiak and the Alaska Peninsula. If the likelihood of big pay-offs in fishing decline, those individuals that can are more likely to engage in non-fishing occupations. Similar declines are not apparent in Washington and Oregon because it is more likely registered vessel owners in these regions are full-time fishers. Estimated payments per FTE position have varied within a relatively narrow band since 1993, with the exception of 1998, when gross revenues and payments to labor fell due to the Asian economic crisis.

<u>Fixed Gear Catcher Vessels Less than or Equal to 32 ft in Length</u>

Synopsis

These are small vessels that focus on salmon, halibut, and high-value groundfish using a mix of gear types primarily in the central GOA (Table 3.9-15).

Description of the Class

This catcher vessel class includes all vessels that are not TCVs for which vessel length is less than or equal to 32 ft. and the total value of groundfish catch is greater than $1000. These vessels constitute a distinct class because of specific differences when compared to larger fixed gear catcher vessels. A length of 32 ft is the maximum for the Bristol Bay salmon drift gillnet fishery, and vessels in this fishery typically are built to this size limit. A large number of vessels of this size have been built for the Bristol Bay fishery and other salmon fisheries in Alaska. Similar size restrictions do not apply to other salmon management areas in the state. Vessels in this class typically were designed for salmon fisheries. The vessels may use a mix of longline, jig, and sometimes pot gear to harvest halibut and groundfish before or after the salmon season. In 2000, vessels in the fixed gear catcher vessel ≤ 32 class had an average length of 30 ft, an average horsepower rating of about 330, an average gross tonnage of approximately 14 tons, and an average hold capacity of 1,193 cubic ft.

Participation in Groundfish Fisheries

The number of vessels in the fixed gear catcher vessel ≤ 32 class decreased significantly in 1995, at least partly as a result of implementation of the halibut and sablefish IFQ system. Groundfish catches are important to the financial health of vessels in the fixed gear catcher vessel ≤ 32 class, but non-groundfish species generally account for the majority of the total earnings for the fleet. In 1999, the most recent year for which complete landings data for non-groundfish species are available, about 19 percent of all ex-vessel value generated by the class came from groundfish fisheries. The central GOA FMP subarea is the most important fishing area for this class. In recent years, this area has accounted for at least half of the total value of groundfish retained by this fixed gear catcher vessel class. In 1994, Kodiak shoreplants accounted for just 6 percent of the ex-vessel value for the class while southcentral Alaska processing facilities accounted for 50 percent. By 2000, gross revenues from Kodiak plants were 61 percent of the class total, while southcentral Alaska plants accounted for 16 percent. This change has come about because of the increasing importance of the Pacific cod fishery to vessels in the fixed gear catcher vessel ≤ 32 class.

Groundfish Landings by Species

Landing volumes were significantly greater for A-R-S-O (primarily sablefish) and Pacific cod than for other species during the entire 1992-2001 period. Pollock and flatfish were the least important species. Between 1992 and 2001, the volume of groundfish retained for the class varied between 700 and 1,200 mt. In the same period, ex-vessel value ranged from a high of $1.5 million in 1993 to a low of $0.7 million in 1995.

Employment, Payments to Labor, and Ownership

This analysis assumed an average crew size of three, including the skipper, for this type of vessel. Another 0.5 position was added to the average to account for vessel support staff. The actual number of crew depends primarily on the size of the vessel. Since 1992, total estimated FTE groundfish employment in the fixed gear catcher vessel ≤ 32 class has varied between 146 and 77. In 2001, about 84 percent of the vessels in this category were registered by Alaska residents or companies, and the remainder were from Washington or Other regions.

Catcher Processors

This section provides brief profiles of the five classes of groundfish catcher processor vessels that participate in the groundfish fisheries off Alaska. In general, catcher processors are integrated operations that harvest fish using various gear types and process them on board. The information provided in this analysis is an abridged version of the detailed sector profiles in *Sector and regional Profiles of the North Pacific Groundfish Fisheries—2001* (Northern Economics, Inc. and EDAW, Inc. 2001). Each of the catcher processor profiles report generally the same types of information to ease comparisons among classes. The remainder of this introductory section provides an overview of the catcher processor activities from 1992-2001 and describes the unique features that distinguish the various classes from each other.

Five different catcher processor classes were defined for this analysis based on predominant product or gear type. These classes, which are mutually exclusive, are as follows:

- Surimi trawl catcher processors: These factory trawlers have the necessary processing equipment to produce surimi from pollock and other groundfish. They are generally the largest of all catcher processors.

- Fillet trawl catcher processors: These factory trawlers have the processing equipment to produce fillets from pollock, Pacific cod, and other groundfish. They are generally smaller than surimi trawl catcher processors and are not surimi-capable according to past production records.

- Head-and-gut trawl catcher processors: These factory trawlers do not process more than incidental amounts of fillets. Most of the vessels are limited to producing headed and gutted products or kirimi. In general, they do not focus their efforts on pollock, opting instead for flatfish, Pacific cod, rockfish, and Atka mackerel. Surimi trawl catcher processors are the smallest of the trawl catcher processors.

- Pot catcher processors: These vessels have been used primarily in the crab fisheries of the North Pacific, but increasingly they are participating in Pacific cod fisheries. They generally use pot gear but may also use longline gear. They produce whole or headed and gutted groundfish products, some of which may be frozen in brine rather than blast frozen.

- Longline catcher processors: These vessels, also known as freezer longliners, use longline gear rather than trawls or pots and focus their effort on Pacific cod. Most longline catcher processors are limited to headed and gutted products. They are typically smaller than surimi trawl catcher processors.

Table 3.9-16 summarizes the operations of the five catcher processor classes in 2001. The table provides a comparison of the relative level of activities of the different classes. Of the 89 catcher processors, 39 were trawl catcher processors and 50 used longlines or pots. The 12 surimi trawl catcher processor vessels had the highest total catch of all catcher processors and generated about 41 percent of the catcher processor total gross product value and payments to labor and 34 percent of the total FTE groundfish employment.

Overview of Catcher Processor Activities

Table 3.9-17 summarizes domestic catcher processor activity in the Alaska groundfish fisheries during the 1992-2001 period. The number of active vessels peaked at 136 in 1992 and declined to 88 by 1999. One likely reason for this decline was the inshore/offshore allocations of pollock and Pacific cod. In addition, the decline after 1998 was directly related to the AFA, which mandated the removal of nine trawl catcher processors from the fishery.

From 1992-2001, catcher processors harvested an average of 1,203 thousand mt of groundfish per year. This annual harvest generated an average of 326 thousand mt of product, with an estimated wholesale value of $672 million. The average ton of product had a value of about $2,000. Pollock accounted for about 60 percent of all groundfish harvested by catcher processors, with about 89 percent of all catcher processor harvests coming from the BSAI. Over the ten-year period, catcher processors improved their average product utilization rate from about 24 percent in 1992 to around 30 percent in 2001.

Catcher processors are estimated to have generated an average annual groundfish employment of 4,487 FTE positions between 1992 and 2001, and annual payments to labor averaged $263 million. The vast majority of catcher processors are registered or operated by Washington-based individuals or corporations, and the WAIW region accounted for approximately 93 percent of total catcher processor groundfish employment and income in 2001. Data on crew complements are reported weekly to NOAA Fisheries by offshore processors (catcher processors and motherships). Therefore, employment estimates of offshore processors are more reliable than estimates generated for inshore processors, which are based on production to labor ratios derived from survey data collected in the early 1990s.

Drawing on information in *Sector and regional Profiles of the North Pacific Groundfish Fisheries – 2001* (Northern Economics, Inc. and EDAW, Inc. 2001), the remainder of this subsection presents summary profiles of the five catcher processor classes. The profile of each catcher processor class includes information on the size and number of vessels; fishing and processing operations; and employment and income linked to regions in Alaska, Washington and Oregon. A summary table provides data on number of active vessels, groundfish catch, groundfish catch by species group; groundfish catch by FMP subarea, quantity and value of the processed products made with groundfish catch, and groundfish employment and payments to labor by region.

<u>Surimi Trawl Catcher Processors</u>

Synopsis

These are large factory trawlers focusing almost exclusively on surimi production in the BSAI pollock fisheries (Table 3.9-18).

Description of the Class

This class is distinct from other trawl catcher processors because all surimi trawl catcher processors have the capacity to produce surimi. Consequently, they are typically the largest catcher processors in the North Pacific. Catcher processors in this class have an average length of 308 ft, an average horsepower rating of about 6,500, an average gross tonnage of approximately 445 tons and an average hold capacity of 50,500 cubic ft. These vessels are capable of harvesting 400 mt or more of fish daily and producing 100 mt or more of frozen surimi or fillets per day. They typically have a full processing deck below the main deck, plus a lower deck of freezer holds. The size of these vessels enables them to operate in the Bering Sea during poor weather. However, they now operate in a pollock cooperative under AFA, which, along with the resulting quasi-property rights, should allow them to modify operations in terms of when they fish and what they process to account for changing weather, markets, and management restrictions.

Participation in Groundfish Fisheries

The number of surimi catcher processors has decreased by about 40 percent since 1992. A combination of excess capacity in pollock surimi production, reduced quotas for the offshore sector, and the decommissioning of vessels under the AFA reduced the number of surimi catcher processors to 12 in 2001. The operational characteristics and activities of these vessels in waters off Alaska are largely determined by the pollock fishing seasons. Their Alaska operations are restricted under the AFA to the Bering Sea and

Aleutian Islands regulatory areas. Surimi catcher processors focus almost exclusively on pollock, although some have produced surimi from yellowfin sole.

Groundfish Landings by Species

Surimi catcher processors focus almost exclusively on pollock, although some have produced surimi from yellowfin sole. In 2001, pollock accounted for nearly all of the total tons of groundfish harvested and wholesale production value of these vessels.

Employment, Payments to Labor, and Ownership

An annual average of 1,641 FTE positions were generated by this vessel class during the 1992-2001 period, and estimated yearly payments to labor averaged $104 million. The registered owners of shoreplants vessels all list addresses in WAIW. While the employment aboard surimi catcher processors is assigned to the regions where the vessels are registered, employment of Alaska residents in this vessel class has increased substantially since the beginning of the western Alaska CDQ program, as discussed in Section 3.9.4.

Fillet Trawl Catcher Processors

Synopsis

These are large factory trawlers focusing mainly on fillet production in the BSAI pollock fisheries (Table 3.9-19).

Description of the Class

These trawl catcher processors produce fillets as their primary product from harvests in the BSAI pollock fisheries. The large size of these vessels also provides room for equipment to produce fishmeal, minced product, and other product forms. Pollock is the primary species harvested by this vessel class, but Pacific cod are also targeted. Their operational characteristics and activities in waters off Alaska are largely determined by the fishing seasons for these species. Fillet catcher processors have been defined as a distinct class because these vessels do not have the capability to produce surimi, and because of their focus on higher value but more labor-intensive fillet production. Catcher processors in this class have an average length of 250 ft, an average horsepower rating of about 4,550, an average gross tonnage of approximately 490 tons and an average hold capacity of 40,425 cubic ft.

Participation in Groundfish Fisheries

The size of the fillet catcher processor fleet has decreased to less than one-fifth of its peak of 22 in 1993. The elimination of excess fishing capacity under the AFA and declining quotas for the offshore sector resulting from inshore/offshore allocations were two factors that contributed to this decline. Competition from surimi catcher processors with the capacity to switch between surimi and fillets depending on the market for pollock products may be another reason for the smaller number of fillet catcher processors. Fishing season regulations in the BSAI groundfish FMPs allow shoreplants vessels to operate from mid-January through March or April, and from July through October. Because of AFA the remaining vessels in this class can be more selective as to when in the pollock fishing seasons they fish. The Bering Sea is clearly the focus of shoreplants vessels, with the Aleutian Islands accounting for about 10 percent total value prior to it closure to pollock fishing in 1999. Vessels in the shoreplants class have not had significant GOA participation since the implementation of inshore/offshore allocations.

Groundfish Landings by Species

All of the fillet catcher processors reported harvesting the major groundfish species groups (pollock, Pacific cod, flatfish, and the A-R-S-O group) for the 1992-2001 period, although some species were bycatch. In 2001, pollock accounted for 95 percent of the total tons of groundfish harvested.

Employment, Payments to Labor, and Ownership

The average crew size is less for fillet catcher processors than for surimi catcher processors, but larger than for other catcher processor classes. Before the AFA was enacted in 1998, the class generated an average of 1,325 FTE positions per year, but from 1999-2001, fillet catcher processors produced less than 400 FTE positions. Virtually all fillet catcher processors are registered by WAIW entities.

Head-and-Gut Trawl Catcher Processors

Synopsis

These are large and medium-sized factory trawlers that primarily produce headed and gutted products from Pacific cod, flatfish, Atka mackerel, and rockfish caught in the BSAI and GOA fisheries (Table 3.9-20).

Description of the Class

This subsection describes the characteristics and activities of trawl catcher processors that primarily produce headed and gutted products from the BSAI and GOA groundfish fisheries. Flatfish is the primary target species for this vessel class, and components of the A-R-S-O species aggregation (primarily Atka mackerel and rockfish) and Pacific cod are important secondary targets. This class was established because 1) it is the only trawl catcher processor group that does not focus on pollock; 2) vessels in this class are smaller than surimi catcher processors or fillet catcher processors; and 3) head-and-gut catcher processors primarily produce one product form—headed and gutted products. Loadline regulations (which establish standards for seafood processing on vessels), space constraints, and other factors make the production of surimi and fillets infeasible for head-and-gut catcher processors.

This focus on trawl fisheries other than pollock results in spatial and temporal differences in the operating patterns of head-and-gut catcher processors compared to surimi catcher processors or fillet catcher processors. Head-and-gut catcher processors have an average length of 166 ft, an average horsepower rating of about 2,100, an average gross tonnage of approximately 345 tons and an average hold capacity of 16,650 cubic ft.

Participation in Groundfish Fisheries

The number of head-and-gut catcher processors decreased from 32 in 1995 to 23 in 2001. These vessels target a number of species and operate for longer periods than the surimi catcher processors or fillet catcher processors. Whereas the surimi catcher processors and fillet catcher processors operate almost solely in the BSAI, head-and-gut catcher processors operate in both the BSAI and GOA. The target fisheries of head-and-gut catcher processors are usually limited by prohibited species catch limits for halibut or market constraints. Only rarely are these vessels able to catch the entire TAC of the target fisheries available to them. The Bering Sea is clearly the focus of these vessels, but a substantial number also fish in the Aleutian Islands, western GOA, and central GOA. Relatively few head-and-gut catcher processors fish in the eastern GOA.

Groundfish Landings by Species

Flatfish species—yellowfin sole and rock sole, in particular—are the primary targets of the head-and-gut catcher processor fleet. These vessels almost never target pollock because headed and gutted pollock sells for less than the cost of production. Species in the A-R-S-O species aggregation have also been very important to the class, particularly Atka mackerel and various rockfish species. In 2001, FLAT and A-R-S-O accounted for about 80 percent of the total tons of groundfish harvested. The recent increase in price of Pacific cod products due to reduced Atlantic cod harvests from the Barents Sea and an improving Asian economy should result in higher gross product values for this class. However, the closure of some of the best fishing grounds for the major target species to protect Bering Sea crab and Steller sea lions has adversely affected the cost structure of the head-and-gut catcher processors. In addition, headed and gutted fish harvested by Japanese and Korean vessels from Russian waters is increasing competition in the marketplace.

Employment, Payments to Labor, and Ownership

The smaller vessel size and limited product forms in the head-and-gut catcher processor class result in much smaller crews compared to surimi catcher processors or fillet catcher processors. The average crew size of about 34 persons is about one-third of the average employment on a surimi catcher processor and less than half of the average crew of a fillet catcher processor. A typical crew might include a captain, a mate, two engineers (one each for the vessel and processing equipment), a cook/housekeeper, two to three crew members dedicated to the deck, a processing foreman and assistant, and about 25 processing workers. On some vessels two or three crew members may split their time between processing and deck work. Any variation in crew size usually is the result of a change in the number of processing workers employed. An annual average of 1,022 FTE positions were generated by this vessel class during the 1992-2001 period, and estimated yearly payments to labor averaged $55 million. As with registered owners of surimi catcher processors and fillet catcher processors, most head-and-gut catcher processor registered owners are located in Washington. Only one head-and-gut catcher processor is currently registered by an Alaskan.

Pot Catcher Processors

Synopsis

These are large and medium-sized vessels that focus on crab fisheries in the Bering Sea but also produce headed and gutted products principally from Pacific cod harvested in the Bering Sea and GOA fisheries (Table 3.9-21).

Description of the Class

The vessels in this class of catcher processors use predominantly pot gear to harvest BSAI and GOA groundfish resources. Virtually all vessels in the pot catcher processor class also fish and process crab in the BSAI. In fact, the crab fisheries in the Bering Sea are the primary fisheries for the class and groundfish harvest and production are typically secondary activities. Because of the focus on crab, operating patterns are much different than for other catcher processors. When harvesting groundfish the pot catcher processor class principally targets Pacific cod and other species that can be captured in sufficient numbers with pot gear to generate adequate revenues. The operating characteristics and activities of this class are the result of both crab and groundfish regulations and the use of pot gear. Vessels in the pot catcher processor class have an average length of 149 ft, an average horsepower rating of about 1,466, an average gross tonnage of approximately 470 tons and an average hold capacity of 15,705 cubic ft.

Participation in Groundfish Fisheries

Pot catcher processors are crab boats that are also capable of processing groundfish. When these vessels are not targeting crab, Pacific cod becomes the primary target. Headed and gutted products are the primary finished products from the pot catcher processor class. During the 1992-2000 period, these products accounted for 88 percent of the wholesale production value for this class. The number of pot catcher processors that process groundfish varied over the past 9 years, reaching a peak of 14 vessels in 1992 and a minimum of 2 vessels in 1993. The success of these vessels in crab fisheries during any given year influences the number of vessels participating in the groundfish fisheries. In recent years, relatively low crab harvests and historically high prices of Pacific cod have made the groundfish fisheries more attractive for pot catcher processors. The Bering Sea FMP subarea is clearly the focus of these vessels.

Groundfish Landings by Species

While participating in groundfish fisheries, pot catcher processors focus on Pacific cod. Other species processed by this class are harvested incidentally. In 2001, Pacific cod accounted for 94 percent of the total tons of groundfish harvested.

Employment, Payments to Labor, and Ownership

This class typically uses a personnel structure similar to that of a catcher vessel. Although pot catcher processors require personnel with some expertise in processing activities, it does not usually hire persons who strictly process, as is the case for other catcher processor operations. Rather, crew members are usually capable of undertaking both fishing and processing tasks, as well as normal ship operational duties. The average pot catcher processor crew size is about 11. Since 1992, annual groundfish employment in the pot catcher processor class has averaged about 36 FTE positions. The relatively small number of FTE positions reflects the fact that pot catcher processors have spent relatively little time participating in the groundfish fisheries. As with registered owners of head-and-gut catcher processors, surimi catcher processors and fillet catcher processors, registered owners of most pot catcher processor are located in Washington. One pot catcher processor has been registered by an individual or company Kodiak since 1995.

Longline Catcher Processors

Synopsis

These are large and medium-sized vessels that primarily produce headed and gutted products from Pacific cod and other high-value species harvested in the Bering Sea and GOA fisheries (Table 3.9-22).

Description of the Class

Vessels in this class are restricted to producing headed and gutted products for reasons similar to those described for head-and-gut catcher processors—loadline regulations plus a lack of space to accommodate additional crew and equipment. Pacific cod is the primary target species, with sablefish and Greenland turbot as important secondary targets. The longline catcher processor class evolved because regulations applying to this gear type provide more fishing days than are available to trawlers. These vessels are able to produce relatively high-value products that compensate for the relatively low catch volumes associated with longline gear. Vessels in the longline catcher processors class have an average length of 135 ft, an average horsepower rating of about 1,275, an average gross tonnage of approximately 385 tons and an average hold capacity of 13,500 cubic ft.

Participation in Groundfish Fisheries

The number of longline catcher processors decreased from a peak of 56 in 1992 to 39 in 1999. In 2001, 43 longline catcher processors participated in the groundfish fisheries. Most of the product of longline catcher processors is marketed overseas, with price determining where product is sold. During the 1992-2000 period, headed and gutted products accounted for about 96 percent of the wholesale production value of the fleet. The longline catcher processor fleet generally begins fishing for Pacific cod on January 1 and continues to April or May. This species is fished again from September 15 to November or December. Most vessels in this class undergo maintenance and repair in the summer months, although several vessels process and custom freeze salmon during this period. The BSAI is by far the most important FMP subarea for the longline catcher processor class.

Groundfish Landings by Species

In 2001, Pacific cod accounted for 79 percent of the total tons of groundfish harvested. The A-R-S-O species complex (primarily sablefish) and flatfish (primarily Greenland turbot) are also important species in terms of volume. Sculpins, which are included in the A-R-S-O species aggregation, are a major component of bycatch of longline catcher processors.

Employment, Payments to Labor, and Ownership

The main employment positions on a longline catcher processor include processing crew, fishing crew, and officers. Large vessels are required to have more licensed officers than are small ones. On smaller vessels, specialized personnel such as the engineer or cook may also have additional crew duties, the processing crew and fishing crew may not be as distinct from one another as they are on larger vessels, and fishing effort must be reduced during processing. A vessel of average size typically has a crew of 16, consisting of six fishers, six processors, a skipper, a cook, an engineer, and an observer. The longline catcher processor class is the most diverse of all the processor classes in terms of ownership. In 2001, 28 percent of owners resided in Alaska or regions other than WAIW and Oregon coast region. Within Alaska, ownership is distributed across all four regions, with 16 of the 23 vessels owned by residents of southcentral or southeast Alaska.

Inshore Plants and Motherships

In addition to catcher processors, the groundfish processing sector includes shore-based plants, several FLPs that are moored or anchored near shore in protected bays and harbors, and motherships. Motherships are grouped with inshore processors because they do not catch their own fish and depend on deliveries from catcher vessels. This analysis includes plants engaged in primary processing of groundfish. It does not include plants engaged in secondary manufacturing, such as converting surimi into analog products (imitation crab), or further processing of other groundfish products into ready-to-cook meals or products. These secondary processors are described in Section 3.9.1.

Seven processor classes were defined for this analysis, primarily based on the regional location of the facilities. The Bering Sea pollock shoreplants are defined as a separate class because of the large scale of their groundfish operations compared to other processors. The seven classes, which are mutually exclusive, are as follows:

- Bering Sea pollock shoreplants (BSP-SP): Includes the four major shore-based BSAI pollock processors in Dutch Harbor/Unalaska and Akutan. Also includes two FLPs—*Arctic Enterprise and Northern Victor*—that have had substantial pollock history and function from a single location in state waters off Unalaska and Akutan Islands.

- Alaska Peninsula and Aleutian Islands shoreplants (APAI-SP): Includes all shoreplants in the Aleutians East Borough and in the Aleutians West Census Area, excluding all Bering Sea pollock shoreplants. In general, these plants are much smaller than Bering Sea pollock shoreplants, do not have the same level of focus on BSAI pollock, and in some cases produce more salmon than groundfish. These plants are treated separately from the Bering Sea pollock shoreplants because of these operational differences.

- Kodiak shoreplants (K-SP): Includes all shoreplants in the Kodiak archipelago. Many of these plants focus on groundfish but also process some salmon and halibut. Others focus on salmon and halibut but also process some groundfish.

- Southcentral Alaska shoreplants (SC-SP): Includes all shoreplants in the Kenai Peninsula Borough, the Municipality of Anchorage, the Matanuska-Susitna Borough, and the Valdez-Cordova Census Area. In general, these processors focus on salmon and halibut but also process some groundfish.

- Southeast Alaska shoreplants (SE-SP): Includes all shoreplants in southeast Alaska from Yakutat to Ketchikan. In general, these processors focus on salmon and halibut but also process some groundfish, primarily higher priced species such as rockfish and sablefish.

- Floating Inshore Processors: Includes all floating inshore plants other than *Arctic Enterprise* and *Northern Victor* (which are grouped with Bering Sea pollock shoreplants).

- Motherships: Includes all motherships operating in the EEZ of the BSAI and GOA. Currently there are only three active motherships. This class does not include FLPs that operate exclusively in state waters.

Table 3.9-23 summarizes activities of inshore processors and motherships by class for 2001. The table provides a comparison of the relative level of activities of the different classes. Overall, 59 facilities contributed to the inshore and mothership processing total in that year. The six Bering Sea pollock shoreplants were the most substantial contributors, producing 61 percent of the inshore processor wholesale product value and total payments to labor and 68 percent of the total FTE groundfish employment. Motherships accounted for 11 percent of the total product value, and shore-based processors in Kodiak generated 11 percent of the total value of this portion of the groundfish processing sector. Shore plants in southcentral Alaska and southeast Alaska contributed only about one percent of the total catch by volume, but because of their focus on high-value species, they generated about 8 percent of the total value.

Overview of Inshore Processor and Mothership Activities

Table 3.9-24 summarizes the activities of inshore processors and motherships in groundfish fisheries during the 1992-2001 period. Inshore processors and motherships profiled in this document rely heavily, but not exclusively on groundfish. In 1999, the most recent year for which complete landings data for non-groundfish species are available, about 31 percent of the total ex-vessel value of landings came from groundfish fisheries. While it appears that groundfish are relatively more important in 2000, the non-groundfish numbers shown for 2000 are preliminary and do not include halibut.

Pollock accounted for about 80 percent of all the groundfish retained and processed by inshore processors and motherships between 1992 and 2001. Pacific cod accounted for about 13 percent. Flatfish and species in the A-R-S-O aggregation accounted for about 4 percent each. Approximately 79 percent of all harvests delivered to inshore processors and motherships came from the BSAI. Between 1992 and 2001, inshore processors and motherships generated an average of 258 thousand mt of product per year, with a wholesale value of $573 million. Inshore processors and motherships improved their product utilization rate from 28 percent in 1992 to 37 percent in 2001.

Inshore processors and motherships were estimated to have generated annual groundfish employment averaging 3,861 FTE positions between 1992 and 2001 and annual payments to labor averaging $225 million. Most of the inshore processors are registered by individuals or companies in the WAIW region. However, because the shoreplants are physically located in Alaska, nearly all FTE groundfish employment and payments to labor have been assigned to Alaska coastal communities. Groundfish employment and payments to labor generated by motherships have been assigned to WAIW, as individuals or companies in WAIW generally own these vessels. Additional employment and payments to labor have been assigned to WAIW to account for home office staff who are assumed to reside in the same region as the plant owners.

Groundfish employment estimates for inshore plants are based on information gathered in surveys of processors conducted by Northern Economics, Inc. (1990 and 1994). The information gathered in the surveys indicated the number of employee hours necessary to generate one ton of product for each product and species. More reliable data on groundfish employment for inshore processors are not available. While the State of Alaska, Department of Labor and Workforce Development regularly collects employment data from processing facilities, the information is aggregated with processing employment in crab and salmon fisheries. If this data were used, groundfish employment would be significantly overestimated.

Drawing on information in *Sector and regional Profiles of the North Pacific Groundfish Fisheries – 2001* (Northern Economics, Inc. and EDAW, Inc. 2001), the remainder of this subsection presents summary profiles of the seven processor classes. Each inshore processor/mothership profile describes the facilities in the class and number of participants; the relative dependence on groundfish compared to non-groundfish species such as salmon, crab, halibut, and herring; fishing and processing operations; relationships with different catcher vessel classes; and employment and labor income associated with the groundfish fisheries. Payments to labor and employment are linked to regions in Alaska and the Pacific Northwest. Table 3.9-24 also summarizes statistics on the number of processing facilities, groundfish catch of catcher vessels that deliver to the facilities, ex-vessel value of groundfish and non-groundfish retained,[13] groundfish catch by species group, groundfish catch by FMP subarea, ex-vessel value paid to catcher vessels by type, and groundfish employment and payments to labor by region.

Bering Sea Pollock Shore Plants (BSP-SP)

Synopsis

These are AFA-eligible plants that operate year-round, processing almost all species harvested in the BSAI, and western GOA. Pollock is the most important species processed at these plants in terms of both volume and value (Table 3.9-25).

Description of the Class

This class includes the major onshore plants at Unalaska/Dutch Harbor and Akutan, and the two large floating pollock processors anchored near shore in Beaver Inlet of Unalaska Island or, more recently, in Akutan. These AFA-eligible, shore-based and nearshore plants are the primary markets for groundfish catcher vessels operating in the BSAI, particularly those harvesting pollock. The plants operate year-round, processing almost all species harvested in the BSAI and western GOA. Pollock is the most important species processed at these plants in terms of both volume and value. Pacific cod is the next most important groundfish species, while flatfish and sablefish are substantially less important. These plants also process large amounts of crab and halibut harvested in the BSAI.

BSP-SPs are a distinct processor class for three reasons: their geographic proximity to each other and the major fishing grounds of the BSAI; the magnitude of the pollock processing at these facilities; and their status as AFA-eligible plants. The nearshore processing ships, *Arctic Enterprise* and *Northern Victor*, are included in this class because they are more similar to shoreplants than to offshore motherships or floating inshore operations, are included in the inshore allocations of pollock, and are treated under AFA as if they were shoreplants.

[13] Ex-vessel value is equal to the amount of fish retained for processing multiplied by the ex-vessel (dockside) price. This value is equal to the payments made by processors for raw fish.

Participation in Groundfish Fisheries

During the 1992-2001 period, there were six BSP-SPs—at Dutch Harbor, one at Akutan, and two FLPs near Unalaska Island or in Akutan Bay. While all BSP-SPs have the capacity to produce fillets, only three have a long history of fillet production. The other three produce larger quantities of surimi and tend to produce headed and gutted or salted products rather than fillets. BSP-SPs are the only inshore processors that generate more ex-vessel value in groundfish fisheries than in non-groundfish fisheries. In 1999, the most recent year for which complete landings data for non-groundfish species are available, approximately 58 percent of the ex-vessel value paid to catcher vessels was from groundfish species. Crab is by far the most important non-groundfish product, accounting for 93 percent of the non-groundfish ex-vessel value in 1999. The plants all process substantial quantities of pollock and Pacific cod. In 2001, pollock accounted for 96 percent of the total tons of groundfish caught. In that year, the Bering Sea FMP subarea accounted for nearly all of the groundfish processed by plants in the BSP-SP class.

Payments to Catcher Vessels and Gross Product Value

Historically, BSP-SPs have worked closely with larger Trawl catcher vessels, especially vessels in the two Trawl catcher vessel BSP classes. On average, vessels in these two classes accounted for roughly 86 percent of the ex-vessel value of groundfish purchases made by Bering Sea pollock-shoreplants from 1992 through 2000. During the 1992-2000 period, surimi accounted for about half of the total wholesale value, and fillets, roe, and meal accounted for the remaining half.

Employment, Payments to Labor, and Ownership

Employment at BSP-SPs fluctuates markedly by season and the type of product being processed, even if the products are derived from the same species. At one BSP-SP, for example, groundfish employment during pollock roe season is 66 percent higher than it is during non-roe pollock processing. The registered addresses of the owners of all six BSP-SPs are in WAIW. A review of the ownership of these facilities was conducted in a previous analysis that examined processing limits for AFA-eligible entities (Northern Economics, Inc. 2000). The study indicated that Japanese companies have ownership shares of at least 50 percent in three of the BSP-SPs. The study also indicated that two of the other facilities are owned by a single U.S. corporation. This company also owns several trawl and pot catcher processors as well as a fleet of Trawl catcher vessels.

<u>Alaska Peninsula and Aleutian Islands Shoreplants (APAI-SP)</u>

Synopsis

These are typically multi-species plants that process salmon, crab, halibut and groundfish such as Pacific cod and pollock harvested mainly in the western GOA (Table 3.9-26).

Description of the Class

These plants process groundfish resources from the BSAI and GOA. The shoreplants on the Alaska Peninsula are the oldest in the region, some dating back to the 1800s, while the plant at Adak, the site of a former U.S. Naval facility, has only been operating for a few years. The facilities in the Pribilof Islands are also relatively recent entrants into groundfish processing. The plants in King Cove and Sand Point are AFA-qualified and process pollock. The class also includes several non-AFA plants in Unalaska/Dutch Harbor for which Pacific cod and crab are of particular importance. Some plants in the APAI-SPs class are limited in the volume they can handle and their ability to process certain species or product forms. APAI-SPs historically have relied mainly on non-groundfish species, particularly salmon. As halibut, sablefish, and crab fisheries developed, they were incorporated into the regional salmon processing pattern. Today, APAI-SPs are typically multi-species plants, with salmon still serving as the "foundation" species. The plants in the region differ in terms of their relative dependence on salmon, groundfish and crab.

Participation in Groundfish Fisheries

In 1999, the most recent year for which complete landings data for non-groundfish species are available, approximately 17 percent of the total ex-vessel value was from groundfish species. Crab is the most important species for APAI-SPs, accounting for about 54 percent of the ex-vessel value paid to catcher vessels in 1999. During the 1992-2000 period, groundfish fillets accounted for about 45 percent of the total wholesale value, while headed and gutted products accounted for 13 percent. In 2001, pollock and Pacific cod accounted for about 95 percent of the total tons of groundfish caught. A majority of the fish used by APAI-SPs facilities came from the western GOA FMP subarea, although in some years a significant amount of the fish processed was caught in the Aleutian Islands subarea.

Payments to Catcher Vessels and Gross Product Value

APAI-SPs historically have worked with a variety of catcher vessels. From 1992 through 2001, Trawl catcher vessels were the most common types of catcher vessels receiving payments from APAI-SPs, with vessels in the Trawl catcher vessel < 60 class receiving the largest share of the ex-vessel value. Wholesale value per ton of round weight deliveries increased dramatically in 1999—from $634 per ton to $920 per ton. These changes are due primarily to changes in Pacific cod processing. At least two new facilities focusing on Pacific cod have come online and product prices have increased to levels well above prices reported by processors in the BSP-SP class.

Employment, Payments to Labor, and Ownership

During the 1992-2001 period, these plants generated an average of about 363 FTE positions per year and an estimated $17 million in annual income. As with shoreplants in other regions, groundfish employment in this class fluctuates markedly by season and the type of product being generated. These seasonal product fluctuations do not affect all components of a plant's work force. There is typically a year round core of 30 to 50 administrative, management, and maintenance staff at each plant, and even during "down" periods a few production workers are required to handle processing odds and ends. For some processing activities the number of persons required is independent of the amount of fish processed (Impact Assessment Inc. [IAI] 1998). For example, fish meal processing may be so automated that it requires a fixed number of persons, regardless of the volume processed (IAI 1994). The plants in the region are registered to companies based in Washington or Alaska.

Kodiak Shoreplants (K-SP)

Synopsis

These are diversified processing facilities that receive nearly of all their fish from the central GOA (Table 3.9-27).

Description of the Class

The groundfish processing plants in Kodiak differ from those in southcentral and southeast Alaska by their capacity to handle larger volumes of groundfish and more product forms. It should also be noted that several of the plants on Kodiak are registered to entities that are AFA-eligible, but none of the plants themselves participate in AFA cooperatives. According to IAI (1998), K-SPs have existed since the 19th century. Initially, plants in Kodiak mainly canned salmon and herring, with some operations reportedly processing frozen halibut. In the 1950s, processing operations expanded to include king crab. Crab processing operations reached a peak in the late 1960s. As these operations began to decline, some processors moved from Kodiak to Dutch Harbor and other ports in order to be closer to Bering Sea king crab fisheries. However, a second boom in king crab stocks near Kodiak Island resulted in the construction of additional plants and expansion of existing ones. After king crab harvests peaked in 1980, K-SPs made a major effort to diversify their operations to include shrimp and groundfish. Processing facilities that did not already process salmon and herring began to do so.

Today, in addition to salmon, K-SPs also depend on pollock, Pacific cod, flatfish, and some other species of groundfish. By processing groundfish, plants can operate for longer periods of the year, thereby providing some stability to the work force. In addition, the groundfish market allows vessels to operate over a longer period, provides them with additional income, and enhances the vessel-processor relationship.

Participation in Groundfish Fisheries

Fourteen Kodiak facilities were active in groundfish through 1994, dropping to 10 by 1996. In 1999, the most recent year for which complete landings data for non-groundfish species are available, approximately 46 percent of the total ex-vessel value was from groundfish species. Salmon and halibut are also important species for K-SPs, together accounting for 49 percent of the total ex-vessel value paid to catcher vessels. In 2001, pollock and Pacific cod accounted for 69 percent of the total tons of groundfish caught. K-SPs receive nearly of all their fish from the central GOA FMP subarea.

Payments to Catcher Vessels and Gross Product Value

In 2000, vessels in the Trawl catcher vessel Div. AFA and Trawl catcher vessel Non-AFA classes accounted for 49 percent of deliveries by value, with vessels in the fixed gear catcher vessel 33-59 class accounting for about 24 percent of delivery value. The size and composition of the fleet delivering fish varies among plants. One plant may cater to a large number of small longline and pot gear vessels, with an occasional delivery from small trawlers, while another plant's fleet may consist of large trawlers. Most vessels that deliver to K-SPs are multi-purpose vessels that change fisheries to meet current market and fishing circumstances. The size of a processor's fleet depends on the season and what species the vessels are targeting. According to IAI (1998), a plant may have a fleet of eight to 16 vessels delivering groundfish and crab. A plant processing pollock usually has a fleet of four to ten trawlers fishing for it. Most plants also have six to ten fixed gear vessels delivering Pacific cod and/or tanner crab. In addition to taking deliveries from their regular fleet, processors will accept deliveries from other vessels if they have the processing capacity. The majority of vessels harvesting groundfish for K-SPs are Kodiak-based vessels. Vessels from Newport, Oregon or Seattle augment the local trawl and longline fleets. In 2000, fillets accounted for slightly more than half of the total wholesale value, while headed and gutted products accounted for 22 percent.

Employment, Payments to Labor, and Ownership

During the 1992-2001 period, these plants generated an average of about 609 FTE positions per year and an estimated $32 million in annual income. The percentage of plants on Kodiak registered to companies in Washington has shown an upward trend. Seventy percent were registered by Washington companies in 2001.

Southcentral Alaska Shoreplants (SC-SP)

Synopsis

These processors rely mostly on salmon but also process sablefish and other groundfish species harvested mainly in the central GOA and eastern GOA (Table 3.9-28).

Description of the Class

The southcentral region includes boroughs and census areas that border the marine waters of the GOA (east of Kodiak), Cook Inlet, and PWS, including the Kenai Peninsula Borough, the PWS census area, the Municipality of Anchorage, and the Matanuska-Susitna Borough. Most of the processing plants in this region were established to process salmon. They later expanded into groundfish processing to increase annual revenues and help cover fixed costs. However, processors in southcentral and southeast Alaska process much less groundfish than processors in the three classes discussed previously (APAI-SPs, BSP-SPs, and K-SPs).

Participation in Groundfish Fisheries

Southcentral shoreplants are located in Anchorage and several communities on the Kenai Peninsula (including Homer, Kenai, Nikiski, Ninilchik, Seward, and Soldotna) and in the PWS Census Area (including Cordova, Valdez, and Whittier). In 1999, the most recent year for which complete landings data for non-groundfish species are available, approximately 21 percent of the total ex-vessel value was from groundfish species. Salmon is the most important species for SC-SPs, accounting for 58 percent of the total ex-vessel value paid to catcher vessels in 1999. Between 1992 and 2001, most SC-SPs reported processing flatfish, Pacific cod and species in the A-R-S-O complex, primarily sablefish. In 2001, species in the A-R-S-O complex accounted for 65 percent of the total tons of groundfish harvested and 88 percent of the wholesale production value. In recent years, two to five processors participating in the groundfish fisheries have not processed pollock. The central GOA FMP subarea is the most important source of groundfish for this processor class. A significant quantity also came from the eastern GOA FMP subarea.

Payments to Catcher Vessels and Gross Product Value

SC-SPs work primarily with vessels in the fixed gear catcher vessel 33 ft to 59 ft and LCV classes reflecting their focus on higher priced groundfish such as sablefish. Between 1992 and 2000, fish delivered by these vessels accounted for more than 85 percent of the ex-vessel value of groundfish. The total value of production varied between $23 million and $40 million. In 2000, headed and gutted products accounted for 85 percent of the total wholesale value from groundfish.

Employment, Payments to Labor, and Ownership

During the 1992-2001 period, these plants generated an average of about 109 FTE positions per year and an estimated $12 million in annual income. In 2001, registered ownership of southcentral Alaska shoreplants was evenly divided between companies in southcentral Alaska and Washington.

Southeast Alaska Shoreplants (SE-SP)

Synopsis

These processors depend primarily on salmon but also process sablefish and other groundfish species harvested mainly in the eastern GOA (Table 3.9-29).

Description of the Class

The southeast Alaska region extends from Yakutat to Metlakatla. This processor class is similar to the SC-SPs class, as most SE-SPs began as salmon processing facilities and later expanded into groundfish, particularly higher priced species such as sablefish and rockfish. Groundfish stocks in the region are not nearly as large as those in areas to the west. In addition, the sheltered nature of many of the fishing grounds, most of which are in state waters, has fostered a fleet composed primarily of relatively small vessels that do not use trawl gear. Local vessels catch Pacific cod and rockfish by longline and pot. SE-SPs are not designed to process the large groundfish landings of trawl vessels. It is difficult for them to compete with the BSAI Pacific cod fishery or with those processors that already process pollock.

Participation in Groundfish Fisheries

Communities with active processors include Hoonah, Juneau, Ketchikan, Petersburg, Pelican, Sitka, Wrangell, and Yakutat. According to IAI (1998), all SE-SPs process multiple species. Groundfish are important to components of the local fishing fleet but are of secondary importance to most processors. In 1999, the most recent year for which complete landings data for non-groundfish species are available, approximately 20 percent of the total ex-vessel value was from groundfish species. Salmon is the most important species for SE-SPs, accounting for 31 percent of the total ex-vessel value paid to catcher vessels in 1999, while halibut accounted for 25 percent of the ex-vessel value. Between 1992 and 2001, most SE-SPs reported processing flatfish, Pacific cod, and species in the A-R-S-O complex. In 2001, species in the A-R-S-O complex (primarily sablefish) accounted for 94 percent of the total tons of groundfish harvested and nearly all of the wholesale production value. The eastern GOA FMP subarea has historically been the most important source of fish processed by SE-SPs.

Payments to Catcher Vessels and Gross Product Value

Most groundfish catcher vessels delivering to SE-SPs are multi-species harvesters. According to IAI (1998), vessels of 40 to 58 ft in length are probably the most productive vessels in the fleet. Most SE-SPs do not have formal contracts with the vessels that deliver to them. Some processors indicated that they had a "core group" of vessels, which constituted about 40 percent of their total delivery fleet. The vessels in the core group consistently delivered to a single processor, whereas the other vessels tended to shift from processor to processor. The sablefish fleet is smaller than the halibut fleet, which, in turn, is smaller than the dungeness crab fleet. Nearly all of the fish processed by SE-SPs is caught in state waters. Fixed gear catcher vessels, especially those 33 to 59 ft in length, accounted for most of the total ex-vessel value paid by SE-SPs to groundfish catcher vessels. Longline catcher vessels were the next most important catcher vessel type.

In 2000, headed and gutted products accounted for 95 percent of the total wholesale value. SE-SPs also produce frozen fillets. When possible, the plants serve the markets for high-price products, such as the seasonal market for fresh Pacific cod in Korea or the domestic market for fresh rockfish. The total value of production varied between $27 million and $42 million.

Employment, Payments to Labor and Ownership

During the 1992-2001 period, these plants generated an average of about 44 FTE positions per year and an estimated $13 million in labor payments. According to IAI (1998), some processors in this class have year-round operations while others operate seasonally. All of the plants have the largest workforce in the summer when salmon is processed. During the off-season a minimal number of people are employed for maintenance and administration. Even the year-round plants have relatively few processing line employees working full-time after the salmon season. Local residents provide most of the labor required to process halibut, sablefish, and species harvested in the winter fisheries. This periodic dependence on local labor distinguishes SE-SPs from processing operations in western Alaska, which almost exclusively employ individuals from outside the region. The summer salmon harvest is the only time in which it is economical for SE-SPs to bring in outside workers. Even then, a few plants can meet their summer labor needs with temporary employees from the local community. When more than one processor operates in the same community there is competition for the available local labor. Those processors with year-round operations usually have an advantage, as they can offer more stable jobs. In addition, processors will offer workers who stay employed with them higher wages in order to maintain a stable workforce.

In 2001, the proportion of SE-SPs registered to companies in Alaska peaked at 53 percent. According to IAI (1998), SE-SPs tend to have been in operation longer than plants other regions. Both third-generation, family-owned plants and facilities owned by multi-state corporations are present in the southeast region.

Motherships

Synopsis

These are large vessels that serve as offshore processors in the Bering Sea pollock fishery (Table 3.9-30).

Description of the Class

Motherships do not catch fish but act as mobile processors. Catcher vessels offload their catch to a mothership for processing, and the mothership, in turn, offloads finished product to trampers (cargo vessels) for transport to foreign or domestic markets. Motherships are among the largest vessels in Alaska's fishing industry. They have an average length of 427 ft, an average horsepower rating of about 5,250, an average gross tonnage of approximately 500 tons and an average hold capacity is 72,770 cubic ft.

The delivery of catch to motherships is performed on the high seas. Catcher vessels can offload without mooring to a mothership by transferring full cod ends to a stern ramp on the mothership. The large size of motherships provides them with considerable processing capacity. Some vessels are reportedly capable of producing 200 mt of finished frozen surimi per day. After the fish are processed, the product is usually stored in freezer holds until offloaded to tramp steamers, which convey the product to Asian markets. Buyers often place inspectors aboard the motherships to monitor product quality. A relatively small amount of groundfish products is offloaded at Unalaska/Dutch Harbor or Seattle. Delivering product to the latter port is an economical option at the end of a season.

Participation in Groundfish Fisheries

In 2001, there were three motherships participating in the groundfish fisheries. In addition to participating in the Bering Sea groundfish fishery, these vessels participate in the whiting fishery off the coasts of Oregon and Washington during the summer. In 2001, pollock accounted for nearly all of the groundfish harvested and wholesale production value.

Payments to Catcher Vessels and Gross Product Value

Motherships participating in the groundfish fisheries rely almost exclusively on vessels in the Trawl catcher vessel BSP 60 to 124 class for their supplies of fish. In 2001, these catcher vessels were all AFA-eligible. According to IAI (1998), motherships typically rely on a mix of company-owned and independent catcher vessels to supply their processing lines. In the past, independent vessels were usually not formally contracted by a particular mothership, but implementation of the AFA may have resulted in the introduction of formal contracts. Motherships usually provide basic services to those catcher vessels that regularly supply them with fish. The operating schedules for motherships coincide with those of their catcher trawlers. The Alaska groundfish fisheries occur from mid-January through April and from late August through October. The motherships are in port or participating in the whiting fishery in May, June, and July, and typically undergo maintenance and repair from November through early January.

The large size of motherships enables them to produce a wide range of products. In 2000, surimi accounted for 74 percent of the total wholesale value and roe products accounted for about 20 percent.

Employment, Payments to Labor, and Ownership

During the 1992-2001 period, motherships generated an average of about 395 FTE positions per year and an estimated $25 million in annual income. According to IAI (1998), the largest mothership employs between 190 and 200 persons during the peak season. The number of core staff, including the captain and crew, engineers, and other personnel necessary for at-sea operations, varies by vessel size, but it is less variable than the number of processing crew. The number of processing crew increases dramatically during peak fishing seasons—vessels reportedly employed 45 to 60 percent more people during the peak pollock seasons. Seattle is the point of hire for both salaried and non-salaried (hourly wage) employees. Most of the latter list one of the Pacific Northwest states as their place of residence, but some are not U.S. residents. Nearly all non-salaried employees sign a formal contract before starting work (IAI 1998). All motherships participating in the BSAI and GOA groundfish fisheries are registered to companies in Washington.

Floating Inshore Processors (FLP)

Synopsis

These are floating facilities that operate in sheltered waters and process mainly non-groundfish species but process some groundfish, especially Pacific cod (Table 3.9-31).

Description of the Class

FLPs are similar to motherships because they have the ability to change their locations in which they operate in order to maximize opportunities for delivery and efficiency. However, unlike motherships, most FLPs were designed to process crab and salmon and typically do not have stern ramps which would allow delivery of trawl cod ends in open waters. Instead FLP vessels take deliveries "over the side" employing pumps or brailers—large net bags that are filled with crab or fish on the delivery vessel and moved to the processor using a crane. The use of brailers or pumps requires that the delivery vessels be alongside the process while delivering. Typically, delivery vessels and floaters are separated only by large rubber bumpers. The necessity to take deliveries from vessels alongside means that FLPs must operate in sheltered waters. In fact, many processors in this class establish semi-permanent moorages with shore-based infrastructures, such as docks, gangways and fresh-water supplies. Processors in the FLP class have an average length of 215 ft, an average horsepower rating of about 1,580, an average gross tonnage of approximately 400 tons and an average hold capacity of 72,950 cubic ft. Several FLPs are barges and not self-propelled. FLPs occasionally operate with auxiliary barges operating alongside that process fish meal.

Participation in Groundfish Fisheries

Groundfish is typically a relatively small part of FLPs' annual round of activities. In 1999, the most recent year for which complete landings data for non-groundfish species are available, approximately 3 percent of the total ex-vessel value was from groundfish species. The groundfish that is processed is most often Pacific cod, which is either headed and gutted or filleted, depending primarily on the equipment on board the vessel. For many FLP vessels, participation in groundfish fisheries is largely dependent on the prospect of a lucrative season in the opilio crab fisheries. If operators believe that the guideline harvest level for opilio is high enough to justify sending the processor north from Puget Sound (where most of the vessels are based), then the FLPs will likely stay on to participate in the groundfish fisheries. Other FLP vessels focus more on salmon than on crab.

Payments to Catcher Vessels and Gross Product Value

Among all processors, the FLP class exhibits the least consistency in terms of the type of vessels from which they take deliveries. However, the fixed gear catcher vessel 33-59 class has typically been the most important for FLPs. On average during the 1992 to 2000 period, catcher vessels in this class have provided nearly 41 percent of the raw product received by FLPs in terms of value.

Between 1992 and 2001, most FLP vessels reported processing flatfish, Pacific cod and species in the A-R-S-O complex. In 2001, species in Pacific cod accounted for 89 percent of the total tons of groundfish harvested and nearly all of the wholesale production value.

Employment, Payments to Labor, and Ownership

Between 1992-2001, FLP vessels averaged about $3 million in estimated annual payments to labor from groundfish. Two of the three active FLP vessels were owned by individuals registered to companies in Washington in 2001.

3.9.3 Regional Socioeconomic Profiles

3.9.3.1 Regulatory Context

The socioeconomic analysis provided in this section is driven by requirements of the NEPA, the MSA, AND EO 12898. Under NEPA, 'economic' and 'social' effects are specific environmental consequences to be examined (40 CFR § 1508.8). This section contains an overview of the standard socioeconomic variables typically found in an EIS, including a summary of population, income and employment data for each region.

This section is also guided, in part, by National Standard 8 under the MSA. National Standard 8 is part of a set of standards that apply to all FMPs and regulations promulgated to implement such plans. Specifically, National Standard 8 states that:

> *Conservation and management measures shall, consistent with the conservation requirements of this [Magnuson-Stevens] Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities and (B) to the extent practicable, minimize adverse economic impacts on such communities (Sec. 301(a)(8)).*

The MSA defines a 'fishing community' as "...a community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew, and United States fish processors that are based in such community" (Sec. 3 [16]). NOAA Fisheries further specifies in the National Standard guidelines that a fishing community is "...a social or economic group whose members reside in a specific location and share a common dependency on commercial, recreational, or subsistence fishing or on directly related fisheries dependent services and industries (for example, boatyards, ice suppliers, tackle shops)" (63 FR 24235, May 1, 1998). 'Sustained participation' is defined by NOAA Fisheries as "...continued access to the fishery within the constraints of the condition of the resource" (63 FR 24235, May 1, 1998). Consistent with National Standard 8, this section first identifies affected regions and communities and then describes and assesses the nature and magnitude of their dependence on and engagement in the groundfish fisheries of the North Pacific.

Beyond NEPA and MSA requirements, social and community analysis needs to take into account Executive Order 12898 (59 FR 7629 [1994]), which requires federal agencies to address environmental justice concerns by identifying "disproportionately high and adverse human health and environmental effects...on minority populations and low-income populations." Existing conditions information needed for subsequent assessment of environmental justice concerns, such as demographic data on minority and low-income populations specific to the relevant groundfish communities, is presented in its own section (Section 3.9.6) for ease of review.

3.9.3.2 Regions and Communities Involved in the North Pacific Groundfish Fishery

In support of the community impact analysis of the various management alternatives under consideration, this section provides a description of the existing regional and community context of the North Pacific groundfish fishery. First, an overview is provided of the fishery as a whole. Next, socioeconomic profiles of six geographic areas with ties to the North Pacific groundfish fishery are provided: four in Alaska, one in Washington, and one in Oregon. The regions were defined based on logical socioeconomic and geographic units. Internal consistency with respect to type of engagement or dependence upon the groundfish fishery was more important in defining the regions than attempting to make them comparable for non-groundfish-related criteria. The regional definitions are consistent with those used in recent groundfish FMP-related analyses, such as the previous 2001 Draft Alaska Groundfish Fisheries Draft Programmatic SEIS (NMFS 2001a), as well as the more recent Steller Sea Lion Protection Measures Final SEIS (NMFS 2001b), and the detailed sector and community profiles on the NPFMC website (NPFMC 2002d). The regions and their constituent jurisdictions or geographies are listed in Table 3.9-32 and shown on Figures 3.9-6 and 3.9-7. Figure 3.9-8 shows the adjacent FMP areas and subareas.

These regional profiles examine the engagement with, and dependence upon, the fishery from a human geography perspective. The regional profiles are designed to be used in combination with the sector information presented in Section 3.9.2 to provide a rounded perspective on the socioeconomic aspects of the fishery. The sector profiles provide descriptions of the groups engaged in the fishery and their activities; the regional profiles describe how those groups and activities fit into a regional socioeconomic context. The regional descriptions in this section complement the more detailed sector and regional descriptions presented in the Sector and Regional Profiles of the North Pacific Groundfish Fisheries (NPFMC 2002d) to provide a more comprehensive treatment of the socioeconomic aspects of the fishery.

Quantitative data used in these regional descriptions are derived from the same data sources used in the sector descriptions that appear in Section 3.9.2. Specific data sources, and their limitations, are described in those sections. The geographic reach of the areas of Alaska, Washington, and Oregon potentially related to the North Pacific groundfish fishery—and likely to experience socioeconomic impacts due to the proposed management alternatives—is enormous. At the same time, these areas encompass many communities with few or no direct ties to the fishery itself. The profiles focus primarily on the regional rather than the community level of analysis, but limited community level information is provided for regionally important groundfish communities where strong historical ties to the groundfish fishery are known to exist and where such information is considered important to understand the specific community context of the fishery. Many more communities are home to at least some very small portion of the far-flung groundfish catcher vessel fleet. A number of other communities are the sites of relatively modest volumes of groundfish processing activity or are attempting to initiate local processing.

Overview of the North Pacific Groundfish Fishery by Region

This subsection presents comparative information on population, employment and income, processing, processing ownership, and catcher vessel ownership and activity across the regions. In subsequent sections, each region is broken out separately, with a broad regional overview following a common format. The intent is to provide the reader with enough information to place the region in terms of its level of participation in the fishery in a comparative context alongside the other regions, as well as to understand the relative level of importance of pollock and Pacific cod vis-á-vis other groundfish fisheries within each region. The topics introduced in this section are presented in the same order as in the individual profiles themselves. The four Alaskan regional profiles closely parallel each other in presentation, but the two Pacific Northwest regional presentations vary somewhat due to the quite different types of engagement in (or dependence on) the Alaskan groundfish fishery.

Fisheries data have been provided in full time series format (1992-2001) where appropriate. The earliest year for which comparable data are available across processing and harvesting sectors is 1992 and 2001 represents the most recent full year for which data are available. Where single year "snapshot" data are more appropriate to the discussion than time series information, data for 1999, 2000, and 2001 are provided. Data from 1999 are presented as this represents the last full year prior to the implementation of the more sweeping Steller sea lion-related protection management measures. Data from 2000 are presented as a transition year, and interpretation of 2000 data in terms of understanding the impacts of Steller sea lion protection measures is problematic for several reasons, not the least of which is that management conditions changed dramatically during the year itself, so that the year as a whole represents neither pre- nor post-Steller sea lion RPA conditions. Data from 2001 are included as these represent the most current full year data available.[14,15]

The population of the regions varies considerably. Within Alaska, the Alaska Peninsula and Aleutian Islands region had a population of approximately 6,000 in 2000; the Kodiak Island region had approximately 14,000 residents; and the southcentral and southeast Alaska regions had populations of about 367,000 and 75,000, respectively. In the Pacific Northwest, the Washington inland waters region had about 3.9 million residents and the Oregon coast region had a population of about 105,000. Beyond overall population, the types of communities within the regions also vary considerably. The Alaska regions contain the largest community in the state. Anchorage, that, along with its surrounding area, contains nearly half of the state's population,

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[14]It should be noted that the 1999-2000 period was a time of structural change for a good part of the groundfish fishery independent of Steller sea lion protection management related issues. The most obvious of these changes were those associated with the AFA which, among other things, reduced the offshore catcher-processor fleet, shifted quota from offshore to inshore, and facilitated the formation of co-ops for offshore catcher processors in 1999 and for inshore and mothership catcher vessels in 2000. A comprehensive discussion of the social impacts of the AFA is beyond the scope of this document, but is provided in the NPFMC's report to Congress. It is sufficient to note that inclusion of 1999 as a base year for this analysis does not portray a socioeconomic context in static equilibrium and it is not realistic to assume that all other things are being held equal.

[15]As a methodological note, it should also be stated that while historic time series data in this document are similar to those found in the previous version of the 2001 Draft Alaska Groundfish Programmatic SEIS, they are not identical. The reason for this variation is discussed in some detail elsewhere (NPFMC 2002d), but in general results largely from a refinement of data resulting from an improved ability to focus on directed catch (and exclude bycatch). It is the target fisheries that will be subject to the more direct impacts of proposed management alternatives. While consistency with previous documents might be valuable in an abstract sense, it is not particularly important in a practical (pragmatic) sense for the present task. For the purposes of the regional and community impact discussions, the precision of individual numbers is much less important than the accuracy of the nature, direction and magnitude of trends in existing conditions, and the direction and magnitude of change resulting from the proposed alternatives.

as well as very small relatively isolated traditional communities. Within the Pacific Northwest, the regions include the greater Seattle metropolitan area as well as relatively small coastal fishing communities.

The population structure of the regions also varies considerably. As shown in the individual regional profiles, the fishery has an impact on the male-female population balance for some of the Alaskan communities that are the focus of intensive groundfish processing. This is due to the fact that processing workers come to these communities for various lengths of time, and there are many more males than females in this workforce. This type of direct impact on population structure attributable to groundfish is seen in few communities, but these tend to be the communities with the highest level of groundfish-related processing activities. Within Alaska, particularly in the Aleutian and Kodiak Island regions, there is also a relationship between percent of Alaska Native population and commercial fisheries development, with communities that have developed as large commercial fishing communities becoming less Native in composition over time compared to other communities in the region. There are many variables involved, but for a few of the communities noted, the relationship is quite straightforward. These differences in the male/female and Native/non-Native population segments are, to a degree, indicative of the relative degree of isolation or integration of the directly fishery-related population with the social and economic structures of rest of the community. Again, this varies considerably from place to place and is not apparent in the Alaska southcentral and southeast regions in the same way it is in the more western regions.

Employment and Income. Employment and income (payments to labor) information presented for each region provides a look at types and levels of economic engagement with the groundfish fishery. Detailed employment and income figures for each region may be found in the community profiles on the NPFMC website (NPFMC 2002d). Information on employment in the processing sector provides insight on the level of employment in the communities that is directly attributable to groundfish fishery activity.

The working assumptions with regard to community employment calculations in groundfish processing are relatively crude, due to the limits of the information available. Employees of shoreplants are counted as part of the labor force for the community in which the shoreplant itself is located, while those of the more mobile processors are counted as part of the labor force of the community of vessel owner's address as listed in CFEC vessel registration files or NOAA Fisheries federal permit data, as described in Section 3.9.2.

With these assumptions, during 2001 primary or direct Alaska groundfish processing employment ranged from none in the Oregon coast region to more than 3,500 persons in the Alaska Peninsula/Aleutian Islands region and nearly 3,800 persons in the Washington inland waters region.

Interpretation of these data in terms of engagement with the community is less straightforward for some regions than for others. For some, processing plants tend to be industrial enclaves that are somewhat separate from the rest of the community, while for others there is no apparent differentiation between the processing workforce and the rest of the regional or local labor pool. For the Washington inland waters region, Alaskan groundfish processing work is at sea, so in some respects it does not take place 'in' a community at all. In all cases, however, processing employment tends to be seasonal in nature.

A further complication for attribution of socioeconomic impacts to a regional base is the fact that many workers in many sectors perform groundfish-related work in a region or community other than the locations where they have other socioeconomic ties. It is not uncommon for fishery-related workers to spend little money in their work region and to send pay 'home' to another community or region (and, further, legal residence may or may not be consistent with what people think of as ‘home’ or what may be considered ‘home’ in terms of where economic benefits ultimately accrue). In this sense, regional employment is indicative of the volume of economic activity, if not a specific level of labor activity directly comparable to other industries. The importance of this flow varies from region to region and from sector to sector, but is most apparent for the communities that are most heavily engaged in the processing aspect of the groundfish fishery.

The CDQ region is a particular or specific example of this type of flow, where a number of catcher processor firms based in the Washington inland waters region have seen significant investment by CDQ groups in recent years, but where registrations and permits have largely been retained by individuals or entities based in Washington. This CDQ ownership interest (along with targeted hiring efforts by some firms as well as other aspects of the CDQ program itself) has resulted in increased levels of Alaska resident employment (and revenue and income for Alaska based entities and individuals) associated with the groundfish fishery. As the growing CDQ based engagement in this sector has not typically resulted in transfers of permits or registrations between regions, or has resulted from aspects of the CDQ program that are unique within the fishery, this activity is not well captured by the economic models and is therefore discussed in detail in its own section (Section 3.9.4).

Tax and Revenue. Tax and revenue information is presented for each Alaska region to provide a perspective on the role of the groundfish fishery in the underpinning of the local economy. Data are from the Alaska Department of Revenue, Alaska Department of Community and Economic Development (ADCED), and local sources, as appropriate.

Information on the local tax structure of each relevant community is provided, and the communities and regions vary in the way that direct revenue is collected on fishery-related transactions that occur in the regions. For communities (and boroughs) in the more western Alaska regions, a local fish tax is often a significant source of local revenue. For other regions, direct revenue benefits are more closely tied to the state fish tax. Information is provided for each region on shared taxes and the role of state shared fish tax in relation to these other taxes. Again, there is considerable variability from region to region. Also apparent is the regional differentiation in the importance of the relatively new fishery resource landing tax. This source of revenue comes from the offshore sectors of the fishery, and is designed to capture some of the economic benefits of offshore activity for adjacent coastal Alaska regions. This tax is far more important to the revenue structure of the Alaska Peninsula/Aleutian Islands region than for any other region.

Inshore Processing. Inshore groundfish processing information is presented for each region to facilitate analysis of the volume and value of the groundfish that are landed in a region. The information is broken out by species, and historical information is provided on utilization rate, product value, and value per ton. When examined on a region-by-region basis, these data point out that the groundfish fishery varies widely from one region to another. For example, in 2001, for the Alaska Peninsula/Aleutian Islands region, local groundfish processing activity is relatively focused on pollock, while in the southeast Alaska region, the fishery is focused much more on the non-pollock, non-cod, non-flatfish, other (A-R-S-O) species. Therefore, there are sharp differences in value per ton (about six times greater in the southeast Alaska region) and in volume (greater in the Alaska Peninsula/Aleutian Islands region, which accounts for about 88 percent of the total volume for the state). These differences correspond with differences in a number of other factors, including the extent to which a local labor force is used in processing and the degree to which a local fleet is harvesting the resource (both measures are high in the southeast Alaska region, but low in the Alaska Peninsula/Aleutian Islands region).

Overall, this information is useful in looking at where fishery resources come ashore, and can be used as a rough indicator of the economic activity generated in processing communities. The relative amount of economic benefit to regions and specific communities varies considerably from place to place, as processing entities are integrated with communities in different ways in different places, and patterns of ownership influence the flow of economic benefits.

Processor Ownership. In part to portray the flow of economic benefits in general and to help characterize them on a regional basis in particular, ownership information is presented for processing entities by region. Caution must be taken in interpreting this information, however, as assignment of entities to regions is based on ownership address information, and this is known to be less than precise in a number of cases due to different criteria for assigning addresses. Also, for entities with ownership interest divided among entities residing in two or more regions, the entire operation was counted for the region with the majority of the ownership interest (and therefore caution must be exercised in the use of this information and this known shortcoming taken into account in interpretation of results). This information presented by region, by sector, and by groundfish species includes all processing sectors, both fixed processors in communities and mobile, at-sea processors (motherships and various catcher processor sectors). The data in this section facilitate consideration of how resource utilization is linked to ownership patterns and how those ownership patterns play out among regions.

For example, the Alaska Peninsula/Aleutian Islands region has the greatest volume and value processed inshore among all the regions, but ownership of shore processing facilities in this region is highly concentrated among individuals and firms located in the Washington inland waters region. The large mobile processors that work the Bering Sea have varying catch and processing locations and at least some ties to adjacent Alaska regions (through CDQ group ownership interest, for example), but ownership again clearly shows predominant ties to the Pacific Northwest. Combining all types of processors (inshore, mothership, and offshore), processors owned by Washington inland waters region residents accounted for 97 percent of total reported tons and 95 percent estimated wholesale value of all North Pacific groundfish processed in 2001.

Catcher Vessel Ownership and Activity. Information on catcher vessel ownership patterns is presented to demonstrate the links between resource harvesting and specific regions. As for catcher processors, region of ownership is based on the vessel owner's address as listed in CFEC vessel registration files or NOAA Fisheries federal permit data, so some caution in the interpretation of this information is warranted. It is not unusual for vessels to have complex ownership structures involving more than one entity in more than one region, or for some of the vessels from the Pacific Northwest that spend a great deal of time in Alaska ports to hire at least few crew members from those ports, but the region of ownership provides a rough indicator of the direction or nature of ownership ties when patterns are viewed at the sector or vessel class level.

Data are presented on the number and types of vessels in the regionally owned fleet and the employment and payments to labor that result from catcher vessel resource activities. Resources from FMP subregions adjacent to the Alaska Peninsula/Aleutian Islands, Kodiak, and other Alaska regions are not uniformly harvested by catcher vessels from those regions. Different regions have varying combinations of local harvesting activity, local processing activity, and ownership of both harvesting and processing entities, and all of these have implications for the role of the groundfish fishery in the local socioeconomic context. For example, in terms of groundfish harvest value and volume, Alaska Peninsula/Aleutian Islands features a mostly non-residential fleet, except for some of the smaller vessel classes. While the highest volume and value of groundfish resources harvest occur near this region, the catcher vessels accounting for most of this activity are from elsewhere (primarily the Washington inland waters and Oregon coast regions).

As discussed in the individual region profiles, the higher the catcher vessel harvest volume in a given area, the less local the fleet tends to be. Put another way, the more important the region is to the overall groundfish fishery, the lower the proportion of total catch is likely to be harvested by the local fleet in that region, although recent CDQ partnership arrangements may serve to ameliorate this historical disjunction.

Information on total groundfish harvest by FMP area for each region is provided to allow consideration of distribution of effort by the fleets of the individual regions in different groundfish management areas. In other words, this information facilitates gauging the relative importance of groundfish from each management area to the catcher vessel fleets based in each region. regions vary widely in how local the catch effort is by the local fleet. For example, catcher vessels in the southeast Alaska region have a very high concentration of effort in the eastern GOA FMP area, while efforts of catcher vessels based in Kodiak are more wide-ranging. More detailed regional harvest information for Pacific cod and pollock, the two most economically important groundfish species overall, is also provided by FMP. Total regional groundfish harvest is also broken out by species so that relative dependency on species by area can be assessed. In this way, relative dependence on alternative measure impacted resources can be examined, at least in general terms.

Harvest Diversity. Recently produced extended sector and regional profiles (NPFMC 2002d) include a treatment of diversity in the catcher vessel fleet, and discusses a brief treatment of the annual cycle for groundfish catcher vessels and information on how groundfish fit into that cycle both in terms of timing and value. Information is also presented on how groundfish has fit into overall catcher vessel effort for groundfish catcher vessels over the last several years so that the relative role of groundfish can be seen over time. This information is abstracted for this document, and clearly shows that the relative importance illustrates marked differences between regions.

For each of the regions a section on community rankings by catcher vessel ownership is provided. While most of the rest of the data are regional in nature, the top communities (to the 95th percentile) for vessel ownership are listed to provide a sense of subregional distribution of engagement with the groundfish fishery from the harvest perspective. (Analogous volume information for processing cannot be shown due to confidentiality restrictions, but the top three communities for processing volume/value for each region are identified but not ranked).

Processor Diversity. Diversity information similar to that presented for catcher vessels is also available for processors (NPFMC 2002d) for each of the regions to allow at least a general-level consideration of the relative importance of groundfish, and that information is abstracted in this document. For the larger Bering Sea pollock inshore plants, for example, groundfish accounted for more than 60 percent of total ex-vessel value over the period 1995-1997, while in the southeast Alaska region, analogous value ranged from 10 to 35 percent over the period 1991-1998. The estimates provided also indicate the amount of groundfish and non-groundfish processed at all regional processors that take deliveries of at least some quantity of groundfish.[16] This document only describes changes in patterns of processor diversity to a limited degree, as they are more clearly associated with local community effects.

Subsistence. Each Alaska region profile contains a brief summary of subsistence resource use for selected communities with known ties to the groundfish fishery. The basic data used for this description were taken from the ADF&G subsistence database. The management of the consumptive use of subsistence resources in Alaska is complex, and is summarized elsewhere (NPFMC 2002d). Groundfish comprise up to 9 percent of total subsistence resources consumed in some communities. Level of Steller sea lion take for subsistence purposes in Alaska coastal communities is mentioned in each of the regional profiles, but is described in more detail in Section 3.9.5 as well as in other existing documentation (NPFMC 2002d). Section 3.9.5 also provides more detail on existing conditions related to a number of other subsistence topics.

Tables 3.9-33 through 3.9-38 present information on participation in the groundfish fishery by region for processing and catcher vessel sectors. Parallel tables are presented for each of the individual regions and provide time series information on most of these same indicators. Confidentiality has been preserved for vessels and processors with few members in any particular class or sector by using a normative value for operations within a particular class that are then adjusted regionally so that regional subtotals will match the actual regional total.

Answers to several "big picture" questions are summarized in the individual regional profiles (and more detailed description is available in the companion community profiles document [NPFMC 2002d]). These include the following questions:

How have fishing communities in Alaska been affected by the growth of the domestic groundfish fishery?

- On a regional basis, and specifically with respect to the high volume, formerly foreign fleet fisheries, the primary regions that have been affected are the Alaska Peninsula and Aleutian Islands region and the Kodiak Island region.

- Within the Alaska Peninsula and Aleutian Islands region, the growth of the domestic groundfish fishery has caused profound changes in the communities of Unalaska and Akutan. In Unalaska in recent years, it has provided the mainstay of the fisheries-based portion of the economy and generally reversed the local economic decline that followed the crash of the King crab fishery. Both inshore and offshore sectors have contributed to the local tax base and the economic climate that has fostered the development of a significant support services sector. In Akutan, the groundfish fishery, primarily in the form of a large groundfish oriented shore plant, has transformed the community from a small primarily Native community to a much larger, predominantly non-Native community. The implications of this change should be interpreted with caution, however, as the processor (through an enclave type of development) and the rest of the community remain separate in a number of different ways. Lesser changes have been seen in Sand Point and King Cove, although both have experienced a significant growth in local groundfish processing in recent years. Sand Point's residential catcher vessel fleet has benefitted disproportionately from the development of the

[16] A summary analysis of processors within the four Alaskan regions defined in this study revealed that shore based processors that took deliveries of at least some amount of groundfish accounted for approximately 77 percent of all non-groundfish processed at all shore based processors within those regions.

groundfish fishery in comparison to other communities in the region, but at the same time, other fishery changes have had the effect of shifting some groundfish processing away from the community. Communities within the Aleutians East Borough with no direct involvement in the groundfish fishery have also benefitted from the borough's fish tax. Other CDQ communities in the region have benefitted in yet other ways.

- Within the Kodiak Island region, the City of Kodiak has been the prime beneficiary of the development of the groundfish fishery. It has served as an important buffer for variation in other fisheries, especially after the decline of the locally important shrimp and crab fisheries, as well as the Bering Sea crab fisheries.

- The Alaska southcentral and southeast regions have not seen the level of changes experienced by communities in the Alaska Peninsula/Aleutian Islands region and the Kodiak Island region. The fishing communities in these regions tend to be quite diversified, although groundfish is an important component of this mix for some communities.

- It should also be noted that the development of the domestic groundfish fishery has also been important for regions and communities outside of Alaska, particularly for the Oregon (primarily Newport) catcher vessel sector, and the Washington (primarily Seattle) distant water fleet (catcher vessels, motherships and catcher processors) and regionally based processing and support entities active in the Alaskan groundfish fishery.

How have historic changes in fisheries management affected fishing communities?

- Beyond the overall development of the domestic fishery, a number of fisheries management changes have had significant impacts on the regions and communities.

- With the JV era, expertise in the groundfish fishery was gained, and the foundation was laid for more complete domestic development of the fishery.

- Concerns regarding overcapitalization of the fishery and growth of the offshore sector in the late 1980s led to management actions based on avoiding preclusion of different sectors. This, in turn, had a number of impacts in both Alaskan and Pacific Northwest regions. Inshore/Offshore allocative splits changed the fishery in both the GOA and Bering Sea.

- Implementation of IFQ-based management for sablefish profoundly changed that part of the groundfish fishery.

- License limitation served to cap entries into the fishery, but did not stabilize ownership patterns.

- The evolution of the CDQ program has served to involve entire regions in the groundfish fishery that were not directly involved in the groundfish fishery prior to the implementation of the program.

- The AFA changed the nature of quota allocations between and among sectors. Co-ops were recently formed both offshore (1999) and onshore (2000), and fishery participants are still adapting to the new context. Significant capital was removed (i.e., vessels retired) from the offshore fleet, the race for fish was essentially eliminated, and new types of operational relationships were formed between processors and their harvesting fleets. Ownership structures changed, with increased American ownership overall, and a specific trend of note has been increased investments in the fishery by CDQ groups. In terms of regional or community-based impacts, the beneficial economic impacts of the reduction of the race for fish have accrued to most participants, but perhaps especially to the Washington inland waters region, due to the ownership patterns and basic operational structure of the sector. Some adverse support sector impacts have been felt in Unalaska due to lessening of seasonal peak demands. In general, not enough time has passed since the full implementation of the provisions of AFA for all likely impacts to have become manifest.

- Management measures directed toward Steller sea lion protection have made a significant impact on the fishery. Some of the more restrictive measures were imposed in 2000, and a full suite of alternative measures were analyzed by NOAA Fisheries in 2001. Given the recency of these developments and the interactive nature of Steller sea lion-related management changes with other management initiatives, impacts are still unfolding, and are expected to vary significantly from community to community and region to region.

These issues are important to an understanding of the cumulative nature of the impacts of commercial groundfish fisheries development on the relevant communities and regions, as well as to developing an understanding of the present context or an “existing conditions” baseline against which the impact of the various management alternatives will be assessed. It is also important to note that among the analytic challenges in providing a baseline is the fact that some aspects of the industry cannot be 'held equal,' although they are clearly important.

First, in trying to isolate community impacts by looking at the intersection of communities and sector entities, the picture is complicated by entities that have a presence in multiple areas, such as both the BSAI and GOA areas, that may experience different types of impacts. Second, some entities have a presence in two or more different sectors (catcher vessels, catcher processors, and shore processing), such that impacts that may be seen as accruing to one sector may be influenced by other sector changes. Third, entities in the groundfish fishery differ markedly in the degree to which they participate in and depend on other fisheries. This, of course, helps to determine the magnitude of impacts, or the consequences of impacts, experienced by the individual entities and communities. Other types of factors that confound the analysis in fundamental ways are aspects of the fisheries context that are outside of the control of the entities engaged in the fishery. As mentioned above, AFA-related consequences have recently changed the fishery in a number of ways at approximately the same time that Steller sea lion Regulatory Flexibility Act (RPA) impacts were being realized. Also, Area M salmon changes have had interactive impacts on a number of alternative measure-influenced entities and communities.

In summary, the Alaska groundfish fisheries are taking place in a dynamic socioeconomic context, one that has proven particularly volatile in the past few years. This volatility has resulted at least in some part from changes within the groundfish fishery itself, as well as with respect to other fisheries that, in turn, have fostered interactive or synergistic impacts to the groundfish fishery context. These factors resulted in a status quo that is by no means a set of static conditions. As a result, there are known limitations on the degree to which causality of recent sector and community changes can be assigned to past individual management actions, and this serves to limit the confidence with which projected future changes can be assigned to the proposed alternatives, or that likely changes can be quantified with assurance of accuracy. As a result, the descriptions in this section (and the subsequent impact analysis) are best viewed as indicative of the type, direction and magnitude of changes seen and expected in the groundfish fishery rather than a precise quantification of the socioeconomic parameters of the fishery. A brief overview of the effects of past/present actions and events on regions and communities is summarized in Table 3.9-126.

Alaska Peninsula and Aleutian Islands Region

Overview. The Alaska Peninsula/Aleutian Islands region, shown in Figure 3.9-9, is in several ways the center of the Alaska groundfish fishery in general and the Bering Sea pollock fishery in particular. The adjacent FMP area features the greatest groundfish harvest, and it sees significant activity from both onshore and offshore fishery sectors. In 2001, the region accounted for about 88 percent by volume and 79 percent by value of all groundfish processed in Alaska. During 1992 and 2000, this region accounted for more than four times the volume of groundfish processed inshore than in the other Alaska regions combined. This volume includes 89 percent of the pollock, 68 percent of the Pacific cod, 42 percent of the flatfish, and 31 percent of the A-R-S-O processed.

The relative dependence of regional communities on the groundfish fishery varies greatly. While four of Alaska's top five groundfish landing ports are in this region, some other communities in the region have little, if any, direct involvement with the fishery. Extended profiles of the regionally important groundfish communities of Unalaska/Dutch Harbor, Akutan, King Cove, and Sand Point are available elsewhere (NPFMC 2002d). No groundfish data are yet available for False Pass, but it is known that substantial processing investment has been made in the community, and that at least some groundfish was locally processed during 2001. Groundfish has not been a major focus of processing in St. Paul in recent years, but groundfish do appear in the processing reports for 2000.[17] Additionally Adak, a former military community, has become a significant regional processor of groundfish in the recent past. Although production figures are confidential, it is common knowledge that although no groundfish were landed in the community prior to 1998, it has since become a significant and growing purchaser of groundfish, particularly cod, within the region. This community is quite different in sociocultural terms from the other communities of the region, given its recent development as an industrial site on a converted military base rather than within or adjacent to a traditional community.

It is also important to note that within this region the Aleutians East Borough encompasses the communities of Akutan, Cold Bay, False Pass, King Cove, Nelson Lagoon, and Sand Point. Given that changes in tax revenue resulting from changes in groundfish landing patterns in one community within the borough are directly linked to expenditures in other communities in the borough (for example, a decline in fish tax revenue in King Cove paid to the Borough would impact Nelson Lagoon if it were large enough to necessitate reductions in school expenditures), the borough structure would serve to distribute impacts to communities in a different way than seen in the rest of the region that has no such structure.

This region, then, is one of strong contrasts with respect to involvement with commercial fisheries in general, and the groundfish fishery in particular. In terms of the structural links to the groundfish fishery, for the purposes of socioeconomic characterization, there are four main categories of communities within the region

[17] It is worth noting that Chignik - although not geographically in the region is lumped analytically in regional totals for the fishery - has run some groundfish as well, but like St. Paul this is clearly not the main focus of local processing. Brief information on the Chignik groundfish fleet is provided in recently produced groundfish community profiles (NPFMC 2002d).

that have links to harvesting or onshore and offshore processing sectors of the Bering Sea groundfish fishery. These are characterized as follows:

- Communities with well-developed socioeconomic ties to both onshore and offshore sectors. This category consists of one community: Unalaska/Dutch Harbor. This community has been the number one fishing port in the United States in terms of volume of catch landed since 1992, and held the number one rank in value of catch landed from 1988 through 1999, slipping to number two in 2000 and 2001. Groundfish (especially pollock) is a central part of the community's fishery-based economy. The community has also seen the development of a significant support service sector in recent years, and this support service sector provides services for a number of sectors engaged in the Bering Sea pollock fishery, including shoreplants, floating processors, catcher vessels, and catcher processors. It is also the shipping hub of the Bering Sea. In line with National Standard 8 under the MSA, Unalaska is both highly "dependent" upon and "engaged" in the fishery. This is particularly true when a sense of scale is applied, and the importance of the fishery in relation to the overall size of the community, both in economic and social terms.

- Communities with large shoreplants that are also CDQ communities. This category consists of one community: Akutan. Akutan is quite different from Unalaska in that it is the host community to a single rather than to multiple shoreplants, and the geo-social relationship between the plant and the community is of quite a different nature than those found in Unalaska.

- Communities that are not CDQ communities, have shoreplants that process groundfish, but that have no direct ties to the offshore sector. These are the communities of King Cove and Sand Point. These communities as a pair also differ from Unalaska and Akutan in that they historically have had a resident fishing fleet that provides more than a negligible amount of product to the local plant. Sand Point differs from Unalaska, Akutan, and King Cove in that they did not qualify as a site for an AFA catcher vessel co-op. Like each of the other communities listed, Sand Point does have an AFA-qualified plant.

- Communities that are CDQ communities without a large shore groundfish processing presence. This includes Atka, Nikolski, St. George, St. Paul, Nelson Lagoon, and False Pass. These communities are not discussed in this section, as CDQ issues are presented in Section 3.9.4 of this document.

The major groundfish communities in the region display quite different histories and this, in turn, continues to influence community socioeconomic structure.

Site of a traditional Aleut village since long before contact times, Unalaska became a Russian trading port for the fur seal industry in 1768. Trade in otter skins was the major economic activity until the turn of the last century. Unalaska has extensive historical links to the groundfish fisheries, with at least some cod fishing and processing taking place for decades.

The pre-World War II American period in Unalaska was characterized by a series of booms and busts. Processing of salmon and herring was established in the early 1900s, although major fisheries based on herring were not established until the late 1920s. The economy was depressed after the WW II, until interest in the fishing industry was renewed in the late 1950s; the present crab fishery was established in the early 1960s. Since that time, the level of activity associated with commercial fishing and fish processing has both increased and diversified, and is now the basis of the local economy. Large multi-species groundfish shore processing plants in the community include Alyeska, Unisea, and Westward. Royal Aleutian is a large crab processor, and Icicle brings significant processing capacity to the community in the form of mobile processing facilities.

In contrast, the contemporary community of Akutan began in 1878 as a fur storage and trading port for the Western Fur & Trading Company. The company's agent established a commercial cod fishing and processing business that quickly attracted nearby Aleuts to the community, and a church and a school were built that same year. World War II affected Akutan by displacing Alaska Native residents, and they were not allowed to return until 1944. In 1948 the first catcher processor was sent to Akutan, and eventually Akutan became established as a premier port for floating processors. Today a large processing plant west of the village proper processes significant quantities of groundfish as well as crab. The processing plant supplies the community with substantial economic benefit, but large-scale commercial fishing activity is largely not integrated with the daily life of the community. The Trident plant is the principal facility in the Akutan port and, historically, a number of smaller, mobile processing vessels have operated seasonally out of the port of Akutan. Akutan does not have a vessel harbor or an airport in the community. Beyond the limited services provided by the plant, no opportunity exists in Akutan to provide a support base for the other major commercial fisheries. Hence, alternative economic opportunities of any kind are extremely limited.

King Cove is historically a commercial fishing community. For decades, King Cove has had processing facilities as part of the community as well as resident commercial fishing fleets that deliver to local seafood processors with longstanding relationships. Local fishermen traditionally have fished for all major species, including groundfish, herring, crab and salmon, with crab and salmon predominant. King Cove was founded in 1911 when Pacific American Fisheries built a salmon cannery on the site. During this time they also acquired a salmon saltery at Thin Point near King Cove. The original settlers were Scandinavian, other European, and Aleut fishermen. Much of the Aleut population came from Belkofski for employment in the local cannery. However, in 1965 when Alaska outlawed salmon traps in Alaska waters, it signified the end of Pacific American Fisheries. Currently Peter Pan Seafoods Inc. controls Alaska's largest production facility in King Cove. Salmon is the primary species harvested and processed. The canned salmon output of King Cove in a single season actually exceeds the annual canned production of the entire country of Canada, but change is occurring. Canned salmon markets have declined over time relative to other product forms and groundfish has gained importance in recent years, with the plant qualifying as an AFA facility.

Sand Point, like King Cove, has had processing facilities as part of the community for decades and resident commercial fishing fleets that deliver to local seafood processors with long-standing relationships. Sand Point was founded in 1898 by a San Francisco fishing company as a trading post and cod fishing station. The cod fishing station employed schooners from its home in San Francisco. It served as a repair and supply center for gold mining during the early 1900s, but fish processing became the dominant activity in the 1930s. World War II affected Sand Point little compared with other communities in the area. The U.S. military built an airport that remains to this day. Aleutian Cold Storage built a halibut plant in 1946. Today it is home to the largest fishing fleet in the Aleutian Chain. Trident operates the current processing plant, processing cod, black cod (sablefish), halibut, pollock, salmon and other assorted bottomfish. Peter Pan Seafoods Inc. operates a support station in Sand Point for their processing plant in King Cove.

Population. The Alaska Peninsula/Aleutian Islands region has the smallest population (6,008 in 2000) of the four Alaska regions characterized. The regional population has declined in recent years with the closure of the military installation at Adak, formerly the largest community in the region. Now Unalaska (population 4,283 in 2000) is the largest community in the region, and has ranked first among domestic ports in volume of landings since 1992 and was first in value of landings from 1988 to 1999.[18] Of the other four communities with more than 200 residents in 2000, three (Akutan [population 713], King Cove [population 792], and Sand Point [population 842, the second largest community in the region]) are substantially involved with the groundfish fishery and are the sites of large processing facilities. These communities have a disproportionately male population, consistent with a predominantly male workforce at the seafood plants that, in turn, comprises a significant proportion of the total community population. Although they vary between plants and communities, processor workforces tend to be made up of short-term residents housed in industrial-enclave-type settings.

Employment and Income. Alaska Peninsula/Aleutian Islands communities have a wide range of employment opportunities and income levels. These opportunities are closely related to the commercial fishery in general, and the groundfish fishery in particular. Communities with sizeable seafood processing operations (Akutan, King Cove, Sand Point, and Unalaska) have typically had very low official unemployment rates.[19] Processing workers tend to be in the community because of the employment opportunity, tend to leave when employment terminates, and comprise a significant portion of the population. Among civilian employment sectors, manufacturing, typically associated with seafood processing in this region, has dominated employment. In 1999, 2,958 persons were employed in manufacturing, almost five times as many as in the next most important sector, state and local government. Regional personal income and earnings from manufacturing exceeded earnings of all other sectors combined in 1999.

Tax and Revenue. Commercial fisheries-related taxes are important to the region in absolute and relative terms. Akutan, King Cove, Sand Point, and Unalaska all have local raw fish taxes, and the first three are also subject to a borough raw fish landing tax. Fisheries-related shared taxes accounted for 99.7 percent of all the shared taxes and fees coming to the region from the state in 1999, and total fisheries-related tax revenues exceeded $7 million. The offshore processing component paid more than $2 million in Fisheries Resource Landing tax in 1999. This tax is considerably more important in the Alaska Peninsula/Aleutian Islands region, in both absolute and relative terms, than for any other Alaska region.

Inshore Processing. In the Alaska Peninsula/Aleutian Islands region in 2001, pollock comprised more than 93 percent of the groundfish volume processed, Pacific cod 5 percent, and A-R-S-O and flatfish 1 percent each. This pattern by species varies considerably from those of other Alaska regions. With 674,000 total reported metric tons of groundfish processed and 268,000 metric tons of total groundfish final product in 2001, the Alaska Peninsula/Aleutian Islands region dominates the other regions in inshore processing. With a 2001 total product value of $491 million and a value of $727 per metric ton, this region has the highest total

[18]In 2000, Unalaska dropped to second in value of landings behind New Bedford, Massachusetts (where the value of landings totaled $146 million [versus $125 million in Unalaska] on a much lower volume [89 versus 700 million pounds] than landed in Unalaska). At least a portion of the relative drop in Unalaska in 2000 can be attributed to declines in the crab fisheries.

[19]Preliminary 2000 census unemployment data show very high unemployment rates in some communities that typically have reported virtually no unemployment (e.g., Akutan). While still being analyzed, from initial review it is apparent that at the time the 2000 census was taken large numbers of processing workers were present in the community but the plants were temporarily idle between seasons, an anomaly that resulted in very large numbers of persons reported as 'not working.' For practical purposes, this means that 2000 census data on employment/unemployment are not useful for at least some communities, pending further review. This is discussed in more detail in Section 3.9.6.

value (reflecting enormous volume processed) and the lowest value per ton (reflecting disproportionate dependence on pollock). In 2001, pollock accounted for 88 percent of processed product value, Pacific cod 10 percent, A-R-S-O less than 2 percent, and flatfish about one-tenth of one percent. Within this region, shoreplants are divided into two subsectors for the purposes of this analysis, as noted in Section 3.9.2: the BSP-SPs and the APAI-SP, based on distinctive operational profiles. The BSP-SPs include three large shore processors in Unalaska, one large shore processor in Akutan, and, as of 2002, one floating processor in Beaver Inlet on Unalaska Island, and one floating processor in Akutan Bay. These same plants have operated every year during the 1992 and 2000 period (although one of the floaters has moved from Beaver Inlet to Akutan Bay during this time). The APAI-SP category is comprised of all other groundfish plants in the region (Aleutians East Borough and the Aleutians West Census Area) exclusive of the six Bering Sea plants (and including the plants in Sand Point and King Cove, among others). The Bering Sea plants dominate processing in the region (and, indeed, the state) in terms of volume of groundfish processed. The number of smaller plants in the region has varied from 5 to 8 per year from 1992 to 2000. In 2000, eight APAI-SP (i.e., the regional non-Bering Sea pollock sector plants) reported processing groundfish in Adak (1), Chignik (1), Unalaska/Dutch Harbor (3), King Cove (1), Sand Point (1), and St. Paul (1).

Processor Ownership. Though the center of both onshore and offshore groundfish processing activity, the Alaska Peninsula/Aleutian Islands region has by far the least ownership of groundfish processing entities of any Alaska region. None of the largest shoreplants are owned by resident entities, and the number of smaller regionally-owned inshore plants varied between zero and six per year over the period 1992-2001. To the extent that economic benefits flow to the location of ownership, most of these benefits leave the region. In terms of reported tons in 2001, groundfish processed by inshore plants owned by residents of the region was equal to less than three-tenths of one percent of the total groundfish processed at plants located in the region. Offshore processing in the region displays the same pattern. Regionally owned shoreplants had a wholesale product value of approximately $1.56 million in 2001, while the analogous figure for motherships was $0. Catcher processors have been well below $1 million for all years data can be disclosed.

Catcher Vessel Ownership and Activity. Groundfish catcher vessel ownership is lower in the Alaska Peninsula/Aleutian Islands region than in any other region. In recent years, none of the AFA Trawl catcher vessels (which supply a very large proportion of the groundfish processed in the region) have been locally owned. Ownership is clustered in two vessel classes (TCVs 60 ft and fixed gear catcher vessels 33 ft to 59 ft) that tend to work the nearshore fisheries in the GOA. Vessel ownership within the region is strongly clustered in Sand Point and King Cove, with a secondary cluster in Unalaska. Sand Point residents owned 49 percent of the regionally owned groundfish vessels that, in turn, accounted for 59 percent of the total regionally owned vessel value landed during the period 1992 to 2000. King Cove residents owned 24 percent of the vessels that, in turn, accounted for 23 percent of the regionally owned vessel landings value over this same period. Analogous figures for Unalaska were 21 percent of regional vessels and 14 percent of regionally owned vessel landings value, respectively. No other community accounted for more than 3 percent of regional vessels or one percent of regional value landed by regionally owned vessels. In 2001, these vessels employed 327 persons, with $2.6 million in payments to labor in groundfish. In 2001, 90 percent of the retained harvest value from these vessels came from the western GOA FMP area. About 34 percent retained harvest volume was Pacific cod, and 64 percent was pollock. For that same year, Pacific cod accounted for 66 percent of total groundfish value, and pollock 33 percent.

Harvest Diversity. For groundfish catcher vessels owned by regional residents, groundfish has accounted for roughly half of the ex-vessel value for major fisheries since 1996, a substantial increase over the early

1990s. These vessels are primarily dependent on the groundfish and salmon fisheries, as each of these two fisheries is economically more important by a factor of four or more than any other fishery. About 7 out of 10 vessels participated in the salmon fishery, about one-third in the halibut fishery, and about one-quarter in crab or other fisheries (NPFMC 2002d).

Processing Diversity. For the smaller groundfish processing plants in the region, groundfish roughly accounted for between 10 and 25 percent of ex-vessel value of landings during 1991-1998, with a general increase over this period. In 1998, groundfish accounted for 23 percent of value, while salmon and crab accounted for 30 and 44 percent, respectively. For the larger BSP-SP, groundfish has accounted for more than 50 percent of ex-vessel value of landings from 1991-1998, and well over 60 percent of value for 1995-1997. At these larger plants in 1998, crab accounted for roughly the same proportion of total value as in the smaller APAI-SP, and groundfish alone accounted for roughly the same value as groundfish and salmon combined in the smaller plants (NPFMC 2002d).

Subsistence. Akutan, King Cove, Sand Point, and Unalaska have a subsistence resource consumption ranging from about 200 pounds per capita to more than 450 pounds per capita. Of this total, groundfish specifically ranges from 4 to 9 percent of the total. Subsistence use of Steller sea lions is not well documented, but is heaviest in southwest Alaska and is historically concentrated among relatively few communities (Atka, Akutan, St. George, St. Paul, and Unalaska). Such use has decreased significantly since 1992, and is discussed in more detail in Section 3.9.5.

Tables 3.9-39 through 3.9-44 summarize information on the Alaska Peninsula/Aleutian Islands regional engagement with the groundfish fishery through 2001.

Kodiak Island Region

Overview. The Kodiak Island region encompasses the Kodiak Island Borough, which includes Kodiak Island, other parts of the Kodiak archipelago, and a portion of the Alaska Peninsula, as shown in Figure 3.9-10. Linkages between this region and the groundfish fishery are predominantly associated with the City of Kodiak and its suburbs. Kodiak is the dominant GOA fishing community for groundfish, and is important for salmon, halibut, and other species. In 2001, the region accounted for about 10 percent of the volume and about 13 percent of the value of the total groundfish processed in Alaska. The region accounted for almost 16 percent of the volume of groundfish processed inshore in all regions of the state (1992 to 2000). This volume included 11 percent of the pollock, 28 percent of the Pacific cod, 54 percent of the flatfish, and 30 percent of the A-R-S-O category of groundfish processed. Within this region, the City of Kodiak is the location of virtually all of the direct links with the commercial groundfish fishery. (Processing data does show that groundfish are also run at Atilak, but this is a relatively specialized operation and very small relative to the aggregated operations associated with the City of Kodiak.) An extended community profile of Kodiak is available elsewhere (NPFMC 2002d).

Traditional communities existed in the area in precontact times, but commercial fish processing in the Kodiak region began on the Karluk spit in 1882. Not long after that, canneries were established in the community of Kodiak. While the quantity and form of shore processing plants in Kodiak have changed, this sector remains an influential component of the fishing industry that is, in turn, fundamental to the community and its economy. Shore processing facilities in the Kodiak region concentrated primarily on salmon and herring prior to 1950, although there was a cold storage facility at Port Williams where halibut was frequently landed. The product produced at these facilities was most often canned fish. Cannery operations expanded in the 1950s and 1960s to accommodate king crab processing. Thirty-two processors processed 90 million pounds of crab in 1966. Declining harvest levels, however, prompted several shoreplants to move their operations during the late 1960s and early 1970s to Unalaska/Dutch Harbor in the Aleutian Islands, closer to the larger supply of Bering Sea-Aleutian Island king crab. When king crab stocks started to crash in the late 1960s, some of the remaining Kodiak plants sought to diversify. At least one plant added facilities to separate the previously dominant crab line and the main plant was then converted into a shrimp plant. Many of the plants maintained halibut production lines while they were processing crab, shrimp, and salmon. By the late 1970s a few K-SPs, according to one plant manager, started experimenting with groundfish resources "because there wasn't much crab to do." However, the majority of the groundfish caught prior to 1988 was processed aboard foreign vessels, first by wholly foreign operations, and then by joint ventures where American boats delivered to floating foreign processors. Plant and dock expansions fostered the ability of local plants to further utilize groundfish resources. The first surimi production in Alaska took place in Kodiak in 1985. According to the City of Kodiak, Kodiak is currently home port to 770 commercial fishing vessels, making it the state's largest fishing port. The development or evolution of the Kodiak harvesting fleet has essentially paralleled that of the processors to which they deliver (along with the development of a fleet component that in part or in whole participates in BSAI fisheries).

Population. In 2000, the Kodiak Island region had a population total of 14,256. The City of Kodiak has become the hub community of the region, at present comprising just less than 50 percent of the total Kodiak Island Borough population. Furthermore, a significant part of the region's population lives very near Kodiak in unincorporated areas of the Kodiak Island Borough. When these areas are taken into account, at present approximately 85 percent of the Kodiak Island Borough population lives in and around the City of Kodiak. In terms of ethnicity, the city is about 13 percent Native, while organized communities outside the city are predominantly Native (68 to 94 percent). The predominant minority in the city and its surroundings is Asian and Pacific Islanders, followed by Natives and Blacks. The predominant minority in other (unorganized) regional communities is Caucasian, with few other minorities present.

Employment and Income. The economies of the Kodiak Island region communities are all dependent to some degree on fishing and, for the City of Kodiak, groundfish are an important component of this dependence. In 1999, regional service sector employment outpaced manufacturing, but manufacturing provides more income than any other sector. The fishing sector provides an important base for the retail and government sectors, which follow it in relative size. The military sector is also significant, and is actually second in income and earnings, primarily because of a local Coast Guard base, the largest in the country. The City of Kodiak can be distinguished from other regional communities in several ways. Whereas the city has relatively low rates of unemployment and poverty, other communities have higher rates. In terms of income measures, the city ranks highest.

Tax and Revenue. The City of Kodiak and the Kodiak Island Borough are the primary taxing entities in the region. City or community services outside the city are quite limited, or are supplied by the Kodiak Island Borough or privately. The Kodiak Island Borough levies a property tax of 9.25 mills, a 5 percent accommodations tax, and a 0.925 percent severance tax on natural resources. Other communities levy limited taxes. The Kodiak Island region is also dependent on income from State of Alaska fisheries taxes. The region's share of the fisheries business tax and fishery resource landing tax amounted to $1,330,856 in 1999.

Inshore Processing. In recent years, groundfish has made up over 70 percent by weight of the fish processed in the Kodiak Island region. In 2001, pollock comprised about 43 percent of the groundfish by volume. Pacific cod made up about 29 percent, A-R-S-O about 13 percent, and flatfish about 17 percent. In terms of value, the pattern is somewhat different. Pollock accounted for 40 percent of product value in 2001, Pacific cod 35 percent, A-R-S-O 17 percent, and flatfish 7 percent. While the volume of groundfish processed in the region is much less than in the Alaska Peninsula/Aleutian Islands region, value per ton of final product was higher. Groundfish has recently comprised 40 to 45 percent of the total value of fish processed in the Kodiak Island region. Since 1995, one plant has operated at Alitak and the rest of the region's plants reporting groundfish processing (11 in 1999 and 10 in 2000) have operated in Kodiak itself.

Processing Ownership. Although Kodiak residents own both onshore and offshore processing facilities, onshore plants that process pollock and Pacific cod are owned predominantly by entities outside the region (1995 to present). Kodiak Island region residents are active in the ownership of offshore processing vessels for groundfish other than pollock. Residents historically have owned three to six offshore processing facilities, with the lower numbers in earlier years. In 2001, catcher processors owned by regional residents had a wholesale product value of $23.6 million, and shoreplants had an analogous figure of $2.8 million. No motherships were owned by regional residents.

Catcher Vessel Ownership and Activity. The Kodiak Island regionally owned fleet is very diverse. Some vessel classes, especially the larger trawl vessels, have displayed remarkable stability over time. Smaller trawlers have become fewer. Fixed gear vessels have increased in number. Most of the fleet's fishing activity is in the central GOA, and product is delivered to K-SPs. Regional vessel ownership is heavily concentrated in the City of Kodiak, whose residents over the period of 1992 through 2000 owned 87 percent of all regionally owned vessels, and these vessels, in turn, accounted for 95 percent of regionally owned vessels' landings value over this same period. No other community was home to 6 percent or more of the regionally owned vessels, or accounted for more than 2 percent of the total value of the landings of regionally owned vessels over the 1992 and 2000 period. Since 1991, catcher vessels owned by Kodiak Island region residents have harvested a significant amount of fish in the Bering Sea as well. In 2001, the central GOA accounted for 57 percent of ex-vessel value, and the Bering Sea accounted for 27 percent. The Aleutian Islands, western GOA, and eastern GOA areas accounted for 2, 8, and 4 percent, respectively. Pacific cod accounted for 25 percent by volume and 45 percent by value of retained groundfish harvest, while pollock accounted for 60 percent of volume and 29 percent by value in 2001.

Harvest Diversity. In terms of the 'annual round' for groundfish catcher vessels owned by residents of the Kodiak Island region, groundfish and other species tend to complement each other. Groundfish have accounted for less than half of the total ex-vessel value accruing to these vessels in recent years. Halibut, crab, and salmon are also important fisheries to these vessels. More than 50 percent of the groundfish catcher vessels participate in the halibut fishery, and more than 33 percent participate in the salmon fishery (NPFMC 2002d).

Processing Diversity. Groundfish have accounted for roughly 30 to 47 percent of ex-vessel value for all onshore processing plants in the Kodiak Island region from 1991 to 1999, with a general increase in value over this period. This increased to about 61 percent for 2000 (with the qualification that halibut numbers were not included in the 2000 totals, so that the significance of this increase is suspect). Groundfish are economically more important than any other species or species group. Salmon are second in importance, in some years being close to (or as recently as 1995 exceeding) groundfish in value. Halibut, while relatively more important for the Kodiak Island region than for the Alaska Peninsula/Aleutian Islands region, generally accounts for less than 20 percent of the ex-vessel value of fish delivered to shoreplants in the Kodiak Island region (NPFMC 2002d).

Subsistence. Kodiak is the single regionally important groundfish community. Residents of the City of Kodiak are reported to harvest and consume about 151 pounds of subsistence resource per capita, of which 72 percent is fish. However, groundfish comprise only about 8 percent of the total (12 pounds per capita). Subsistence use of Steller sea lions is not well documented, but has historically been important in the Kodiak Island region, particularly for the communities of Old Harbor and Akhiok. Such use has decreased since 1992 (see Section 3.9.5).

Tables 3.9-45 through 3.9-50 summarize information on the Kodiak Island regional engagement with the groundfish fishery through 2001.

Southcentral Alaska Region

Overview. The southcentral Alaska region, shown in Figure 3.9-11, spans the most heavily populated area of the state. In the southcentral Alaska region, participation in the groundfish fishery varies considerably from other Alaska regions, and the region is little involved with the Bering Sea pollock fishery in particular. In 2001, the region accounted for less than one percent of the volume and 3.8 percent of the value of all groundfish processed in Alaska. While accounting for less than 1 percent of the pollock, 2 percent of the flatfish, and 5 percent of the Pacific cod processed inshore in Alaska regions over the period of 1992 through 2000, the southcentral Alaska region did account for 19 percent of the A-R-S-O species group. The region also differs from the others by virtue of its connection of communities and ports by a road system and this, in turn, influences the nature of engagement with the groundfish fishery. Homer and Seward serve as the primary ports for groundfish trucked on the Alaska road system. During 1991 through 1999, groundfish were processed in 11 regional communities, with (in alphabetical order) Cordova, Nikiski and Seward accounting for the majority of processing. Like other regions, the recent situation is somewhat fluid, as Steller sea lion protection measures may have already had significant effects on the groundfish (and especially pollock) fisheries that exist in the region.

The important groundfish communities of southcentral Alaska have a very different socioeconomic context than those of the previous regions profiled. Cordova, arguably southcentral's most fishery-dependent community, has its origins in transportation as well as fishing. One of the first producing oil fields in Alaska was discovered at Katalla, 47 miles southeast of Cordova, in 1902. Cordova became the railroad terminus and ocean shipping port for copper ore from the Kennecott Mine up the Copper River. The Bonanza-Kennecott Mines operated until 1938 and yielded over $200 million in copper, silver and gold. By 1938, however, the ore supply had diminished, the price of copper dropped and the mines and railway closed down. The Katalla oil field produced until 1933, when it was destroyed by fire. The commercial fishing foundation of the local economy dates back to the 1800s. In 1893, commercial fishing had expanded from the Copper River to include PWS. Between 1889 and 1917, canneries opened in locations including Shepherd Point, Eyak Village, Valdez, Port Nellie, Port San Juan, Drier Bay and Canoe Pass. World War I stimulated the development of the fishing industry, though it decreased after the war. Chinese immigrant labor became prevalent in the canneries. By 1924, seven canneries existed in the PWS with two in the Cordova area. Herring fishing began in 1913, and harvesting of commercial razor clams began in 1916 and lasted until the 1964 earthquake. Dungeness crab harvesting began in the 1930s, followed by catching Tanner crab in the late 1960s. Shrimp fishing, longlining of rockfish, sablefish, and lingcod occurred intermittently in the late 1970s, and salmon seining and gillnetting followed thereafter.

The Homer area has been the site of traditional communities since long before contact times. In 1895 the USGS arrived to study coal and gold resources, and soon thereafter local beach mining operations began. In 1899, Cook Inlet Coal Fields Company built a town and dock on the Homer Spit, a coal mine at Homer's Bluff Point, and a 7-mile-long railroad that carried the coal to the end of Homer Spit. Various coal mining operations continued until World War I, and settlers continued to trickle into the area, some to homestead in the 1930s and 1940s, others to work in the canneries built to process Cook Inlet fish. Coal provided fuel for homes, and there are still an estimated 400 million tons of coal deposits in the vicinity of Homer. The City government was incorporated in March 1964. After the Good Friday earthquake in 1964, the Homer Spit sunk approximately 4 to 6 ft, and several buildings had to be relocated. Today, sport fishing for halibut and salmon contributes significantly to the economy along with the commercial fisheries. A total of 541 area residents hold commercial fishing permits. In 2000, the estimated gross fishing earnings of residents neared $27 million. The fish dock is equipped with cold storage facilities, ice manufacturing and a vacuum fish-loading system. A sawmill processes borough timber, and wood chips are exported from Homer to Japan. Tourism is also an important component of the local economy (ADCED 2002).

Nikiski, now important as a landing/processing/shipping location for the groundfish fishery does not have the type of historical ties to commercial fisheries seen in a number of the other communities. Nikiski is located on the Kenai Peninsula, nine miles north of the city of Kenai. Although Russian fur traders first arrived in 1741, it was not until 1791 that Kenai became the second permanent settlement established by the Russians in Alaska, when a fortified post called Fort Saint Nicholas was built near the community. In 1848, the first Alaska gold discovery was made on the Russian River. In 1869, the U.S. Army established Kenai and in 1899, a Post Office was authorized. The area was homesteaded in the 1940s, and grew from the mid-1950s, when oil exploration led to the first major discovery in the area, the Swanson River oil reserves, 20 miles northeast of Kenai (discovered in 1957). In 1959, natural gas was found in the Kalifornsky beach area 6 miles south of the city of Kenai. By 1964, oil-related industries located within the vicinity included Unocal, Phillips 66, Chevron and Tesoro. Extensive exploration offshore in upper Cook Inlet has established Cook Inlet's middle ground layers containing one of the major oil and gas fields in the world. Today, the main economy is based on the oil industry and derivative products. The industrial complex of Unocal Chemicals produces ammonia and urea for fertilizer, Phillips Petroleum operates a liquid natural gas plant, and Tesoro has a refinery in Nikiski. Fifteen drilling offshore platforms are in the Cook Inlet around Kenai's waters, all equipped with underwater pipelines bringing the crude oil to the shipping docks on either side of the Cook Inlet and from there directly onto tankers. While petroleum activity dominates, federal and state agencies, commercial and recreational fishing, fish processing and tourism are also important parts of the economy of the community.

Non-Native settlers began arriving in Seward in the 1890s. Seward became an incorporated city in 1912. The Alaska Railroad was constructed between 1915 and 1923, and Seward developed as the ocean terminus and supply center. By 1960, Seward was the largest community on the Kenai Peninsula. Tsunamis generated after the 1964 earthquake destroyed the railroad terminal and killed several residents. As an ice-free harbor, Seward has become an important supply center for Interior Alaska. At the southern terminus of the Alaska Railroad, Seward has been a transportation hub for decades. The economy also includes tourism, commercial fishing, ship services and repairs, oil and gas development, a coal export facility, a state prison and the University of Alaska's Institute of Marine Services.

Population. At 366,984 persons in 2000, the southcentral Alaska region is the largest of the four Alaska regions, and it includes Anchorage (population 260,155), as well as small rural communities. Many fishing enterprises and organizations as well as government agencies have offices in Anchorage, and the community is the home of the NPFMC. The southcentral Alaska region groundfish communities tend to be largely non-Native. The high male-to-female ratio often present in small to moderate-sized communities with relatively large processing capacity (such as Alaska Peninsula/Aleutian Islands communities) is not present in this region. This circumstance reflects both a smaller scale of processing operations and a more resident workforce.

Employment and Income. The economies of the southcentral Alaska region groundfish communities tend to be more diversified than those of the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. In part, this greater diversification is a function of road-connectedness and associated access to a large population base, as well as the presence of other developable resources. Groundfish are of lesser importance for employment and income to the region in absolute and relative terms than for either the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. In comparison with the manufacturing sector, in 1999 ten sectors in this region had greater employment and income (the service sector alone had 12 times the number of jobs and 8 times the income of manufacturing).

Tax and Revenue. None of the southcentral Alaska region groundfish processing communities have a local or borough fish tax. At $1,521,569 in fiscal year 1999, 73.3 percent of the region's shared taxes and fees were fisheries-related. This is a higher amount than the Kodiak Island region received (although derived to a lesser extent from groundfish).

Inshore Processing. The groundfish processed in the southcentral Alaska region in 1999 accounted for less than two percent of the groundfish processed inshore in all Alaska regions. The A-R-S-O species group accounted for 43 percent of the volume reported over the period 1991-1998, and Pacific cod, pollock, and flatfish accounted for 35, 17, and 5 percent of the total, respectively. Pollock landings were highly variable. The groundfish value per mt ($3,380 in 2001) for the southcentral Alaska region was almost five times higher than in the Alaska Peninsula/Aleutian Islands region. However, the total product value, $23 million in 2001, was approximately 21 times lower than in the Alaska Peninsula/Aleutian Islands region. The differences between the regions can be accounted for by relative importance of comparatively high-value, low-volume groundfish species. In 2001, A-R-S-O accounted for 52 percent of the volume and 82 percent of the product value for all groundfish processed in the region, while Pacific cod accounted for 18 percent of volume and 10 percent of value. Pollock comprised 25 percent of the volume and 9 percent of value of regional processing, with flatfish accounting for 4 percent of volume and far less than one percent of value. Furthermore, the A-R-S-O species group varies internally among regions, with Atka mackerel (lower value) concentrated to the west, and rockfish (higher value) becoming more important to the east. Processing is also different in the aggregate, as shown by the much higher utilization rates in the southcentral Alaska region (more than 61 percent in 1999) compared to the Alaska Peninsula/Aleutian Islands and Kodiak Island regions (35 and 27 percent in 1999, respectively).[20] In 2000, 17 regional plants reported processing groundfish in Anchorage (2), Cordova (3), Homer (5), Kenai (4), Ninilchik (1), and Seward (2).

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[20]It should be noted, however, that utilization rates are changing (increasing) significantly in the more western regions due, in large part, to recent changes associated with AFA provisions, so this gap will likely narrow somewhat.

Processor Ownership. Groundfish processor ownership by southcentral Alaska region residents is concentrated in the shore plant sector, with secondary focus on head and gut trawl and longline catcher processor sectors. More processing entities are owned by southcentral Alaska region residents than by residents of any other Alaska region. For these processors during 1991-1999, A-R-S-O and flatfish far outdistanced Pacific cod in volume for most years. Although variable, Pacific cod, in turn, represented a higher-volume fishery year to year than pollock. In 2001, 18,000 tons with a wholesale value of $25 million were reported for regionally owned processors. Of the total value, $20 million came from shoreplants and $5 million from catcher processors. There were no motherships owned by regional residents.

Catcher Vessel Ownership and Activity. More groundfish catcher vessels are owned by southcentral Alaska region residents than by residents of either the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. Fixed gear catcher vessels predominate, and since 1995, five or fewer trawl vessels have been locally owned. In the fixed gear vessel class, smaller vessel classes predominate by a large margin. This pattern is due, in part, to the relatively small scale of fisheries (and processing capacity) in the southcentral Alaska region, the diversified nature of the fisheries pursued, and the presence of relatively sheltered waters. Ownership of vessels is spread through numerous communities in the region, but (in order of importance) Homer, Anchorage, Cordova, and Seward combined accounted for 63 percent of the total number of regionally owned vessels between 1992 and 2000, and these vessels, in turn, accounted for 73 percent of the ex-vessel value accrued by regionally owned vessels over this same period. Homer accounted for 26 percent of regional value and 32 percent of regional vessels, Anchorage for 19 percent of value and 14 percent of vessels, Cordova for 15 percent of value and 9 percent of vessels, and Seward for 13 percent of value and 8 percent of vessels. No other community accounted for more than 5 percent of value for regionally owned vessels, nor more than 8 percent vessels themselves for the 1992 through 2000 period. Locally owned vessels harvested groundfish in all five Alaska FMP areas, but relatively little effort is directed at the Aleutian Island eastern GOA areas (4 and 6 percent of value of total groundfish retained harvest for these vessels for each of these areas). In 2001, 67 percent of value came from the central GOA, 14 percent came from the western GOA and 10 percent come from the Bering Sea. In 2001, for retained harvest, 49 percent of volume and 44 percent of value came from Pacific cod, while A-R-S-O accounted for 11 percent of volume and 47 percent of value. Pollock, while comprising 32 percent of total groundfish volume only accounted for 6 percent of total value; flatfish was 7 percent of volume and 3 percent of value for that same year.

Harvest Diversity. In recent years, groundfish has accounted for roughly 25 percent of ex-vessel value for groundfish catcher vessels owned by southcentral Alaska region residents. In 1998, halibut was the most important species, accounting for about one-third of total ex-vessel value. Groundfish and salmon account for roughly 25 percent and crab about 15 percent of the total ex-vessel value. Fully 75 percent of all groundfish vessels fished halibut, and 6 out of every 10 fished salmon (NPFMC 2002d).

Processing Diversity. Groundfish has accounted for roughly 10 to 35 percent of ex-vessel value at all southcentral Alaska region inshore plants over the period from 1991 to 1998. In 1998, ex-vessel value was slightly less for groundfish than for halibut (29 and 31 percent, respectively), and quite a bit less important than for salmon (40 percent of ex-vessel value). Virtually no crab is processed at these plants (NPFMC 2002d).

Subsistence. Until May 2000, Homer, Kenai, and Seward were not classified as subsistence communities. Older data suggest that residents of Homer and Kenai consumed between 84 and 94 pounds of subsistence resources per capita per year and zero or less than one pound of subsistence groundfish. No information exists for Seward. Anchorage is not classified as a subsistence community. For Cordova, groundfish are reported as approximately 4 percent (7 pounds per capita) of the total subsistence consumption (179 pounds per person per year). Subsistence use of Steller sea lions in the region is not well documented, but has historically been important for the community of Tatitlek. No other southcentral community is noted to have a regular pattern of harvest for Steller sea lions (see Section 3.9.5).

Tables 3.9-51 through 3.9-56 summarize information on the southcentral Alaska regional engagement with the groundfish fishery through 2001.

Southeast Alaska Region

Overview. The southeast Alaska region, shown in Figure 3.9-12, encompasses a wide range of communities from Yakutat to Ketchikan and Prince of Wales Island. In 2001, the southeast Alaska region accounted for only 0.8 percent by volume and 4.4 percent by value of the groundfish landed and processed in Alaska. In this regard it is much more similar to the southcentral Alaska region than to the Kodiak or Alaska Peninsula/Aleutian Islands regions. For the period of 1992 and 2000, regional processors accounted for 21 percent of the A-R-S-O ("other groundfish") species category, but one percent or less for flatfish, Pacific cod, pollock, and groundfish taken as a whole. The top three southeast Alaska region ports account for almost all of the region's reported processing. In alphabetical order, they are Petersburg, Sitka, and Yakutat. All three communities support diverse fisheries, pursued by fishers participating in multiple fisheries. Of most importance are salmon and halibut. The main groundfish fisheries are rockfish and sablefish.

The regionally important groundfish processing ports of Petersburg, Sitka, and Yakutat each have quite different histories. The economy of Petersburg historically has been based on commercial fishing and timber harvests. "Peter's Burg" was founded by Peter Buschmann, who built the Icy Strait Packing Company cannery, a sawmill, and a dock by 1900. His family's homesteads grew into the community, populated largely by people of Scandinavian origin. By 1920, 600 people lived in Petersburg year-round. During this time, fresh salmon and halibut were packed in glacier ice for shipment. Alaska's first shrimp processor, Alaska Glacier Seafoods, was founded in 1916. A cold storage plant was built in 1926. The cannery has operated continuously since its founding, and is now known as Petersburg Fisheries, a subsidiary of Icicle Seafoods, Inc. Petersburg has developed into one of Alaska's major fishing communities with the largest home-based halibut fleet in Alaska, but landings of shrimp, crab, salmon, herring and other fish are also locally important. Several processors operate cold storage, canneries and custom packing services, employing over 1,100 people during the peak season. The state runs the local Crystal Lake Hatchery, which contributes to the local salmon resource.

Sitka is one of the oldest communities in Alaska. In 1804, the Russian Empire occupied the area, dubbing it New Archangel, until the sale of Alaska in 1867. For sixty-three years Sitka was Russia's major Pacific port with ships calling from many nations, and headquarters of the Russian-American Company—in its heyday the most profitable fur trading company in the world. Furs destined for European and Asian markets were the main export, but salmon, lumber and ice were also exported to Hawaii, Mexico and California. In 1878 one of the first canneries in Alaska was built in Sitka. During the early 1900s, gold mines contributed to its growth. After the U.S. purchased Alaska in 1867, Sitka remained the capital of the Territory until 1906, when the seat of government was moved to Juneau. During World War II, the town was fortified and the U.S. Navy built an air base on Japonski Island across the harbor, with 30,000 military personnel and over 7,000 civilians. The U.S. Coast Guard now maintains the air station and other facilities on the island. The Alaska

Pulp Corporation, the major employer in Sitka, closed in September 1993, forcing nearly 400 persons into unemployment. The city is home to a sizable fishing fleet, a U.S. Coast Guard Air Station, which handles marine search-and-rescue missions, a campus of University of Alaska southeast and the private Sheldon Jackson College. Founded in 1878 the college is the oldest school in Alaska. The economy is diversified with fishing, fish processing, tourism, government, transportation, retail, and health care services. Sitka is a port of call for many cruise ships each summer and fish processing provides seasonal employment. Regional health care services provide approximately 675 jobs. The U.S. Forest Service and U.S. Coast Guard are significant federal employers.

In the 18th and 19th centuries, English, French, Spanish and Russian explorers came to the area around Yakutat. The Russian-American Company built a fort in Yakutat in 1805 to harvest sea otter pelts. In 1884, the Alaska Commercial Company opened a store in Yakutat. By 1886, the black sand beaches in the area were being mined for gold. In 1889 the Swedish Free Mission Church had opened a school and sawmill in the area. A cannery, sawmill, store and railroad were constructed, beginning in 1903 by the Stimson Lumber Company. Most residents moved to the current site of Yakutat to be closer to this cannery, which operated through 1970. During World War II, a large aviation garrison and paved runway were constructed. Troops were withdrawn after the war, but the runway is still in use. The city of Yakutat was formed in 1948, but in 1992, the city was dissolved and a borough was organized. Fishing and subsistence activities are prevalent, and Yakutat's economy depends on fishing, fish processing and government employment. A cold-storage plant is the major private employer, although lodges and fishing charters in the Situk River drainage provide some jobs. Subsistence hunting and fishing activities focus on salmon, trout, shellfish, deer, moose, seals, bears and goats.

Population. In 2000, the region had a total population of 74,820. There is no clear common regional dynamic of community growth in the southeast Alaska region. Among the important processing communities, Petersburg, Yakutat, and Sitka all display different patterns. Southeast Alaska is ethnically mixed, but communities differ markedly in this matter. Furthermore, ethnic diversity is more limited in the southeast Alaska region than in the other Alaska regions considered in this document. The main groups present are Caucasians and Alaska Natives, with other groups present only in relatively small percentages. In Sitka and Petersburg, Caucasians are the great majority of the population (74 and 87 percent, respectively), with Alaska Natives at 21 and 10 percent, respectively. Yakutat is 55 percent Native and 43 percent Caucasian. This overall population composition reflects the general identity or 'character' of each community, as the contemporary demographics of Petersburg highlights its Norwegian fishing history, Sitka its diverse Native/Russian-American history, and Yakutat its Native heritage. Males outnumber females in the region, but no community shows the great differences that are present in the four large groundfish ports of the Alaska Peninsula/Aleutian Islands region.

Employment and Income. Fisheries in general, and groundfish fisheries in particular, are relatively small contributors to southeast Alaska region employment, especially compared to the government, services, and retail sectors. For the three communities of most concern, fishing and fish processing are more important in absolute terms than the 'average' regional community. Still, the groundfish fishery does not provide a large base for regional employment. There are fewer overall economic opportunities in Yakutat compared to the other two communities.

Tax and Revenue. In contrast to some Alaska groundfish communities in other regions, revenues directly resulting from local landings or processing of groundfish are not the basis for local taxation in the southeast

Alaska region. Only Yakutat has a local fish tax, and it applies to salmon rather than to fish in general (and thus does not apply to groundfish). Shared state fisheries taxes do generate revenue for local communities, however. The region's share of the fisheries business tax and fishery resource landing tax amounted to $2,221,926 in 1999, which was 88 percent of such shared revenue for the region.

Inshore Processing. Most southeast Alaska regional groundfish processing occurs in Petersburg, Sitka, and Yakutat. These communities differ in the degree to which they participate in groundfish fisheries and in the mix of species that they exploit. Of greatest significance regionally among groundfish is A-R-S-O, the mixed category that lumps Atka mackerel, rockfish, sablefish, and "other" (non-pollock, non-cod, and non-flatfish) groundfish. Most of the active processors in this region use groundfish only as a supplementary product acquired as bycatch. Rockfish are targeted only sometimes as a primary product, and total volume is still low. The groundfish fishery is important for components of the local fleet, but serves a secondary role for most processors. Southeast Alaska processing plants extract a large return from the fish that they process, with a relatively high utilization rate, compared to the Kodiak and Alaska Peninsula/Aleutian Islands regions. At 74 percent in 1999, utilization was over twice that of the Alaska Peninsula/Aleutian Islands region. Product was valued at $5,665 per ton in 2001, which was 6 times greater than the Alaska Peninsula/Aleutian Islands region and 28 percent higher than the comparable value of the southcentral Alaska region, the next closest region. Total product value was less than one-eighteenth of that of the Alaska Peninsula/Aleutian Islands region, and total retained volume was less than one percent of the volume of that region. For the most part, southeast regional processors tend to concentrate on higher-value, low-volume species such as sablefish and rockfish that are typically sold whole or as headed and gutted product. In 2001, A-R-S-O accounted for 94 percent of the volume and over 99 percent of the value of all groundfish processed in the region. Pacific cod accounted for one percent of the volume and two-tenths of one percent of the value of the groundfish processed in the region; flatfish accounted for the virtual remainder of the regional volume (4 percent), but its value was negligible on a regional basis. In 2000, 13 regional plants reporting groundfish processing operated in Hoonah (1), Juneau (2), Ketchikan (2), Petersburg (2), Pelican (1), Sitka (3), and Yakutat (2).

Processing Ownership. Groundfish processing capacity in the southeast Alaska region owned by residents of the region is concentrated in two sectors, inshore processing plants and longline catcher processors. A substantial percentage (half or more) of regional onshore processing capacity is owned by residents of other areas. It appears that regional pollock and flatfish processing is concentrated primarily in non-locally owned onshore facilities. For regionally owned facilities, groundfish of greatest importance are Pacific cod and the A-R-S-O category (mainly sablefish and rockfish). In 2001, catcher processor wholesale product value was $10.7 million, while shoreplant wholesale product value was $8.0 million. No motherships were owned by regional residents.

Catcher Vessel Ownership and Activity. Ownership patterns for catcher vessels are much the same as for processors, in that they indicate a fishery more dependent on limited quantities of Pacific cod, rockfish, and sablefish pursued with longline gear rather than higher volumes of fish pursued with trawl gear. Most locally owned vessels are relatively small and use longline gear for groundfish (and probably participate in other fisheries). Sitka, Petersburg, Juneau, and Ketchikan are the most important communities in terms of regional vessel ownership. Over the 1992 to 2000 period, Sitka vessels accounted for 30 percent of the value of the groundfish landed by the regionally owned fleet, and for 29 percent of the vessels in that fleet. Petersburg residents accounted for 17 percent of the value and 16 percent of the regionally owned fleet, while Juneau residents owned 13 percent of both value and vessels during this period. Ketchikan resident-owned vessels accounted for 7 percent of the ex-vessel value of landings by regionally owned vessels during 1992 to 2000, and 7 percent of the regionally owned fleet. No other community accounted for more than 4 percent of the regional total for either value or vessels. In 2001, 74 percent of the harvest value came from the eastern GOA, 20 percent from the central GOA, and 3 percent from the western GOA. Approximately 2 and one percent came from the Aleutian Island and the Bering Sea areas, respectively. It is likely that regionally owned vessels harvest and deliver nearly all fish in the A-R-S-O category. In 2001, A-R-S-O accounted for 77 percent of the volume and 97 percent of the value of the harvest, while Pacific cod represented 23 percent of the volume of the total groundfish harvest and 3 percent of the value. The local fleet is a multi-species, multi-gear fleet concentrated in Sitka and Petersburg. For groundfish, the fleet targets sablefish and rockfish. Thus, most of the Pacific cod and pollock processed by the region's shoreplants is harvested and delivered by non-local vessels.

Harvest Diversity. In terms of the fishing annual round, groundfish and non-groundfish species tend to complement each other. The importance of groundfish as a proportion of total ex-vessel value has remained relatively stable, between 30 and 40 percent in recent years. Halibut and salmon each contribute about 25 percent each of the total ex-vessel value. The fleet is relatively diversified, with more than 80 percent of groundfish catcher vessels owned by southeast Alaska region residents participating in the halibut fishery, and about 70 percent of groundfish vessels participating in the salmon fishery. Twenty-five percent of the vessels also fish for crab. About 60 percent participate in fisheries other than halibut, salmon, and crab (NPFMC 2002d).

Processing Diversity. Groundfish has accounted for roughly 20 to 30 percent of ex-vessel value at regional processing facilities over the period from 1991 to 1998, with a gradual increase in value. Groundfish accounts for roughly 29 percent of the value of total plant production, compared to 40 percent for salmon and 20 percent for halibut (NPFMC 2002d).

Subsistence. Subsistence utilization in the regionally important groundfish communities of Petersburg, Sitka, and Yakutat ranges between about 200 and 400 pounds per capita. Groundfish represents 1 to 5 percent of the total subsistence resources consumed. No community in the southeast region is noted to have a regular pattern of harvest for Steller sea lions.

Tables 3.9-57 through 3.9-62 summarize information on the southeast Alaska regional engagement with the groundfish fishery through 2001.

Washington Inland Waters Region

Overview. The Washington inland waters region spans a good portion of northwestern Washington, as illustrated in Figure 3.9-13. The Washington inland waters region as a whole, and especially the greater Seattle area in particular, is engaged in all aspects of the overall North Pacific groundfish fishery, and is particularly heavily involved in the Bering Sea pollock fishery. While this region is distant from the harvest areas, it is the organizational center of much of the industrial activity that comprises the human components of the fishery. Clearly, specific industry sectors based in or linked to Seattle are substantially engaged in or dependent on the North Pacific groundfish fishery. The scale and diversity of the Washington inland waters region makes a socioeconomic assessment directly related to the Alaska groundfish fishery very complex. Seattle's relationship to the Alaska groundfish fishery in general (and the Bering Sea pollock fishery in particular) is paradoxical. When examined from certain perspectives, Seattle is arguably more involved in the Alaska groundfish fishery than any other community. One example is the large absolute number of Seattle jobs in the Alaska groundfish fishery compared to all other communities, whether counted in terms of current residence, community of origin, or community of original hire (setting aside the matter of where the jobs are actually located). On the other hand, when examined from a comparative and relativistic perspective, it could be argued that the fishery is less important or vital for Seattle than for the other communities considered. Using the same example, the total number of Alaska groundfish-fishery-related jobs in greater Seattle compared to the overall number of jobs in Seattle is quite small, in contrast with the same type of comparison for the much smaller Alaska coastal communities. When examined on a community-wide basis, one perspective is that Seattle as a whole is more engaged in, but less dependent upon, the groundfish fishery than all of the other previously mentioned "groundfish communities." An extended groundfish-oriented community profile of Seattle is available elsewhere (NPFMC 2002d).

Regional Economy. As can be expected of a region encompassing a large metropolitan area and containing 3.9 million residents, retail trade and services are extremely important economic sectors and are the two largest economic sectors in terms of employment. Manufacturing employs more people than the state and local government sector, followed by finance, construction, wholesale trade, and transportation. The military, civilian federal, agricultural, and mining sectors are relatively small. The fishing industry has a substantial presence in parts of the Washington inland waters region, but is greatly overshadowed in terms of employment by other industry sectors. During the period 1992-2001, between 3,718 and 5,973 Washington inland waters region residents were employed annually by Alaska groundfish processing sectors. At-sea processor sectors (motherships, trawl catcher processors, and longline catcher processors) are by far the most significant contributors. Due to the methodology employed, in which all employment for these entities accrues to the region of the residence of the owner, regional employment attributable to these sectors is probably overstated in absolute terms. On the other hand, many entities in these sectors have various business relationships with Alaska CDQ groups, which has resulting increased Alaska Native employment (and other sources of revenue and income for Alaska Native entities and individuals) as discussed in detail Section 3.9.4 (as this type of detail, unique to the CDQ program, is not otherwise well captured in the economic model). (This type of interregional employment tie is also seen where other entities have special arrangements to foster Alaska, and especially Alaska Native, hire.) Furthermore, shoreplant employment for Washington inland waters region residents may be understated, because all such employment, except for head office staff, is attributed to the region where the plant is located, and much shoreplant recruiting takes place in the Washington inland waters region (as well as elsewhere in the Pacific Northwest and beyond). Payments to labor for processing employment ranged between $232 million and $323 million during this same period. The Washington inland waters region is also home to a very large proportion of the support service industry related to the groundfish fishery. This activity is captured in the regional baseline figures of a total direct, indirect, and induced labor income of $560 million and employment of about 10,300 FTEs, both of which are easily more than double the analogous figures for the region with the next highest levels of total groundfish associated income and employment (the Alaska Peninsula and Aleutian Islands region).

Processing Ownership. Ownership of Alaska groundfish processing capacity is highly concentrated among owners with residence in the Washington inland waters region. This concentration or overwhelming dominance applies to shoreplants, catcher processors and motherships, and varies in degree between sectors. In 2001, Washington inland waters regionally owned processors reported processing 1.9 million tons of groundfish (97 percent of all Alaskan groundfish processed in that year). In terms of estimated wholesale value, Washington inland waters regionally owned processors processed $1.3 billion worth of groundfish in 2001 (95 percent of the total fishery). In 2001, wholesale product value from catcher processors owned by regional residents was $631.8 million, from shoreplants was $589.7 million, and from motherships was $86.9 million.

Catcher Vessel Ownership. Residents of the Washington inland waters region own catcher vessels in each vessel class that participates in the Alaska groundfish fishery. Numbers in all categories except the smaller vessels (fixed gear vessels less than 60 feet [and especially those less than 32 feet] and trawl vessels less than 60 feet) are large relative to ownership levels in the Alaska regions. Catcher vessels owned by residents of the Washington inland waters region tend to be larger than those owned by residents of Alaska, and this comparison emphasizes the region's concentration of ownership (and participation) in the BSAI groundfish fisheries. This is especially true for trawl vessels in general and large, AFA-eligible trawlers in particular. Catcher vessel ownership in this region is strongly concentrated in Seattle. During the 1992 to 2000 period, Seattle residents owned 45 percent of all regionally owned vessels, and these vessels, in turn, accounted for 65 percent of the total regionally owned vessel value of landings. Outside of Seattle, regional vessel ownership is widely dispersed. Residents of no other community accounted for more than 7 percent of the regionally owned vessels, or more than 5 percent of the regionally owned vessel landings value during this period, and a total of 70 communities have at least one or more vessels in this fleet. Catcher vessels owned by Washington inland waters region residents accounted for 1,238 employees in 2001, with payments to labor of $54 million. Harvest retained by these vessels is heavily concentrated in the Bering Sea FMP area. In 2001, 81 percent of retained harvest ex-vessel value came from the Bering Sea, 7 percent from the central GOA, and between 3 and 5 percent came from each of the eastern GOA, western GOA, and Aleutian Islands regions. In terms of volume of retained harvest, in 2001, 95 percent was pollock, 4 percent Pacific cod, and less than one percent each of A-R-S-O and flatfish. In terms of value, 75 percent derived from pollock, 10 percent from Pacific cod, and 14 percent from A-R-S-O for the same year. Flatfish value was negligible on a regional basis. Within the region in 1999, 43 percent of the vessels representing 67 percent of the volume and 62 percent of the value of the harvest were located in Seattle, and no other community in the Washington inland waters region had residents with ownership of more than 6 percent of the region's vessels or 10 percent of the region's total volume or value of harvest.

Catcher Vessel Diversity. While Alaska groundfish make up the greater part of the ex-vessel value of the harvest by Alaska groundfish catcher vessels owned by Washington inland waters region residents, other fisheries are seasonally important. Although harvest volumes and values vary, over the period 1988-1998, groundfish has amounted to about 60 percent of the ex-vessel value of the harvest for these vessels. In 1998 specifically, groundfish comprised 57 percent of the ex-vessel value of the annual harvest round. About 27 percent was from crab, 11 percent from halibut, and 5 percent from salmon. Among regionally owned Alaska groundfish vessels, 47 percent also fished for halibut, about 28 percent also fished for crab, about 28 percent also fished for salmon, and about 27 percent also fished for other species in Alaska FMP areas (NPFMC 2002d).

Tables 3.9-63 through 3.9-68 summarize information on the Washington inland waters regional engagement with the groundfish fishery through 2001.

Oregon Coast Region

Overview. For the purposes of this analysis, the Oregon coast region is defined as the area encompassing Tillamook County, Lincoln County, and Clatsop County, as illustrated in Figure 3.9-14. This area includes those ports and communities in Oregon with the most direct ties to the Alaska groundfish fishery, and had a population of 104,955 in 2000. The Oregon coast region has long had significant involvement in the Alaska groundfish fishery, from the development of the joint venture fishery through the present. The most visible aspect of this participation is the fleet of catcher vessels based in Oregon that participate in a variety of fisheries across the various Alaska regions. Though Oregon coast region residents own fewer catcher vessels than the residents of any of the other regions profiled (35 in 2001), these vessels harvested more North Pacific groundfish by volume than the vessels from any other region except the Washington inland waters region. In value of harvest, the Oregon coast region ranked far behind the Washington inland waters region but were very close to the Kodiak Island and Alaska southeast regions, but well ahead of the other two

Alaska Regions. This activity is highly concentrated in the community of Newport. For the period 1988-1998, Newport accounted for 72 percent of the total harvest volume and 67 percent of the total harvest value of Alaska groundfish by Oregon coast region owned vessels. No other regional port accounted for eight percent or more of the regional total. Oregon coast region ports are important for local fisheries as well as the distant Alaska fisheries. Most of the fish landed in Oregon is delivered to Astoria or Newport, the county seats of Clatsop and Lincoln counties, respectively. Onshore facilities to process whiting (from Pacific Northwest waters) are concentrated in Newport.

Regional Economy. The Oregon coast region economy is relatively diversified and relies heavily on the retail, service, and government sectors. Fish and timber are also significant components of the multi-industry "agriculture, forestry, fishing, and other" and "manufacturing" categories. Manufacturing, as measured by earnings, is similar in magnitude to the retail trade, service, and government sectors. As an aggregated category, however, it is not clear how much of this magnitude is due to fish-related activity. It is almost certain that none of this manufacturing activity is related to Alaska groundfish. There are no onshore plants in this region that process Alaska groundfish, and only one regionally owned longline catcher processor in the years 1992-1994 (none at present). Thus, it would appear that none of this region's processing employment is attributable to Alaska groundfish.

Processing Ownership. There is no current Oregon coast regional ownership of Alaska groundfish processing capacity, and such ownership has been limited in the past.

Catcher Vessel Ownership. Catcher vessel ownership of Alaska groundfish vessels in this region is highly concentrated in Newport. Residents of Newport owned 44 percent of the groundfish vessels owned by the residents of the region over the period 1992 to 2000, and these vessels, in turn, accounted for 66 percent of the value of all groundfish landings by regionally owned vessels. No other community in the region accounted for more than 14 percent of regionally owned vessels, and none accounted for more than 6 percent of the total value of landings made by regionally owned vessels. On all measures, Newport is clearly the dominant Oregon coast region community in terms of engagement with North Pacific groundfish fisheries in general, and the Bering Sea pollock fishery in particular. Of the vessels owned by Oregon coast region residents that participate in the Alaska groundfish fishery, trawlers predominate, followed by pot vessels, longliners, and miscellaneous 'other' vessels in about equal numbers. Trawlers are the most active and productive component of this fleet. They are based primarily in Newport or the nearby area. In employment related to the Alaska groundfish fishery on regionally owned vessels, trawlers supplied the bulk of opportunities in 1998 (about 67 percent of the total). Pot vessels provided 16 percent and longliners about 18 percent. In 2001, retained harvest ex-vessel value derived 64 percent from the Bering Sea, 33 percent from the central GOA, and approximately one percent each from the eastern GOA and the western GOA. Value from the Aleutian Islands was negligible on a regional basis. On a species basis, in 2001 pollock accounted for 83 percent of volume and 62 percent of value of regionally owned vessels, while Pacific cod accounted for 11 percent of volume and 29 percent of value. A-R-S-O and flatfish accounted for about 3 percent of volume each, and approximately 7 percent and 2 percent of value, respectively.

Catcher Vessel Diversity. Catcher vessels owned by Oregon coast region residents have a specific dependence on the Alaska groundfish fishery, but generally participate in other Alaska fisheries. As a class, these vessels derive a clear majority of their Alaska ex-vessel value from groundfish activity. In 1998 groundfish accounted for almost two-thirds of the Alaska ex-vessel value accruing to this fleet. Crab make up about one-quarter of the ex-vessel value. About half of the groundfish vessels also participate in the halibut fishery, and about one of five participate in the salmon and crab fisheries. About one-third of the Oregon-owned groundfish catcher vessel fleet participates in Alaska fisheries other than groundfish, halibut, crab, or salmon (NPFMC 2002d).

Tables 3.9-69 through 3.9-74 summarize information on Oregon coast regional engagement with the groundfish fishery through 2001.

3.9.4 Community Development Quota Program

3.9.4.1 Community Development Quota Overview

The CDQ program region differs from the Alaska and Pacific Northwest regions and communities profiled by the nature of its engagement with and dependence upon the Alaska groundfish fisheries. The communities within this region primarily engage in the fishery through the auspices of the program rather than through historic participation in the fishery, so the focus of this section is the program itself rather than a characterization of the many communities in the region.

CDQ Establishment and Purpose

In 1992 the CDQ program was developed to facilitate the participation of BSAI community residents in the fisheries off their shores, as a means to develop a local community infrastructure and increase general community and individual economic and social well-being. The CDQ program was granted in perpetuity through the MSA authorized by the U.S. Congress in 1996. The State of Alaska is responsible for the administration and monitoring of the program. The state administers the program jointly through the ADCED (the lead agency) and the ADF&G.

The CDQ program is a federal program that allocates a portion of the TAC (or GHL, as appropriate) for federally managed BSAI species to eligible communities in western Alaska. Originally involving only the pollock fishery, the program has in recent years expanded to become multi-species in nature. The CDQ program includes such species as pollock, Pacific cod, Atka mackerel, flatfish, sablefish, and other groundfish, along with halibut, and crab. Currently, the CDQ program is allocating portions of the groundfish fishery that range from 10 percent for pollock to 7.5 percent for most other species. The CDQ program has contributed to infrastructure development projects within the region as well as loan programs and investment opportunities for local fishermen. In recent years the program has provided more than 1,000 jobs annually for region residents and yearly wages have exceeded $8 million.

Sixty-five Alaska Native Claims Settlement Act (ANCSA) villages near the Bering Sea have established eligibility under federal and state regulations, and these villages formed a total of six non-profit regional groups through which they participate in the program. The State of Alaska and the NOAA Fisheries periodically allocate percentages of each species, based upon its evaluation of the Community Development Plans submitted by individual CDQ groups. The six CDQ groups are: Aleutian Pribilof Island Community Development Association (APICDA); Bristol Bay Economic Development Corporation (BBEDC); Central Bering Sea Fishermen's Association (CBSFA); Coastal Villages Region Fund (CVRF); Norton Sound Economic Development Corporation (NSEDC); and Yukon Delta Fisheries Development Association (YDFDA). The groups have established partnerships with fishing corporations. Local hire and reinvestment of proceeds in fishery development projects are a required part of the program.

In addition to each CDQ group filing a management plan with the state when they apply for their requested share of the overall CDQ allocation, they also file quarterly reports that detail their activities and track their progress in relation to the goals they have set in their management plans. The state can adjust the percentages awarded to each group from one allocation period to the next, based on the state's evaluation of various factors documented need, adequacy of the proposed plans to use the requested allocation to meet those needs, past performance, and perhaps other needs. Reports summarizing and/or reviewing the activities of the CDQ program have been prepared for several purposes (NPFMC 1998d, NRC 1999, ADCED 2001, NMFS 2001b), and the existing conditions portion of this regional profile is largely abstracted from the most recent of two of these documents, the Steller Sea Lion Protection Measures SEIS (NMFS 2001b) and the BSAI Crab Rationalization Program Alternatives analysis (NPFMC 2002d).

CDQ Performance Overview

Since its inception, the CDQ program has contributed to fisheries infrastructure development. According to the ADCED, during the first decade of the program approximately 9,000 jobs have been created with wages totaling more than $60 million. As annual royalties grow, the revenue streams have permitted development and accumulation of considerable savings and investment capital within the CDQ groups, for use in a variety of future investments. Data suggest that CDQ groups, when taken as a whole, have retained almost half of their gross revenues in some form of equity, whether infrastructure projects, vessel ownership, or cash. Since 1992, the CDQ group's equity growth has averaged 37 percent per annum, or slightly more than $10 million each year. It has been reported by the State of Alaska that, by 1997, CDQ groups had more than 200 people employed in the pollock fishing industry alone, 846 individuals in CDQ training and a total expenditure by CDQ groups of $1,041,309. From 1993 to 1997, CDQ programs generated approximately 1,000 employment positions a year, with associated annual total wages of about $5 million to $8 million. Management and administration accounted for 6 percent of the jobs and 23 percent of the wages. This level of direct engagement in the fishery can only enhance the control communities may exercise over the joint economic activity. CDQ partnerships bring training and employment within the partners' fishing operations and other development benefits, as well as providing vessel loan programs; education, and other CDQ-related benefits. CDQ groups and their residents are able to learn first hand how the industry functions. They are better able to take part in decisions that directly affect business operations and, thus, profitability. A brief overview of the past/present effects of actions and events on CDQ is presented in Table 3.9-127.

CDQ Communities

CDQ communities are remote, isolated settlements with few commercially valuable natural assets with which to develop and sustain a viable, diversified economic base. As a result, economic opportunities have been few, unemployment rates have been chronically high, and communities (and the region) have been economically depressed. CDQ communities border some of the richest fishing grounds in the world, but they have largely been unable to exploit this proximity. The full Americanization of the BSAI fisheries occurred relatively quickly. However, the very high capital investment required to compete in these fisheries precluded small communities from participating in their development. The CDQ program serves to ameliorate some of these circumstances by extending an opportunity to qualifying communities to directly benefit from the productive harvest and use of these publicly owned resources.

As shown in Table 3.9-75, the six CDQ groups contain between one and 21 communities in each group. As seen in this same table, CDQ communities are predominantly Alaska Native villages, with Alaska Native residents comprising 86.8 percent of the combined total population of all CDQ communities. Table 3.9-76 summarizes the six CDQ groups in terms of their membership, approximate populations, and office locations. The total population of the 65 CDQ communities in 2000 was estimated to be 27,073. However, this population figure may include a substantial number of individuals who are not year-round residents. The administrative offices of CDQ groups tend to be located in regional hub communities, near government or industry partner offices, and/or near community or other ongoing projects.

The CDQ communities are geographically dispersed, extending westward to Atka, on the Aleutian chain, and northward along the Bering coast to the village of Wales, near the Arctic Circle, as shown in Figure 3.9-15. According to Sec. 305(i)(1)(B) of the MSA, to be eligible to participate in the CDQ program a community must:

- Be located within 50 nm from the baseline from which the breadth of the territorial sea is measured along the Bering Sea coast from the Bering Strait to the western most of the Aleutian Islands, or on an island within the Bering Sea.

- Not be located on the GOA coast of the North Pacific Ocean.

- Meet criteria developed by the Governor of Alaska, approved by the Secretary, and published in the Federal Register.

- Be certified by the Secretary of the Interior pursuant to the Alaska Native Claims Settlement Act (43 USC 1601 et seq.) to be a Native village.

- Consist of residents who conduct more than one-half of their current commercial or subsistence fishing effort in the waters of the Bering Sea or waters surrounding the Aleutian Islands.

- Not have previously developed harvesting or processing capability sufficient to support substantial participation in the groundfish fisheries in the Bering Sea, unless the community can show that the benefits from an approved Community Development Plan would be the only way for the community to realize a return from previous investments.

CDQ Allocations and Harvest

In 1991, NPFMC recommended to the Secretary of Commerce that a fishery CDQ program be created. As initially envisioned, the CDQ program set aside 7.5 percent of the BSAI annual TAC for Alaska pollock for allocation to qualifying rural Alaskan communities. The program was initially proposed to run for a period of 4 years, lasting from 1992 through 1995, but was subsequently extended for an additional 3 years, carrying it through 1998. In subsequent actions, a CDQ program for BSAI halibut and sablefish followed and was implemented in 1995. A CDQ program for BSAI crab was initiated in 1998, and the multi-species groundfish CDQ program was implemented in late 1998. The NPFMC also extended the pollock CDQ allocations permanently by including pollock in the multi-species groundfish CDQ program. The AFA of 1998 increased the pollock allocation for the CDQ program to 10 percent of the annual TAC.

Today, under the current regulations all groundfish and prohibited species caught by vessels fishing for CDQ groups accrue against the CDQ allocations and none accrue against the non-CDQ apportionment of the TAC or prohibited species catch limits. The CDQ groups are required to manage their catch to stay within all of their CDQ allocations. Each CDQ group is allocated a share of the suite of the species subject to CDQ allocations, although not all groups receive allocations of all species or regional populations. The CDQ allocations recommended by the state for 2001-2002 are displayed in Table 3.9-77. In 2001, these percentages represented approximately 185,000 metric tons of groundfish (Table 3.9-78).

Additional details on the harvest amount and wholesale value of the groundfish CDQ allocations are presented in Table 3.9-79 and Table 3.9-80. As noted above, prior to implementation of the multi-species groundfish CDQ program in 1998, the only groundfish species for which CDQ allocations existed were pollock and sablefish. However, other groundfish species were harvested incidentally. After 1998, CDQ allocations became available for all groundfish species, and the harvest of some species such as Pacific cod and Atka mackerel increased.

As shown in Table 3.9-79, pollock dominates the volume of groundfish landings over the years provided, varying between approximately 98 percent of volume each year from 1993-1997 before dropping to around 82 percent by 1999-2000. The current dominant economic importance of pollock and Pacific cod to the CDQ program among the various groundfish species may be seen in Table 3.9-80. As shown, in 2000, pollock and Pacific cod when added together account for $107.67 million (or 96.3 percent) of the $111.80 million total wholesale value of CDQ allocations for all groundfish species for that year. Further, as shown in that same table, wholesale value of pollock value was almost six times greater than that of Pacific cod, and the wholesale value of Pacific cod, in turn, was almost eight times greater than Atka mackerel, the next most valuable groundfish species for that same year (Table 3.9-80).

Table 3.9-81 shows the seasonal variability in the value of groundfish catches. The bimodal distribution in the groundfish fishery is a function of the winter/spring and fall seasons, the timing of which has changed somewhat in the last few years. Fishing is usually more lucrative in the early portion of the year because of the relatively high value of pollock roe.

3.9.4.2 Community Development Quota Group Profiles

The six CDQ groups are made up of regional alliances of Alaska Native villages on or near the Bering Sea. The CDQ groups have emerged through the establishment of a management structure and the formulation of a detailed business plan. Each group is a CDQ corporation with a board of directors made up of representatives from the communities, executive officers, and professional staff. To facilitate interaction with industry partners and government oversight agencies, most of the CDQ groups established headquarters in Juneau, Anchorage, or Seattle.

The communities are required to invest profits in fishery-related assets such as fishing vessels, processing plants, and port facilities. Contractual arrangements are not typically limited to payment of royalties per ton of quota but also include provisions for training and employment of residents of CDQ villages, scholarship programs, and a variety of other considerations. Some of the groups have used revenue sharing agreements that allow the royalty to vary with product mix and first wholesale prices. Increasingly CDQ groups are taking equity positions in existing commercial harvesting and processing operations, which then use their CDQ allocations. Individual groups have followed a variety of strategies for using their CDQ allocations, and for the investment or other use of the proceeds. Most have formed stable partnerships with established fishing industry participants and have, or are seeking to, invest in the fishery. The following CDQ group profiles are adapted from those contained within the inshore/offshore pollock allocation amendment to the Bering Sea groundfish FMP as updated in subsequent NMFS/NPFMC documents. The dominant importance of pollock and Pacific cod to the CDQ program can be seen in the fact that together they accounted for a full 90 percent of all CDQ royalties for all species (including non-groundfish species) included in the program in 2000.[21] It is important to note, however, as shown in subsequent sections, individual fisheries wholesale value and species royalty rankings do not necessarily directly correspond to levels of employment.

Aleutian Pribilof Island Community Development Association

The communities represented by APICDA are relatively small and located adjacent to the BSAI fishing grounds. As detailed elsewhere (Section 3.9.3), the Aleutian Islands/Alaska Peninsula region is the center of the BSAI groundfish fishery, with Unalaska, Akutan, King Cove, and Sand Point being its primary ports. While all of these communities are within the geographic span of APICDA, only Akutan is a CDQ group member. Unalaska, the largest community in the region and the hub of the Bering Sea fishery, is not a CDQ community but is an *ex officio* member of APICDA and has a non-voting member of the APICDA Board of Directors. Unalaska residents are eligible for APICDA training and education opportunities, many of which are located in Unalaska to take advantage of proximity to the industry, rather than in the other member villages. (King Cove and Sand Point were not eligible for CDQ membership because they are located outside the overall CDQ eligible region [they are located on the GOA], and because they were the sites of substantial existing commercial fisheries development, as detailed elsewhere [Sections 3.9.3 and 3.9.6].).

Currently, APICDA is allocated 14 percent of the pollock and 16 percent of the Pacific cod CDQ allocations, which are shared among its inshore and offshore partners in such a way as to maximize the benefit to APICDA. Because of proximity to the fishing grounds and year-round access to ice-free waters, APICDA's focus is primarily on community development and employment opportunities that occur in or near each community. These villages do not have the same need for factory trawler employment, as do residents of many other CDQ communities, who do not have the same opportunity for local fishery development. This

[21] As of 2003 a preferred alternative amendment to the BSAI Crab FMP is being analyzed that would increase CDQ allocations for crab from 7.5 percent to 10 percent and bring more species under the program umbrella. Given the state of crab stocks, however, and the relative total values of the fisheries involved, whether or not this amendment is approved will notchange the dominant nature of groundfish within the overall CDQ program.

is reflected in APICDA's employment statistics, which show one of the highest total employment levels, but a relatively low number of pollock processing jobs. APICDA also has a wide variety of investments in different sectors of the fishery, as well as in tourism, and other areas.

APICDA has employment provisions with both its inshore and offshore partners and has invested, both with them and individually, in a number of fisheries-based development projects in several of its villages, creating a variety of employment opportunities. Though the group has placed residents with all three pollock sectors, APICDA residents in general have shown a preference for non-pollock employment, with the single largest source being renovation and operation of a halibut processing plant in Atka.

Bristol Bay Economic Development Corporation

BBEDC represents 17 villages distributed around the circumference of Bristol Bay, including Dillingham, the second-largest CDQ community with approximately 2,200 residents and the location of BBEDC's home office. BBEDC is currently allocated 21 percent of the pollock and 20 percent of the Pacific cod CDQ harvest.

To date, BBEDC has focused its community development efforts primarily on creating offshore employment opportunities, and it has employed more village residents in pollock processing jobs than any other group. The group changed from one offshore partner to another before the 1996 harvest. BBEDC's current partner is said to hire approximately 20 percent of its crew from CDQ villages.

BBEDC has also invested in a variety of fishing vessels, including part-interest in two pollock catcher processors and a freezer longliner. However, BBEDC also has a program to evaluate investments in regional infrastructure. The group also has active vocational training and internship programs with its offshore partner, and provides internship opportunities with out-of-region and local businesses to develop administrative and other specialized skills. BBEDC is also helping to promote workforce readiness skills through the four Bristol Bay school districts.

Central Bering Sea Fisherman's Association

CBSFA is unusual among CDQ groups in that it represents a single community, St. Paul in the Pribilof Islands. St. Paul is strategically located to serve the Bering Sea fishing industry. As a result, CBSFA has focused attention on working with other island entities to improve St. Paul's harbor facility and on expanding the island's small boat fleet. The group also operates a revolving loan program to provide boat and gear loans to resident fishermen. CBSFA has primarily invested in crab vessels and has a small ownership interest in American Seafoods. CBSFA has been working with industry partners to explore the possibility of developing a multi-species processing facility in St. Paul. Currently the CBSFA is managing 4 percent of the pollock harvest and 10 percent of the Pacific cod harvest.

Reflecting the focus of St. Paul residents on developing local fishing ventures and infrastructure, CBSFA has not seen much demand among residents for off-island processing jobs, either offshore or inshore. The group is partnered with a large offshore company and would like to build on the benefits of product offloads at St. Paul harbor and the attendant support services its residents can provide. Currently, CBSFA receives 4 percent of the pollock and 10 percent of the Pacific cod CDQ harvest.

Coastal Villages Region Fund

CVRF currently manages 24 percent of the pollock and 17 percent of the cod CDQ harvest for its 21 member villages. The villages are located along the coast between the southern end of Kuskokwim Bay and Scammon Bay, including Nunivak Island. This remote area is poorly located to engage in the current Bering Sea fisheries. Furthermore, its residents, for the most part, have had little experience with commercial enterprise. CVRF has focused on helping residents adjust to working conditions outside of the immediate area and employs a training coordinator who actively recruits residents for employment and internship opportunities. CVRF sees a distinct employment advantage in the offshore sector for its residents, primarily because of shorter time commitments and higher wages. However, the group currently has both inshore and offshore partners. has purchased 22.5 percent of American Seafoods, the largest offshore fishing company in the Bering Sea. This investment includes seven factory trawlers.

CVRF provides employment to fishermen through its nearshore CDQ halibut fishery and on a longline vessel that harvests CDQ sablefish. The group continues to be interested in establishing salmon processing facilities both on the Kuskokwim and elsewhere in the region, as well as halibut processing facilities.

Norton Sound Economic Development Corporation

Fifteen villages make up the region represented by NSEDC, which ranges from St. Michael to Diomede. The geographic expanse and diversity of interests among NSEDC's communities are challenging, as are the hurdles to developing local fisheries in this remote area that is ice-bound in winter.

Nevertheless, NSEDC has actively pursued both local fisheries and Bering Sea pollock investment strategies. The group has purchased approximately 50 percent of its offshore processor partner, Glacier Fish Company, including two catcher processors and a seafood marketing subsidiary. Together with the Glacier Fish Company, NSEDC owns the Norton Sound Fish Company, which operates a longline vessel and employs significant numbers of region residents. The group also owns independently two tender vessels specially built for the Norton Sound region.

NSEDC has developed or planned fisheries development projects in several villages, including Norton Sound Crab Company in Nome and commercial halibut operations on St. Lawrence Island. Glacier Fish Company hires residents of the Bering Sea region on a preferential basis for CDQ fishery operations. NSEDC operates an employment and training office in Unalakleet. This CDQ group currently receives 23 percent of the pollock and 18 percent of the Pacific cod CDQ allocations.

Yukon Delta Fisheries Development Association

YDFDA represents five communities. The group's emphasis has been on creating employment opportunities in the Bering Sea fishery through its mothership partner and through other pollock processors, both inshore and offshore. Another area of focus has been on a comprehensive training program that includes a combination trawl/pot/longline vessel and a 47-foot longline crab vessel. YDFDA has received steadily increasing CDQ pollock allocations and currently receives 14 percent of the pollock and 19 percent of the cod CDQ allocations. YDFDA faces the challenges of representing a region with few natural resources to develop, long distances to most viable fisheries, and relatively undeveloped human resources with respect to active participation in a commercial economy setting. While the group places residents in jobs with all three sectors, it indicates that offshore and mothership employment are most useful for its residents. The group's CDQ royalties fund a variety of training activities encompassing technical and office skills.

3.9.4.3 Economic Impacts of the Community Development Quota Program

Revenue Generation

To be eligible to participate in the CDQ program, CDQ communities could have no current or historical linkage to the fisheries in question at the time of the program's implementation. Therefore, it has been necessary (with the exception of some of the halibut CDQs) for each CDQ group to enter into a relationship with one or more of the large commercial fishing companies that participate in the fishery. The CDQ community brings the asset of preferential access to the fish while the partnering firm brings the harvesting/processing capacity and experience in the fishery. The nature of these relationships differs from group to group. In every case, the CDQ community receives royalty payments on apportioned catch shares. Some of the agreements also provide for training and employment of CDQ community members within the partners' fishing operations, as well as other community development benefits. Each of the six groups negotiates a specific price per metric ton for the use of the apportioned CDQ shares, or a base price plus some form of profit sharing.

Based upon reports of consistently high bid-prices for CDQ shares (see, for example, testimony before NPFMC on the impacts of Inshore/Offshore III on the pollock CDQ program), the partnering companies also apparently receive substantial benefits from these CDQ relationships. These benefits may include preferred access to the resource, resulting in better yields and more valuable product forms (e.g., roe), and the more efficient use of capacity. The positive aspects of the CDQ pollock fishery probably contributed to the successful implementation of the offshore cooperative management system.

For the years 1992 through 1998, pollock CDQ royalties fluctuated between $17 million and $20 million per year (Figure 3.9-15). Royalty income rose substantially in 1999 and 2000 because both the TAC and lease price of pollock CDQ shares increased. Stronger overseas markets for groundfish products and a shift by processors to higher value products were among the reasons for the increase in CDQ lease values. In 2000, the CDQ groups received over $33 million in pollock CDQ royalties.

While pollock still dominates the program in terms of total royalties, royalties from the multi-species program provided an additional $7.3 million to the CDQ groups in 2000 (ADCED 2001). Of the 2000 total of approximately $40.5 million for all species, pollock accounted for approximately 82 percent of all royalties, while all other species combined represented approximately 18 percent of total royalties. The percentage of the total 2000 royalties generated by each non-pollock species were as follows: Pacific cod - 8 percent; opilio crab - 5 percent; Bristol Bay red king crab - 3 percent; and other species, including sablefish, Atka mackerel, halibut and turbot - 2 percent. The non-pollock royalty proportions have changed somewhat in recent years, particularly with the BSAI crab fisheries phasing into the program beginning in 1998.

Asset Accumulation

The revenue stream from the lease of CDQ allocations has permitted the development of considerable savings within the CDQ groups. These savings provide important capital for making investments, and asset accumulation by CDQ communities is one empirical measure of the performance of the program. Amassment of equity interest in real assets represents a clear community development strategy. Data suggest that CDQ groups, when taken as a whole, have retained almost half of their gross revenues in some form of equity, whether vessel ownership, processing facilities, marketable securities, loan portfolios, and IFQ holdings. The value of CDQ assets in aggregate increased from $1.5 million in 1992 to over $157 million in 2000 (ADCED 2001).

Another benefit of capital asset acquisitions and venturing with industry participants is the enhanced control communities may exercise over the joint economic activity. As members in fishing companies with ownership interest, the CDQ groups are better able to take part in decisions that directly impact business operations and, thus, profitability. Also, the opportunity for technology transfer and hands-on experience (whether operational or managerial) occurs from the industry partner to the CDQ group. CDQ groups and their residents are able to learn first-hand how the industry functions. This increases the likelihood of local control as CDQ residents, who have spent time learning from established industry partners, may one day be in control of their own operations and be able to operate independent of the CDQ program. In the interim, expanded employment opportunities, made available through vessel acquisition and partnering with established industry members, increase the sharing of benefits that accrue from the CDQ activities.

Increasingly, CDQ groups are using their CDQs to leverage capital investment in harvesting/processing capacity. Acquisition of ownership interest in commercial fishing operations and other fisheries-related enterprises is one important means of directly adding to a CDQ group's economic sustainability, consistent with the program's mandate. Current equity acquisitions in vessels are presented in Table 3.9-82. The table also specifies, if applicable, the catcher vessel class or catcher processor class in which each vessel has been included for the sector analysis.

All six CDQ groups have acquired ownership interests in the offshore pollock processing sector. In addition, APICDA and NSEDC have invested in inshore processing plants, some of which process groundfish (Table 3.9-83). These inshore plants include both shorebased and floating processing facilities.

In most of the processing ventures in which CDQ groups have invested, the groups are minority owners. However, the revenues derived from these investments may be substantial. An overview of the relative economic importance of investments in the offshore and inshore groundfish processing sector may be acquired by examining the historical quantity and value of groundfish processed by catcher processors and inshore plants in which CDQ groups currently have an equity interest (Table 3.9-84 and Table 3.9-85). The groundfish processed by these enterprises accounted for about 14 percent of the total tonnage and 15 percent of the total wholesale value of groundfish processed in the Alaska fishery in 1999 and 2000. Overall, it is estimated that the ownership shares of CDQ groups represents approximately 27 percent of the total groundfish revenues of these enterprises based on a weighted average of wholesale product revenue.

The most important component that CDQ groups bring into investments in the offshore groundfish processing sector is quota (ADCED 2001). As shown in Table 3.9-84 and Table 3.9-85, CDQ catch accounts for a substantial portion of the total amount and value of groundfish processed by the companies in which the groups have invested.

The vessel list in Table 3.9-82 shows that CDQ groups have also invested in catcher vessels harvesting groundfish and other species. An overview of the relative economic importance of investments in these enterprises may be obtained by examining the historical quantity and value of groundfish caught by catcher vessels in which CDQ groups currently have an equity interest (Table 3.9-86). The groundfish harvested by these fishing operations accounted for about two percent of the total tonnage and three percent of the total ex-vessel value of groundfish harvested in the Alaska fishery in 1999 and 2000. Overall, it is estimated that the ownership shares of CDQ groups represents approximately 50 percent of the total groundfish revenues of these enterprises based on a weighted average of ex-vessel revenue.

Employment and Income

At the time of the 1990 U.S. Census, all the communities in rural, western Alaska were experiencing relatively high levels of unemployment, ranging from 9 percent in the Bristol Bay area to 31 percent in the Yukon Delta area (ADCED 2001). While these high unemployment rates partly reflect the seasonality of employment opportunities and the timing of the census in April, they also may show the effects of limited employment opportunities. All of the communities in the CDQ areas had median incomes that were lower than the state median income (ADCED 2001). The median income of the Central Bering Sea area and the Bristol Bay area was less than ten percent below the state level, but in the Yukon Delta area and the Aleutian Pribilof area the median income was only slightly greater than half the state level (ADCED 2001). The poverty rates in all the CDQ areas except the Central Bering Sea were at least twice the state rate of seven percent.

Employment opportunities have been one of the most tangible direct effects of the CDQ program for many western Alaska village residents. Indeed, the CDQ program has had some success in securing career track employment for many residents of qualifying communities, and has opened opportunities for non-CDQ Alaskan residents, as well. Jobs generated by the CDQ program included work aboard harvesting vessels, internships with the partner company or government agencies, work at processing plants, and administrative positions. As noted in Section 3.9.3, due to the unique nature of the CDQ program, much of this employment (as well as other groundfish related economic activity, including other income and revenue) is not well captured in the regional analysis of the groundfish fishery (and is therefore presented in detail in this section).

Table 3.9-87 summarizes the total annual CDQ employment and wages presented in quarterly reports. The CDQ program has created an excess of $8 million in wages annually since 1998. As shown in Table 3.9-87, non-pollock fisheries, although accounting for a relatively small proportion of total CDQ fisheries value or royalties, account for a significant majority (62.5 percent) of CDQ employment and almost half (47.6 percent) of total wages earned in 2000.

From 1993 through 2000, CDQ management and administration accounted for about 6 percent of the jobs and 24 percent of the wages. Pollock harvesting and processing accounted for 24 percent of the jobs and 26 percent of the wages. Other fisheries, which include halibut, salmon, sablefish, herring and crab related employment, accounted for 51 percent of the jobs and 34 percent of the wages. Finally, other employment, including internships, accounted for 18 percent of the jobs and 15 percent of the wages.

An overview of the relative impacts of the CDQ program may be gained by comparing income generated by the CDQ program with the total income in CDQ communities. Adjusted gross income data by zip code are available from the Internal Revenue Service for two years during the period that the CDQ program has existed - 1997 and 1998. The total adjusted gross income for all CDQ communities in these two years was $242,200,000 and $252,600,000, respectively. In addition, an estimate of adjusted gross income can be derived for 1999, the most recent year for which personal income data are available from the Regional Economic Information System of the U.S. Bureau of Economic Analysis for Alaska boroughs and census areas. In 1997 and 1998, adjusted gross income in CDQ communities was approximately 27.5 percent of the total personal income in the boroughs and census areas in which CDQ communities are located. Applying this percent to the 1999 Regional Economic Information System personal income data yields an estimated adjusted gross income of $259,800,000 in CDQ communities for that year.

Table 3.9-88 shows CDQ wages in 1997 and 1998 as reported to ADCED and total adjusted gross income for all CDQ communities as estimated above. CDQ-related income accounted for about 4.1 percent of the total income in CDQ communities by 1999.

While this analysis is based on the best information available, it yields only a rough approximation of the contribution of CDQ wages to regional income. As noted above, CDQ management and administration account for nearly one-fourth of CDQ wages. Many of the individuals in administrative positions work and reside in non-CDQ communities (Table 3.9-76). By including the wages of those individuals, this analysis overestimates the contribution of CDQ wages to the total income of CDQ communities. Some level of error may also have been introduced in the analysis because Internal Revenue Service income data are reported by zip code. The incomes of a number of small non-CDQ communities that share a zip cope with CDQ communities were included in the figure for total adjusted gross income. However, given the small size of the non-CDQ communities included, it is unlikely that the introduced error appreciably changed the analysis results. Similarly, the incomes of certain CDQ communities (Kongiganak, Napaskiak, Newtok and Oscarville) were omitted from the total adjusted gross income figure because their zip code overlapped with the relatively large non-CDQ community of Bethel. Again, the introduced error is likely insignificant due to the small size of the CDQ communities omitted.

Adjusted gross income data obtained from the Internal Revenue Service for 1997 and 1998 can also be used to examine the contribution of CDQ wages of each CDQ group (Table 3.9-89). Among the factors that account for the differences across groups is the presence or absence of communities with comparatively large populations and diverse economies. For example, the CDQ communities of King Salmon and Dillingham in the BBEDC region and Nome in the NSEDC region contributed about half of the total adjusted gross income for all CDQ communities in 1997 and 1998. The higher level of economic activity in these towns results in higher per capita incomes and reduces the relative importance of CDQ wages.

Indirect Employment and Income Effects

Some of the income earned in CDQ jobs, as well as spending for supplies and services in support of CDQ projects, passes through local merchants, service providers, and others before leaking out of the region in exchange for imports. The additional employment and income generated in this way is referred to as indirect economic impacts. In an area such as western Alaska, where very few goods and services are provided locally, money leaks out of the region relatively quickly. Nevertheless, every extra contribution to jobs and income helps, and these additional economic impacts of the CDQ program should not be overlooked.

Training and Education

Training of CDQ community residents has been a primary objective for all the CDQ groups from the outset of the program and has been promoted as an essential means to a sustainable locally based fishery economy. Each CDQ group provides training for their residents, based not only upon the individual needs of the trainee, but upon the overall needs of the community.

Training programs span the range of educational opportunities, from vocational and technical training, to support for higher education at college and university levels. CDQ groups have spent nearly $8 million directly on training expenditures involving over 7,000 residents since 1993 (ADCED 2001). These investments are wholly dependent upon the revenues generated by the CDQ apportionments and, therefore, are another empirical measure of benefits deriving from the groundfish fisheries of the BSAI management area.

3.9.5 Subsistence

The subsistence use of natural resources by Alaska Native peoples represents a set of relationships to the local environment and a continuity of use that stretches back to prehistoric times, despite changes in technology and society. Subsistence activities are a central element of contemporary village life that often involve myriad social and cultural elements and whose importance ranges from being a basic component of physical sustenance to a part of relationships involved with a sense of group identity and individual feelings of well-being. Subsistence is also important to many of Alaska's non-Native residents, despite greater or lesser differences between groups in the specific cultural context of subsistence. For more than a few non-Native Alaska residents, a lifestyle that includes subsistence pursuits as a key element (or at least an opportunity) influences such basic life decisions as whether or not to move to, or remain in, rural Alaska. The importance of subsistence crosses social and cultural boundaries, and different subsistence pursuits may feel the impact of commercial use of the same or interrelated natural resources. As noted in the following subsections, the commercial groundfish fishery overlaps with a number subsistence related activities in a variety of ways.

3.9.5.1 Introduction

This section provides information on existing subsistence conditions relevant to the subsequent impact analysis of the proposed alternatives. This section is divided into three main discussions:

Regional Summaries of the Use of Groundfish and Other Subsistence Resources. These summaries provide information on current levels of the direct use of groundfish as a subsistence resource, as well as information on the current levels of use of other subsistence resources on a region-by region basis in order to put the use of groundfish into a broader subsistence context. In this manner, the importance of groundfish as a subsistence resource under existing conditions can be gauged both in absolute and relative terms (or engagement and dependence terms) to allow for subsequent analysis of potential impacts by alternative.

Subsistence Use of Steller Sea Lions. This discussion is specifically included due to the central role Steller sea lion population dynamics have played in recent groundfish fishery management strategies and are likely to continue to play under at least some future management approaches. Information is provided on differential use of Stellers by community and region. Steller sea lion subsistence is also presented as a stand-alone or special case consideration as different groundfish management approaches may have an impact on this subsistence resource that is likely different than other indirect subsistence impacts.

Other Relevant Subsistence Activities. This discussion focuses on subsistence activities other than groundfish and Steller sea lion subsistence that may or may not be subject to a range of impacts from the various groundfish fishery management approaches. These include subsistence salmon fisheries, and joint production opportunities. Subsistence salmon concerns span a wide geography in western and interior Alaska, while joint production issues are confined, by definition, to direct participants in the commercial groundfish fishery.

3.9.5.2 Regional Groundfish Subsistence Summaries

The following sections provide a region-by-region groundfish oriented summary of subsistence activity levels in each of the four Alaska regions analyzed. Groundfish subsistence occurs over a very large geographic area, but in general, subsistence groundfish use levels are low in comparison to use levels of subsistence resources overall, and in relation to other fish resources in particular. There is little, if any, indication that subsistence groundfish use is likely to experience direct impacts under any of the currently contemplated commercial groundfish fishery management alternatives, but there is a potential for joint production type of impacts where commercial and subsistence activities overlap. Given this set of circumstances, these summaries focus primarily on the regionally important groundfish communities identified in Section 3.9.3 and place the role of groundfish in the context of overall subsistence activities, including non-fishing related subsistence. The ability to differentiate between subsistence use of groundfish retained from commercial catches as opposed to the subsistence use of groundfish that were targeted for take during exclusively subsistence activities is not possible with the available data. In practical terms, however, this does not present difficulties analyzing the level and relative importance of groundfish subsistence use in general. In general, given the relatively low dependency on direct groundfish subsistence use, and the fact none of the alternatives would restrict subsistence groundfish take nor cause a decline in groundfish stocks, the potential impacts of any of the alternatives on subsistence uses of groundfish are not likely to be substantial. There is, however, variation between communities and regions and, as a result, localized effects will need to be considered. Within each of the summaries, the major species of groundfish within overall groundfish utilization are also specified, and this varies from community to community. (In the discussion in this section, as in other parts of this document, halibut and sablefish are not included as part of the "groundfish" category.)

The information presented in each of the regional summaries is extracted from the ADF&G Community Profile Database. The Community Profile Database is a compilation of the data collected by community surveys, primarily focused on wildlife harvest documentation, but also typically including associated demographic and economic information as well.

Unfortunately, analysis of trends is largely not possible with these data. Community surveys are not conducted on a regular schedule, but rather are typically performed in relation to other ongoing studies or directed towards specific resource management questions. Thus, the time series information from some communities and for some resource categories is better than for others. For some communities only one survey is available, and such information can be quite dated. Furthermore, even for communities with multiple years of information available, the interpretation of the differences from year-to-year can be problematic.

Since community subsistence activities and harvests vary each year, and surveys are not conducted annually or even within an overall temporal sampling design, the results from different years cannot simply be averaged. Where information for more than one year is available, ADF&G has addressed this problem by designating one year's results as "most representative" of the overall pattern of subsistence activities and level of harvest for that given community. This designation is based on ethnographic and other non-survey community context information. Where available, information on subsistence groundfish use from years that are not "most representative" are presented below. Where information from only one year is available, it is by definition the "most representative" year, but must only be used as an estimate given the amount of variation from year-to-year. This limitation is especially important for communities for which information is rather dated.

Subsistence in the Alaska Peninsula and Aleutian Islands Region

Subsistence resource use by residents of the regionally important groundfish communities of Unalaska, Akutan, Sand Point, and King Cove are is characterized in this section. All of these communities feature subsistence activity, with consumption ranging from about 200 pounds per capita to over 450 pounds per capita. Groundfish ranges from about 4 to 9 percent of total subsistence resource consumption.

Residents of Unalaska are reported to harvest and consume about 195 pounds of subsistence resource per capita, based on a 1994 survey of an estimated 700 year-round households, for a total ADF&G effective population[22] of 1,825 individuals (ADF&G 2000a). Of the subsistence total, 28 percent was salmon, 42 percent was non-salmon fish (of which various groundfish are a component), 5 percent was land mammals, 5 percent was marine mammals, one percent was birds and eggs, 14 percent was marine invertebrates, and 6 percent was vegetation. Groundfish average about 7 percent of the total per capita subsistence consumption (14 pounds per capita). The major contributors to this component are cod (8 pounds) and rockfish (5 pounds).

Residents of Akutan are reported to harvest and consume about 466 pounds of subsistence resource per capita, based on a 1990 survey[23] of an estimated 31 year-round households, for a total ADF&G effective population of 102 individuals (ADF&G 2000a). Of the subsistence total, 26 percent was salmon, 31 percent was non-salmon fish (including groundfish), 6 percent was land mammals, 23 percent was marine mammals, 6 percent was birds and eggs, 6 percent was marine invertebrates, and 2 percent was vegetation. Groundfish average about 9 percent of the total per capita subsistence consumption (43 pounds per capita). The major contributors to this component are cod (29 pounds) and rockfish (11 pounds).

[22] ADF&G calculates an "effective population" based on a unique determination of long-term residency that varies from typical community population counts. As a result, the ADF&G effective population for a given community will not normally correspond with either local or U.S. Bureau of the Census counts. For this reason, "effective population" figures are presented in the discussions in this section, and it should be borne in mind that per capita subsistence consumption figures presented represent total resources harvested divided among a population smaller than what are typically considered community residents (resulting in higher per capita figures than if standard total population figures were used). For the purposes of this analysis, per capita figures are perhaps most useful if they are conceived of as being applicable to those residents who are most likely to engage in subsistence production or consumption.

[23] More recent (1996) subsistence survey information for Akutan covers only bird and egg resources harvest levels.

Residents of Sand Point are reported to harvest and consume about 256 pounds of subsistence resource per capita, based on a 1992 survey of an estimated 204 year-round households, for a total ADF&G effective population of 606 individuals (ADF&G 2000a). Of the subsistence total, 54 percent was salmon, 21 percent was non-salmon fish (including groundfish), 11 percent was land mammals, 2 percent was marine mammals, 2 percent was birds and eggs, 7 percent was marine invertebrates, and 3 percent was vegetation. Groundfish average about 9 percent of the total per capita subsistence consumption (22 pounds per capita), most of which are cod (12 pounds) and rockfish (8 pounds).

Residents of King Cove are reported to harvest and consume about 256 pounds of subsistence resource per capita, based on a 1992 survey of an estimated 158 year-round households for a total ADF&G effective population of 560 individuals (ADF&G 2000a). Of the subsistence total, 53 percent was salmon, 17 percent was non-salmon fish (including groundfish), 15 percent was land mammals, one percent was marine mammals, 4 percent was birds and eggs, 7 percent was marine invertebrates, and 3 percent was vegetation. Groundfish average about 4 percent of the total per capita subsistence consumption (10 pounds per capita). The major contributors to this component are cod (6 pounds) and rockfish (2.5 pounds).

Subsistence in the Kodiak Island Region

As discussed in Section 3.9.3, the city of Kodiak itself is the single regionally important groundfish community. Subsistence in Kodiak may be characterized as follows:

Residents of the City of Kodiak are reported to harvest and consume about 151 pounds of subsistence resource per capita, based on a 1993 survey of an estimated 1,994 year-round households, for a total ADF&G effective population of 6,058 individuals (ADF&G 2000a). Of the consumption total, 32 percent was salmon, 40 percent was non-salmon fish (including groundfish), 15 percent was land mammals, 6 percent was marine invertebrates, and 7 percent was vegetation. Groundfish average about 8 percent of the total per capita subsistence consumption (12 pounds per capita). The major contributors to this component are cod (4.8 pounds), rockfish (3.6 pounds), and greenling (2.4 pounds). For the three other years for which survey information is available (1982, 1991, and 1992) the annual groundfish subsistence harvest per capita ranged from 5 to 10.5 pounds, representing from 3.4 to 6.6 percent of the total per capita subsistence harvest for Kodiak during those years.

Subsistence in the Southcentral Alaska Region

Cordova, Homer, Nikiski, Seward and Anchorage are the regionally important groundfish communities in the southcentral region, as discussed in Section 3.9.3. With the exception of Cordova, available subsistence data for groundfish for these communities show a much lower level of use than similar data show for the Aleutian and Kodiak Island regions.

Residents of Cordova are reported to harvest and consume about 179 pounds of subsistence resource per capita, based on a 1997 survey of an estimated 830 year-round households, for a total ADF&G effective population of 2,507 individuals (ADF&G 2000a). Of the total of subsistence resources, 35 percent was salmon, 24 percent was non-salmon fish (including groundfish), 30 percent was land mammals, 2 percent was marine mammals, one percent was birds and eggs, 3 percent was marine invertebrates, and 5 percent was vegetation. Groundfish average about 4 percent of the total per capita subsistence consumption (7 pounds per capita). The major contributors to this component are rockfish (5 pounds) and cod (1 pound). For the five other years for which survey information is available (1985, 1988, 1991, 1992 and 1993) the groundfish subsistence harvest per capita ranged from 6.7 to 15.5 pounds, representing from 4 to 6.6 percent of the annual total per capita subsistence harvest in Cordova during those years.

Homer was designated by the Federal Subsistence Board as a "rural" community in May 2000. Prior to that time, Homer residents had not been federally qualified subsistence users and, as a result, no data were collected for many years leading up to the change in designation. The rural designation was also recent enough that no data have been collected since the community's change in status. As a result, the only available information on Homer's community subsistence use pattern is over 20 years old.

Residents of Homer are reported to harvest and consume about 94 pounds of subsistence resource per capita, based on a 1982 survey of an estimated 1,798 year-round households, for a total ADF&G effective population of 5,633 individuals (ADF&G 2000a). Of the total of subsistence resources, 21 percent was salmon, 32 percent was non-salmon fish (potentially including groundfish), 25 percent was land mammals, 2 percent was birds and eggs, 18 percent was marine invertebrates, and 2 percent was vegetation. No groundfish were reported as part of the Homer subsistence harvest, but based on experience elsewhere, this probably reflects a relatively low level of harvest. This lack of reporting may be due to incidental take while targeting some other species, rather than no take whatsoever.

Similar to Homer, Nikiski had been classified as "non-rural" (non-subsistence) communities until the Federal Subsistence Board changed their classification in May 2000, when the board designated all communities on the Kenai Peninsula as "rural." The ADF&G subsistence does not contain any information for Nikiski, but does include some historical harvest information for nearby Kenai. The information for Kenai is summarized here as it is the information most likely to be indicative of the type of subsistence use that occurs in Nikiski. Residents of Kenai are reported to harvest and consume about 84 pounds of subsistence resource per capita, based on a 1993 survey of an estimated 2,274 year-round households, for a total ADF&G effective population of 6,372 individuals (ADF&G 2000a). Of the total of subsistence resources, 46 percent was salmon, 19 percent was non-salmon fish (including groundfish), 20 percent was land mammals, one percent was marine mammals, one percent was birds and eggs, 6 percent was marine invertebrates, and 6 percent was vegetation. The amount of groundfish harvested was negligible (0.32 pounds per capita). Similarly, for the three other years for which survey information is available (1982, 1991, and 1992) the groundfish subsistence harvest per capita ranged from 0 to 0.7 pounds, representing from 0 to 1.0 percent of the total subsistence harvest during those years.

Seward cannot be described in terms of its residents' subsistence use patterns because there is no available information. Like Homer and Nikiski (and the other communities on the Kenai Peninsula), Seward was classified as a "non-rural" community until May 2000. Based on general community characteristics, Seward's pattern of subsistence resource use is likely similar to that seen in Homer, where groundfish subsistence use is negligible.

Anchorage cannot be described in terms of its residents' subsistence use patterns based on existing data because Anchorage is defined as a "non-rural" community and thus its residents are not federally qualified subsistence users. While there may be some minimal per capita groundfish take through sport fishing, this is considered negligible for this analysis.

Subsistence in the Southeast Alaska Region

Petersburg, Sitka, and Yakutat are the regionally important groundfish communities in this region, as described in Section 3.9.3. Total subsistence resource consumption ranges between about 200 and 400 pounds per capita in these communities, with groundfish ranging between 1 and 5 percent of the total annual consumption.

Residents of Petersburg are reported to harvest and consume about 198 pounds of subsistence resource per capita, based on a 1987 survey of an estimated 1,123 year-round households, for a total ADF&G effective population of 3,739 individuals (ADF&G 2000a). Of the subsistence resource total, 23 percent was salmon, 22 percent was non-salmon fish (including groundfish), 29 percent was land mammals, 2 percent was birds and eggs, 19 percent was marine invertebrates, and 4 percent was vegetation. Groundfish average about 2 percent of the total per capita subsistence consumption (3.5 pounds per capita), most of which are cod and rockfish.

Residents of Sitka are reported to harvest and consume about 205 pounds of subsistence resource per capita, based on a 1996 survey of an estimated 3,053 year-round households, for a total ADF&G effective population of 8,535 individuals (ADF&G 2000a). Of the subsistence resource total, 28 percent was salmon, 26 percent was non-salmon fish (including groundfish), 25 percent was land mammals, 4 percent was marine mammals, 13 percent was marine invertebrates, and 3 percent was vegetation. Groundfish average about 5 percent of the total per capita subsistence consumption (9.9 pounds per capita). The major contributors to this component are rockfish (5 pounds) and greenling (3 pounds). Similarly, for the only other year for which a survey was conducted (1987), subsistence groundfish were about 6 percent (8.7 pounds per capita) of the total subsistence harvest.

Residents of Yakutat are reported to harvest and consume about 398 pounds of subsistence resources per capita, based on a 1987 survey of an estimated 169 year-round households, for a total ADF&G effective population of 589 individuals (ADF&G 2000a). Of the subsistence resource total, 54 percent was salmon, 19 percent was non-salmon fish (including groundfish), 4 percent was land mammals, 8 percent was marine mammals, one percent was birds and eggs, 10 percent was marine invertebrates, and 4 percent was vegetation. Groundfish average about one percent of the total per capita subsistence consumption (5 pounds per capita). The major contributors to this component are flounder (2.5 pounds), cod (1.5 pounds), and rockfish (1 pound). For the only other year for which a community survey was conducted (1984), subsistence groundfish comprised about 3.5 percent (12.7 pounds per capita) of the total subsistence harvest, most of which were greenling (4.1 pounds), rockfish (3.2 pounds), flounder (3.1 pounds), and cod (2.1 pounds).

3.9.5.3 Subsistence Use of Steller Sea Lions

This section presents information on the subsistence harvest and consumption of Steller sea lions in Alaska by region and community for recent years. As discussed in previous sections of this Programmatic SEIS, a number of Alaska groundfish management actions have in recent years been linked to the interrelationship of groundfish and Steller sea lion populations. Because of this focus, this section examines subsistence use of Steller sea lions by community and region, including information on relative dependency on Stellers among other subsistence resources where data permit, and discusses the relationship of subsistence activities to the Steller sea lion population dynamics.

It should be noted that most of the documented harvest information is for years when Steller sea lions were classified as "threatened," before the western stock of Steller sea lions was reclassified in 1997 as "endangered." How this official change in status per se has influenced subsistence take, if at all, is unknown. Further, it is also important to note that while subsistence use of other resources is open to a broader spectrum of residents of coastal Alaskan communities, the take of marine mammals is restricted to the Alaska Native portion of the population under the terms of the MMPA of 1972 (as reauthorized in 1994 and amended through 1997; the specific subsistence exemption for Alaska Natives is found in Section 101 [16 USC 1371]). Therefore, any subsistence impacts to Steller sea lions would be concentrated among Alaska Native residents of these communities.

Steller Sea Lion Subsistence Methods

Steller sea lions are taken by a number of methods throughout the year. Unlike a number of other subsistence activities that are more broadly participatory, hunting for sea lions is a relatively specialized activity, and a relatively small core of highly productive hunters from a limited number of households account for most of the harvest. For the years surveyed, individuals from only 20 to 29 percent of all households in the relevant communities actually hunted sea lion (Wolfe 2001). Once harvested, sea lion is distributed among a much wider range of households (Wolfe and Hutchinson-Scarbrough 1999, Wolfe 2001).

There has been some change in harvesting techniques over recent years, and there is also variation by region. For Kodiak Island communities, the sea lion harvest used to take place at their haulouts, and 20 or 30 were transported at a time aboard purse seiners. Thus, one or two hunters could supply an entire village. Currently, hunting sea lions involves two or three individuals using skiffs to hunt swimming sea lions in open water. The hauling capacity of such skiffs is one or two animals, and Kodiak hunters prefer to take young adults of medium size rather than large bulls or young pups. Some sea lions are taken from shore locations where sea lions are known to swim close to the shoreline. The animal is then retrieved using a skiff. Peak months for harvest are October through December (Hayes and Mishler 1991).

Hunting methods vary somewhat in the Aleutians and Pribilof Islands and are documented in Wolfe and Mishler (1995). Pribilof Island residents hunt sea lions almost exclusively from the shore and target swimming juvenile (mid-size) males. On St. Paul Island sea lion hunting is most commonly done from shore at Northeast Point, accessible by truck. St. Paul hunters take advantage of known sea lion "swimways." Once shot, the hunter waits for the wind and sea to bring the carcass to shore, as heavy seas generally preclude the use of a skiff. A "sea dog" (a retrieval device consisting of a piece of wood with hooks attached to a 30- to 40-foot rope) assists in this process. Not all animals are recovered, but hunters try to shoot only those animals for which there is a high probability of eventual recovery. Hunters will at times hunt from skiffs in calm weather. Sea lion hunting on St. Paul occurs mainly from September through May. Sea lion hunting on St. George is similar to that of St. Paul, being predominately shore-based. Harvest occurs mainly from January through May. Sea lion harvest in the Aleutian Chain (Atka, Unalaska, Akutan, and Nikolski) occurs mostly from skiffs in open water, and hunters target both sexes. When skiff travel is risky or for a change of pace, sea lion hunting is also done from concealed shore stations. Aleutian Chain hunters will concentrate effort near haulout locations, and take more adult and female animals than do Pribilof Island hunters. Seasonality of sea lion harvest is quite variable, and appears to be dependent on sea lion abundance and distribution.

Harvest Levels and Regional Variation

Historical documented subsistence harvests of Steller sea lions are presented in Tables 3.9-90 through 3.9-93. These figures represent both recovered and “struck and lost” animals.

Table 3.9-90 presents information derived from ADF&G surveys of all subsistence resources harvested by a given community plus the specific Steller sea lion harvest. Together, these two types of information allow for an assessment of the relative dependency of a community on Steller sea lions within the overall subsistence harvest. A major caveat for the information contained in this table is that each community was surveyed only a limited number of times and for different years than most other communities, meaning comparability between communities is limited. It is also important to note that the documented Steller sea lion percentage of total subsistence harvest shown in the table is a measure of the past use and reliance upon this resource, and almost certainly does not represent the current harvest, which generally is assumed to be much lower than that in the past. For Atka, Akutan, St. George, and St. Paul (and perhaps Unalaska and several other communities) it can be seen that Steller sea lions have in the past represented a very significant subsistence resource in terms of relative contribution to overall community subsistence resource consumption. It should also be clearly noted that the information in Table 3.9-90 is not totally consistent with the information presented in Tables 3.9-91 through 3.9-93, which underscore the general lack of precision in the data. What is evident, however, is that the area of heaviest subsistence use of Steller sea lions is in southwestern Alaska, and is concentrated in relatively few communities.

Tables 3.9-91 through 3.9-93 present information from surveys documenting only sea lion (and harbor seal) subsistence harvest in all Alaskan communities for the period 1992 (the first year of focused surveys on sea lion and harbor seal harvests) through 2000, except for 1999, when no survey was conducted (due to lack of funding). (Subsequent information was collected for 2001, but is not available at the time of this writing.) Nine communities surveyed in previous years could not be included in the 2000 survey, however, as local surveyors could not be secured. For these communities (Anchorage, Atka, Homer, Hydaburg, Kenai, Nikolski, St. George, Tyonek, and Valdez), ADF&G estimated that the sea lion harvest in 2000 was the same as in 1998 (the most recent year for which harvest information was available). In addition, the 2000 harvest survey for a tenth community, St. Paul, was conducted independently by a local hunter association with funding from NOAA Fisheries. The results of this project were not available at the time of publication of Wolfe (2001), so estimates from 1998 were also used to represent the year 2000 sea lion harvest for this community in the ADF&G data set. As a result, caution must be taken in the interpretation of 2000 harvest data.

Of the 206 sea lions shown in Table 3.9-91 as “taken” in 2000, over half (104) are attributed to those communities assumed to have harvested the same number of sea lions in 2000 as in 1998 (Atka 17, Nikolski 1, St. George 20, St. Paul 58, and Valdez 8). All other communities were documented to have harvested 102 sea lions in 2000, while in 1998 these same communities harvested a total of 75 sea lions (an overall increase in harvest for 2000, primarily in Unalaska, compensating for a steep decline in Tatitlek). However, the independent St. Paul harvest project estimated that only 23 sea lions were taken in St. Paul during 2000 (Lestenkof and Zavadil 2001), 35 fewer than assumed by Wolfe (2001), so it is unclear whether actual totals for 2000 would have been higher or lower than the projected totals that appear in the tables. It is reasonable to assume, however, that the overall or longer term trend of decline in total harvest has continued in more recent years in parallel with the overall sea lion population decline, but year-to-year harvest in individual communities is considerably more variable (for example, Unalaska and Tatitlek). The reasons for such community variability are most likely related to local sea lion populations, hunting conditions, hunter characteristics, and the community context (Wolfe and Hutchinson-Scarbrough 1999, Wolfe 2001).

Table 3.9-92 provides break-out information by community for the Aleutian/Pribilof region for the period 1992 to 2000, while Table 3.9-93 provides similar information for communities in the combined Kodiak-Southcentral region. As shown, in years between 1992 and 2000, Atka, St. George, St. Paul, and Unalaska dominate subsistence take of Steller sea lions in the Aleutian/Pribilof region. Similarly, while there is a great deal of variation from year-to-year in the Kodiak-South Central area, the dominance of Old Harbor in most years is also clear.

Steller Sea Lion Populations and Subsistence Efforts

ADF&G has tried to address the possible linkage between the decline in the overall Steller sea lion harvest and a decrease in the sea lion subsistence harvest effort between 1992 and 1998 (Wolfe and Mishler 1997 and 1998, Wolfe and Hutchinson-Scarbrough 1999, Wolfe 2001). They note that while the total number of sea lions harvested for subsistence use has decreased, interpretation of this change is not straightforward. A number of factors could be at work. For example, take of sea lions has decreased at the same time that the number of people hunting sea lions has decreased. One possibility is that take is down simply because fewer people are hunting. While it is not clear that the annual average harvest per hunter has declined (although ADF&G has not investigated this in a rigorous manner), it is likely that declining Steller sea lion populations play a role in the decisions people make regarding whether to hunt or not. ADF&G states:

> *"… there are probably a variety of local factors related to the year-to-year changes in the number of households hunting sea lions in particular communities, including seasonal hunting conditions, local food needs, and personal circumstances of hunters. It is likely that the declines in the numbers of sea lion hunters in many communities are because sea lions are increasingly harder to find and consequently more difficult and expensive to hunt. As sea lions become scarcer in a community's hunting area, an increasing number of hunters in the community probably choose to stop hunting them. While the hunters that continue to hunt appear to maintain annual harvest rates similar to past years, hunters probably are investing more time and money in pursuit of the sea lions harvest. In addition to these factors, it is quite likely that some sea lion hunters have chosen to reduce their hunting activity because of perceived problems with sea lion populations" (Wolfe and Hutchinson-Scarbrough 1999:69, and essentially repeated in Wolfe 2001:77).*

In earlier documents, ADF&G had also suggested that another factor in the decrease of sea lion subsistence take may be the increased availability of seasonal wage employment in local communities (presumably including work in the groundfish fisheries). Some hunters may be choosing to work rather than to hunt, as a conscious economic choice of time allocation (Wolfe and Mishler 1997 and 1998). This explanation is not stressed as much in their 1999 report, being included in the phrase "… personal circumstances of hunters" (Wolfe and Hutchinson-Scarbrough 1999:69). It should be noted that hunting Steller sea lions requires a considerable amount of effort, and in most cases the cooperation of several people, so that time management and allocation could be a significant factor. An additional possible contribution to a decrease in sea lion subsistence harvest could be a cultural change in taste, so that the consumptive demand for sea lion may have decreased over time (for example, younger generations, less exposed to regular consumption of sea lions, may not desire sea lion as a foodstuff as much as elders do). While this was mentioned anecdotally during field research conducted for this project, no systematic information exists on this possible factor.

While the available information suggests some support for a direct relationship between the overall Steller sea lion population and the level of subsistence harvest, such support is not definitive and other factors cannot be excluded. Given the relatively small numbers involved, the concentrated efforts of a single hunter or just a few hunters can make relatively large percentage changes in community harvest totals. The weighting of factors is also not possible from the evidence available. It does appear that present Steller sea lion harvest methods are likely to be more successful, and certainly more efficient, when resource populations (and density) are higher. A number of factors may be at work, however, such that a recovery in Steller sea lion abundance may not necessarily result in a marked increase in subsistence take, but too little is known regarding the determinants of subsistence demand for Steller sea lions to reach any definitive conclusions.

3.9.5.4 Other Relevant Subsistence Activities

The communities of the Bering Sea and GOA regions engage in a wide range of subsistence activities other than direct groundfish and Steller sea lion use that may be directly or indirectly affected by the proposed alternatives. These activities include subsistence salmon fishing (which could potentially be affected by salmon bycatch in the groundfish fishery) as well as a wide range of subsistence activities that are facilitated by engagement in the groundfish fishery. Some subsistence activities are facilitated by engagement in the groundfish fishery either through joint production (using commercial groundfish vessels or gear for subsistence) or by applying income derived from the commercial fishery towards subsistence pursuits. While characterization of existing conditions for the entire range of subsistence activities that could be indirectly affected by the alternatives is not practical for inclusion in this document, information on subsistence salmon fisheries and a general level discussion on joint production opportunities are summarized in this section.

Subsistence Salmon Fisheries

Current Alaska groundfish fishery management includes provisions for the minimization of salmon bycatch, but salmon bycatch has remained a concern, particularly with respect to potential ongoing impacts to subsistence salmon fisheries. This issue has also been repeatedly noted in the public comment process for this Programmatic SEIS.

Overview

The following information on historic and current subsistence salmon harvest are summarized from ADF&G (2001a). This is the latest year for which data were available at the time of this writing (December, 2002). In 1999, fisheries in four management areas accounted for 77 percent of the total subsistence salmon harvest statewide. These were Yukon (232,070 salmon; 25 percent of the statewide total); Kuskokwim (202,413 salmon; 21 percent); Northwest Alaska (154,294 salmon; 16 percent); and Bristol Bay (143,756 salmon; 15 percent). The total estimated salmon subsistence harvest in Alaska in 1999 was 975,617 fish based on annual harvest assessment programs.

The species of most concern as bycatch in the groundfish fishery are chinook and chum, and of these two, chinook is considered a much larger potential problem. The largest subsistence harvests of chinook salmon in 1999 occurred in the Kuskokwim Area (77,660 salmon; 50 percent), followed by Yukon (50,515 salmon; 33 percent), Bristol Bay (13,009 salmon; 8 percent); and Northwest (6,242 salmon; 4 percent). Three areas dominated the subsistence chum salmon harvest in 1999: Yukon (162,670 salmon; 48 percent of the statewide harvest), Northwest (115,676 salmon; 34 percent), and Kuskokwim (47,612 salmon; 14 percent).

Given the dominance of the Yukon and Kuskokwim areas in total subsistence salmon harvest, and particularly in chinook harvests, those areas are profiled in overview in this section in order to illustrate the extensive geography of the fishery and the number of communities and households involved.

Yukon Region

In historic times as well as today, residents of the Yukon River area rely heavily upon fish for food, and salmon comprises the bulk of the total subsistence fish harvested. Although four salmon species are harvested in the Yukon drainage subsistence fishery, chinook, chum and coho salmon comprise the majority of the subsistence harvests, with subsistence harvests often far exceeding commercial harvests. Depending on the area of the drainage, subsistence fishing occurs from late May through early October. Fishing activities are either based from a fish camp or from the home village. Fishing patterns and preferred sites vary from community to community. Extended family groups, typically representing several households, often undertake subsistence salmon fishing and typically cooperate to harvest, process, preserve, and store salmon for subsistence use.

Chinook salmon are harvested and processed primarily for human consumption, although small kings and those fish deemed not suitable for human consumption are often fed to dogs. In addition, while chum and coho salmon are primarily taken for human consumption, relatively large numbers are harvested and processed to feed sled dogs. The practice of keeping sled dogs is more common in communities along the Upper Yukon River.

In 1999, it is estimated that 2,888 households in the Yukon region participated in the fishery (Table 3.9-94). The estimated 1999 total subsistence salmon harvest for the Yukon area broken down by species included 50,515 chinook (22 percent), 79,250 summer chum (34 percent), 83,420 fall chum (35 percent), 19,984 coho (9 percent), and 681 pink salmon (0.3 percent).

The estimated 50,515 chinook salmon harvested for subsistence in the Yukon Area in 1999 was near the recent five-year average of 51,609. These chinook accounted for approximately 22 percent of the total subsistence catch in the Yukon Area in 1999 (Figure 3.9-16). However, the estimated 1999 summer chum subsistence harvest of 79,250 was about 27 percent below the recent five-year average of 108,051 (Table 3.9-95). The 1999 estimated subsistence harvest of fall chum of 83,420 was about 17 percent below the recent five-year average. However, the five-year average includes harvests from 1995 to 1998, when regulatory restrictions were imposed to reduce fishing opportunity for fall chum subsistence. (A similar restriction was in place in 1994.) A comparison with years in which restrictions were not imposed suggests that the 1999 fall chum harvest is approximately 41 percent below the 1989 to 1993 five-year average (a period with more typical harvests).

Kuskokwim Area

The harvest of fish and wildlife for subsistence use is an important component of the mixed subsistence-cash economy throughout the Kuskokwim Area. During summer, early June through August, the day-to-day activities of many Kuskokwim Area households revolve around the harvesting, processing, and preserving of salmon for subsistence use. The seasonal movement of families from permanent winter communities to summer fish camps situated along rivers and sloughs, continues to be a significant element of the annual subsistence harvest effort. ADF&G Division of Subsistence studies in the region indicate that fish contribute as much as 85 percent of the total pounds of fish and wildlife harvested in a community annually, and salmon as much as 53 percent of the total annual harvest (Coffing 1991).

Approximately 1,700 households in the region annually harvest salmon for subsistence use. Many other households, which are not directly involved in catching salmon, participate by assisting family and friends with cutting, drying, smoking, and associated preservation activities (salting, canning and freezing). Subsistence catches of chinook salmon in the Kuskokwim Area exceed the commercial catch of this species.

There are 37 communities consisting of approximately 4,200 households with subsistence permits within the Kuskokwim Area (Table 3.9-96). The majority of the area households (3,059) are situated within the drainage of the Kuskokwim River. Bethel is the largest community in the region, containing approximately 1,508 households. Approximately 342 households are located in the northern Kuskokwim Bay communities of Kwigillingok, Kongiganak and Kipnuk. Residents of these three communities harvest subsistence salmon from the Kuskokwim River as well as from areas closer to the communities. Residents of Quinhagak, Goodnews Bay, and Platinum, located along the south shore of Kuskokwim bay, harvest salmon stocks primarily from the Kanektok, Arolik, and Goodnews River systems. Residents of Mekoryuk, Toksook Bay, Nightmute, Tununak, Newtok, and Chefornak, situated near the Bering Sea Coast, also harvest salmon from coastal waters as well as local tributaries.

The 1999 total subsistence salmon harvest estimates for the Kuskokwim Area was 77,660 chinook, 47,612 chum, 49,388 sockeye, and 27,753 coho salmon. Seventy-six percent of the overall subsistence salmon harvests in the Kuskokwim Area were taken by residents of communities located from Tuluksak downstream to Eek.

Chinook salmon are particularly sought after for subsistence use in the Kuskokwim Area and account for a large percentage (38 percent) of the total subsistence salmon catch (Figure 3.9-17). The 1999 subsistence chinook harvest was about 9 percent below the 1995-1999 average of 86,208 fish. The estimated sockeye harvest during 1999 (49,388 fish) was the highest it has been since 1993 (Table 3.9-97). The 1999 harvest was also 28 percent greater than the 1995 through 1999 harvest average of 38,379. Subsistence harvests of both coho and chum salmon have both experienced a general decline since 1989. The estimated harvest of 27,753 coho salmon in 1999 is 13 percent below the average harvest of 31,914 fish from 1995 through 1999. The harvest of 47,612 chum salmon during 1999 was the second lowest catch since 1985. The average harvest of chum salmon from 1995 through 1999 is 63,087 fish. Only in 1997 was the chum harvest lower.

On occasion, commercial fishers sometimes keep salmon caught during a commercial fishing period and take them home for subsistence use. During 1999, approximately 11 percent of the households which reported commercial fishing also reported that they kept salmon from their commercial catch for subsistence use. A total of 105 chinook salmon, 37 chum, 106 sockeye, and 140 coho salmon were reportedly retained from the commercial catch for subsistence use. The number of salmon retained from commercial fishing activities for subsistence use is usually relatively low. The lack of commercial fishing opportunities in 1999 is partly responsible for the low numbers retained.

Salmon Bycatch under Groundfish Fishery Existing Conditions

As detailed in the salmon prohibited species discussion (Section 3.5.2.2), the five species of Pacific salmon are divided into two FMP management groups: chinook salmon, and "other" salmon (chum, sockeye, coho, pink). (Steelhead trout have not been observed recently in either the BSAI or GOA and were not considered in that assessment.) All groundfish fisheries in the BSAI and GOA are prohibited from retaining any species of salmon except for those retained under the Voluntary Salmon Donations Permit that authorizes their retention for local food banks (BSAI Amendment 26, GOA Amendment 29). In 1999, over 3 million pounds were donated. Of the five salmon species, only the bycatch of chinook and chum salmon are of any serious concern in the BSAI and GOA. Pink, coho, and sockeye salmon populations in Alaska are considered healthy and bycatch in the groundfish fisheries represents only a minuscule portion of state harvests. These three species also are small components of bycatch in the groundfish fishery relative to chinook and chum salmon.

As detailed in Section 3.5.2.2, although the overall bycatch of chinook and chum salmon is also very small relative to state harvests, bycatch take could pose a threat to specific stocks (rivers of origin). Some western stocks of chinook salmon are currently depressed. In 2000, there were fishing closures in the Yukon and Kuskokwim river systems and it is possible that ADF&G escapement goals may not be realized over the immediate future. If individual stocks become so depressed that full closure of direct fisheries is insufficient to enable a rebound in the population, then any additional mortality, including bycatch, could negatively impact the stock. It is estimated that 58-70 percent of chinook salmon bycatch in the BSAI groundfish fisheries may originate from western Alaska stocks, but it is unknown what proportion of these salmon are specifically from depressed stocks. Analysts contend that there is insufficient information to determine the effects of BSAI bycatch and PSC limits on specific at-risk stocks within this western group.

As summarized in Appendix C, under BSAI Amendment 21b, the PSC limit represents about 19.2 to 36.9 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chinook salmon landings reported between 1997 and 1999. This is a substantial portion of the domestic harvest. In 1999, NPFMC adopted BSAI Amendment 58 which will (1) further reduce the chinook salmon bycatch limit from 48,000 to 29,000 fish over a four-year period, (2) implement year-round accounting of chinook salmon bycatch in the pollock fishery, (3) revise the boundaries of the Chinook Salmon Savings Areas, and (4) set more restrictive closure dates. This reduced PSC limit represents about 11.6 to 22.3 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chinook salmon landings reported between 1997 and 1999. PSC limits have not been established for salmon in the GOA, nor is bycatch considered a potential problem for subsistence fisheries under existing conditions. Some western Alaska stocks of chum salmon are also depressed, but analysts estimate that only about 19 percent of chum salmon bycatch in the BSAI is from western stocks. Because this is equivalent to only 1.3 to 1.5 percent of the combined Arctic-Yukon-Kuskokwim and Bristol Bay chum salmon landings reported between 1997 and 1999, bycatch represents a tiny fraction of landings even for depressed stocks.

A recent paper by Witherell *et al.* provides a compilation of the latest data on Alaska groundfish fisheries salmon bycatch under existing conditions:

"Chinook salmon Oncorhynchus tshawytscha and chum salmon O. keta are caught incidentally in Alaska groundfish fisheries, primarily in the walleye pollock Theragra chalcogramma trawl fishery. From 1990-2001, an average of 37,819 chinook salmon and 69,332 other salmon species (>95 percent are chum salmon) were incidentally caught annually in the Bering Sea and Aleutian Islands groundfish trawl fisheries, and 20,799 chinook salmon and 20,496 other salmon [> 95 percent are chum salmon] were incidentally caught annually in the GOA trawl fisheries. . . Bycatch is primarily juvenile salmon that are one or two years away from returning to the river of origin as adults. The origin of salmon taken as bycatch includes rivers in western Alaska, southcentral and southeast Alaska, Asia, British Columbia, and Washington. Analysis indicates that an incidental catch of 30,000 chinook salmon in the Bering Sea and Aleutian Islands groundfish trawl fisheries equates to about 14,581 adult chinook salmon from western Alaska. Similarly, a bycatch of 60,000 chum salmon in the Bering Sea and Aleutian Islands groundfish trawl fisheries equates to about 13,120 adult chum salmon from western Alaska. We estimated that, on average, salmon bycatch in the Bering Sea and Aleutian Islands groundfish trawl fisheries reduced the western Alaska chum salmon run by less than 0.2 percent, and reduced the western Alaska chinook salmon run by less than 2.7 percent. Impacts of salmon bycatch from the GOA groundfish trawl fisheries cannot be estimated at this time (Witherell et al. 2002)."

Although the numbers of salmon bycatch and associated impacts of western Alaska stocks would appear relatively low, salmon bycatch is nonetheless a contentious issue given the current state of some of the salmon fisheries. For example, in 2000, "salmon returns throughout the Yukon and Kuskokwim River drainages and the entirety of Norton Sound were less than 50 percent of the 20-year average" (D. Eggers, ADF&G Juneau, personal communication, cited in Witherell *et al.* 2002). These, and correspondingly adverse conditions in the Bristol Bay sockeye fishery, have led to constraints on commercial, recreational, and subsistence harvests, and in 1998, 1999, and 2000, an economic disaster was formally declared for western Alaska based on collapsed salmon runs (Witherell *et al.* 2002). While year-to-year fluctuations are common (and are more so in the GOA than in BSAI fisheries), in recent years chum salmon bycatch in the BSAI has remained fairly stable. However, BSAI chinook bycatch increased in 2001 to about 7 percent over the 1990-2001 annual average (Witherell *et al.* 2002). Given the existing conditions in the salmon fisheries, and the specific importance of salmon to overall subsistence take, the cause of public concern over salmon bycatch in the Alaska groundfish fisheries, even in low numbers, is readily apparent.

Commercial Groundfish Fishing and Subsistence Joint Production Opportunities

Joint production refers to the use of commercial fishing vessels and/or gear in the pursuit of subsistence. Joint production can occur in at least two fundamentally different ways. Subsistence fish can be retained during what are otherwise commercial trips, or separate trips (using the commercial vessel and gear) may be taken that focus on subsistence.

In general, there is a paucity of information on joint production within the groundfish fishery. Below are some general points about the vessels involved, followed by points about the communities involved.

- Some, but not all, vessels in the commercial groundfish fishery are used for subsistence in addition to commercial fishing.

- Depending on the community involved, a greater or lesser proportion of fleet engaged in the local commercial groundfish fishery is a non-resident fleet.

As a general rule, trips specifically dedicated to subsistence are uneconomic for the larger vessels engaged in the groundfish fishery. Larger vessels also tend to fish more away from the community of residence of owner, skipper, and crew, therefore subsistence use is not practical even during what could otherwise be combined commercial/subsistence trips. For the largest vessels participating in the fishery, there is no indication of any subsistence utilization in any form. (For the large vessels that are based in communities where subsistence does take place, dedicated subsistence trips for fishing may be unusual, but it is known from field interviews that sometimes larger vessels are used to make hunting trips with several persons going at once.)

Smaller vessels are most likely to be involved in joint production. The proportion of the total subsistence production for individual communities that result from joint production from these particular vessels during the groundfish fishery is unknown, but as a general rule of thumb, the smaller vessel classes are less likely to be narrowly specialized than the larger vessels. Nearly all of the smaller class vessels that engage in the groundfish fishery are also involved in some combination of (or all of) the salmon, halibut, sablefish, and herring fisheries.

In practical terms, joint production opportunities vary by gear type as well as vessel size. Although quantitative data are slim, knowledge of the industry would suggest that little subsistence takes place using trawl vessels compared to other gear types. Among the fixed gear classes, much more time is directed toward sablefish, salmon, and herring than is devoted to groundfish, therefore the joint production opportunities in this class would remain relatively high independent of the groundfish management alternative chosen.

Commercial vessel owners and crew are not restricted to use of commercial vessels and gear, and in practice the use of specific platforms appears to be fluid. Field observations and discussions would indicate that almost all commercial vessel owners resident in communities where subsistence takes place also own at least one skiff from which they can engage in subsistence pursuits, so even if the larger commercial vessel is not available for any number of reasons, it will not mean the discontinuation of subsistence efforts. Even if a commercial vessel owner does not individually own a skiff, it is a truism of village life that there will always be other vessels owned by sons, fathers, brothers, other kin, or neighbors. It is also important to note that if commercial fishing time goes down (or even joint production opportunities per se), it is entirely possible that subsistence activities will increase, because the relative importance of subsistence in the household economy (e.g., supplying food for the table) will increase, as long as fuel and necessary gear can be obtained.

Short and long-term variation in joint production is not uncommon. Field observations would indicate that different individuals look at the balance between commercial and subsistence catches during times of resource scarcity or other forced decision-making (such as when the price being paid for fish by processors is especially low) in very different ways. From one point of view, if the fishing is poor because few fish are available, the vessel owner should direct effort to the greatest extent possible toward the commercial catch in order to get at least some economic return out of a scarce resource for the family or household economy. From another point of view, if conditions are bad, subsistence fishing should be accomplished first, because subsistence takes care of the basic need to put food on the table in the most direct way possible. Clearly both points of view are held, and both strategies are pursued by different individuals, and this is illustrative of another dimension of the complex relationship between commercial and subsistence pursuits. Poor market conditions also force tough decisions, and different decisions may be influenced by a threshold effect after an individual operation is able to recoup expenses. Again, there are many factors at work in this dynamic decision-making environment and, as a result, similar conditions may result in different outcomes for individual operations, and individual operations may show considerable variability over time.

CDQ-owned vessels that participate in the groundfish fishery largely do not participate in subsistence activities. Although CDQ communities in general have relatively high levels of subsistence engagement, CDQ owned vessels participating in the groundfish fishery may not be based in those communities (i.e., they are an investment that is not directly run out of one of the communities, as is the case for ownership interest in catcher processors). Other CDQ-owned vessels do not participate in the groundfish fishery (or those portions of the groundfish fishery that could change as a result of the alternatives) at all, or at only very low levels. For example, some CDQ owned vessels concentrate nearly exclusively on the salmon fishery, while others focus on halibut and sablefish (blackcod). (A more detailed discussion of CDQ-owned fleet characteristics is provided in Section 3.9.4).

As noted earlier, factors involved in whether or not individuals engage in subsistence pursuits are multiple and complex, and this applies to vessels as well. Some data from ADF&G (and mentioned in the Steller sea lion discussion above) suggest that in at least some instances, level of engagement in subsistence activities declines when individuals are engaged in commercial pursuits. Therefore it may be the case for at least some individuals that if their commercial groundfishing activity declines, their direct participation in subsistence activities may increase. Field interviews and other studies (Kruse *et al.* 1981, Kruse 1982, Schroeder *et al.* 1987) suggest that in other cases, individuals who are the most economically successful in a given community are often also among the highest subsistence producers.[24] This likely results from these individuals having access to more income to purchase better or more efficient equipment (and to be able to afford to engage in activities that require cash outlay for longer periods of time), and the flexibility of schedule that often comes with higher paying employment, among other individual or personal factors. In sum, the factors leading to subsistence participation are many and complex.

There is considerable variation in joint production opportunities by community and region under existing conditions. In the case of Unalaska, none of the large commercial vessels that deliver groundfish to the local processing plants are owned or crewed by residents of the community. There is a small boat fleet from the community that jigs for cod, although the most recent data available suggest that none or very few jig boat owners derive their income exclusively from commercial fishing. The fact that commercial fishing for small boat owners is generally one part of a (variable) multiple income strategy suggests that even when there is a partial reduction in opportunity to fish, there are still incentives to continue to fish.

In terms of the number of participants, this fleet has seen growth and decline in recent years. According to CFEC/ADF&G fish ticket data, three Unalaska/Dutch Harbor jig vessels fished groundfish in 1992, two fished in 1993, and then there was an upsurge in participation with between 13 and 18 vessels reporting per year from 1994 to 1997, inclusive. A decline quickly followed, however, as in 1998, 1999, and 2000, there were 9, 8, and 7 vessels participating each year, respectively. There are also some small boat longline groundfish activity by small boats, but the level of effort in federal waters by local residents within this small boat fleet is difficult to assess with currently available data.

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[24] This general point is also developed on the ADF&G website Subsistence FAQ at: http://www.subsistence.adfg.state.ak.us.

In Akutan, like Unalaska, the fleet that delivers at the local processing facility is a non-residential fleet. Unlike Unalaska, however, the small boat fleet from the community is comprised nearly exclusively of open-skiff type of vessels that generally do not deliver groundfish to the plant, so the residential fleet from the village/traditional community is essentially not engaged in the commercial groundfish fishery. At present, there are few if any joint production opportunities.

In the case of Sand Point and King Cove, there is a residential fleet that delivers groundfish in significant volume to the plants, in addition to deliveries from non-residential catcher vessels. In 2000, 57 of the 80 total vessels in the Alaska Peninsula and Aleutian Islands region were owned by residents of King Cove and Sand Point (including six of the 10 'ghost' vessels[25]). Looking at the vessel classes involved, it is unlikely, for reasons outlined above, that the four local pot boats (all over 85 ft in length) are even in part subsistence vessels. It is also unlikely that the two "04-Trawl catcher vessel Non-AFA" vessels over 90 ft in length (two in King Cove and one in Sand Point) commonly engage in subsistence (due to high operating costs and an inherent lack of flexibility when compared to smaller vessels), although the third vessel in this class, at 68 ft, is more likely to do so. The rest of the local vessels are of a size that they are likely to engage in subsistence, just as their size typically corresponds to a higher degree of diversity within commercial fisheries, as seen in the information presented in Section 3.9.2.

For Kodiak, similar to Sand Point and King Cove, there is a residential fleet that delivers significant amounts of groundfish to the local processing plants. The City of Kodiak-based vessels account for 95 percent of the groundfish total ex-vessel value of the region, and about 87 percent of all groundfish vessels in the region. Old Harbor and Ouzinkie vessels each account for between one and 2 percent of the total regional catcher vessel ex-vessel value. Old Harbor is home to about 6 percent of the groundfish vessels in the region, and Ouzinkie about 3 percent of these vessels. Port Lions and Larsen Bay each represent less than one percent of value and 2 percent of regional vessels. As a general rule, the larger vessels in the region tend to be disproportionately associated with the community of Kodiak compared to the smaller villages, so some joint production can be assumed to be taking place in these smaller communities as well as among the smaller vessels within the Kodiak fleet.

For southcentral and southeast communities with their diversified groundfish fleets, little is known about current joint production practices, but joint production may be assumed to be occurring. In general, however, while joint production may be relatively widespread, joint production concerns resulting from any of the groundfish management alternatives being contemplated are likely to be concentrated among small vessel owners in a relatively small number of communities. A summary of past/present effects of actions and events on subsistence is presented in Table 3.9-127.

3.9.6 Environmental Justice Existing Conditions

3.9.6.1 Regulatory Context

Concerns regarding environmental equity are generally termed environmental justice. Environmental justice can also be defined as "the determination of equal justice and equal protection under the law for all

[25] One factor to keep in mind is that 'ghost' vessels are so classified because while they made groundfish landings, they did not make enough to put them into a particular class, and therefore they are not likely to be affected by any of the alternatives.

environmental statutes and regulations without discrimination based on race, ethnicity, and /or socioeconomic status" (Bryant 2001). Environmental justice issues encompass a broad range of impacts including those on the natural and physical environment and related social cultural and economic effects. While not a part of NEPA itself, EO 12898 (Environmental Justice, 59 FR 7629 [1994]) requires each federal agency to achieve environmental justice by addressing "disproportionately high and adverse human health and environmental effects on minority populations and low-income populations."

As under NEPA itself, "environmental" effects under EO 12898 are construed to encompass social and economic effects, and these are discussed in some detail in this section. Human health effects, as mentioned in EO 12898, would appear to be less relevant to impacts potentially associated with the various groundfish fishery management alternatives being considered in this Programmatic SEIS. EO 12898 does include language regarding the need to identify differential patterns of subsistence consumption of fish and wildlife (which is done in Section 3.9.5 and noted in summary form in this section), but it goes on to link this data collection with potential human health risks associated with the consumption of pollutant-bearing fish and wildlife. While subsistence in Alaska is associated more strongly with minority (Alaska Native) populations and low-income populations (those in rural areas with fewer commercial economic opportunities) than other populations, there is no indication that any of the alternatives being considered would result in a degradation of resources in a manner such that their consumption would result in a health risk elevated above existing conditions.[26]

In order to determine whether environmental justice concerns exist, the demographics of the relevant area are examined to determine whether minority populations or low-income populations are present and could be disproportionately impacted by the proposed alternatives. The question as to whether a proposed alternative raises environmental justice issues depends to a large degree on the history or circumstances of a particular community or population, as well as the specific ties of that community or population to the resources (or access to resources) that will be changed by the alternative.

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[26] This is quite a different situation than found in a number of other parts of the United States, where there are health concerns that result from minority populations and low-income populations being more reliant on pollution-bearing subsistence resources than the general population as a whole. This, along with the observation that minority populations and low-income populations were bearing the brunt of locally undesirable land uses - including those that involved direct environmental health concerns - was one of the major equity concerns that sparked the environmental justice movement. Pollution associated with the commercial groundfish fishery is not understood to be of particular concern for subsistence in Alaska, with the possible exception of commercial fishery operations in general being associated with localized environmental degradation in and around commercial fishing harbors. One example of this is seen in the major port of Unalaska where local residents typically avoid use of at least some subsistence resources (such as intertidal invertebrates) in the immediate harbor area due to concerns over contamination from vessels and various shore based commercial/industrial activities (and even earlier military activities) dating back to at least the World War II era. This is clearly a complex and long-standing situation, and no studies on the incremental contribution of environmental contaminants associated specifically with the groundfish fishery (as opposed to all of the other activities that have historically taken place or are currently taking place in this busy harbor) are known to exist, but it is understood that contemporary environmental regulations make current operations much less environmentally problematic than earlier harbor related activities.

Alternatively, in the Alaska (and groundfish fishery) specific context, it could be argued that any of the management alternatives that have the effect of decreasing subsistence resource consumption could result in a degradation of overall health (or other well-being) of human populations engaged in subsistence activities. This argument would be based on the assumption that consumption of wild resources results in positive health benefits in comparison to benefits derived from commercially available foodstuffs (or that participation in subsistence activities has beneficial health effects due to its central sociocultural importance and an associated perception - or psychological reality - of well-being). Available data do not allow a definitive treatment of this issue and, as a result, potential impacts to subsistence are treated in social and economic terms in this section rather than as a human health issue.

There is no standardized methodology for identification or analysis of environmental justice issues. The demographics of the affected area should be examined to determine whether minority or low income populations are present. If so, a determination must be made as to whether the implementation of the alternatives may cause disproportionately high and adverse human health or environmental effects on the minority populations, or low income populations present.

In determining what constitutes a low-income or minority 'population,' CEQ guidance, with specific regard to minority populations, states: "if the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis." While no available federal guidance addresses the determination of low-income populations, a similar approach has generally been adopted when preparing NEPA documents (King, 2001). The U.S. EPA has stated that addressing environmental justice concerns is entirely consistent with NEPA and that disproportionately high and adverse human health or environmental effects on minority or low-income populations should be analyzed with the same tools currently intrinsic to the NEPA process. NOAA environmental review procedures[27] state that, unlike NEPA, the trigger for analysis under Executive Order 12898 is not limited to actions that are major or significant, and hence Federal agencies are mandated to identify and address, as appropriate "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

3.9.6.2 Community Variations and Data Limitations

The population structure of the regions varies considerably. As discussed below and elaborated in the detailed groundfish regional and community profiles recently produced for NPFMC (NPFMC 2002d), within Alaska, and particularly in the Aleutian and Kodiak regions, there is a relationship between the percentage of Alaska Native population and commercial fisheries development. Specifically, communities that have developed as large commercial fishing communities have become less Native in composition over time compared to other communities in the region. There are many variables involved, but most communities noted the relationship is quite straightforward. The fishery has also had an impact on the male-female population balance for some of the Alaskan communities that are the focus of intensive groundfish processing. This is due to the fact that processing workers reside within these communities for varying durations, and that this workforce is predominately male. While this type of direct impact on population structure attributable to groundfish is seen in few communities, these tend to be the communities with the highest level of groundfish-related processing activities and the highest engagement in, and dependence upon, the fishery. The differences in the male/female and Native/non-Native population segments are, to a degree, indicative of the type of structural relationship of the directly fishery-related population with the rest of the community. Again, this varies considerably from place to place and is not apparent in the southcentral and southeast Alaska regions in the same way it is in the Alaska Peninsula/Aleutian Islands and Kodiak Island regions.

Interpretation of these data, in terms of engagement with the community, is less straightforward for some regions than for others. As detailed in the regional discussions, and in the community profiles available elsewhere (NPFMC 2002d), communities are engaged in, and dependent upon, the fishery in quite different ways through resident catcher vessel fleets, onshore processing facilities, and locally associated catcher

[27] NOAA *Environmental Review Procedures for Implementing the National Environmental Policy Act* (Issued 06/03/99)

processor (and/or mothership) entities. While no consistent data are available, field observations would tend to indicate that ownership and crew demographics of the residential catcher vessel fleet for the relevant Alaska groundfish communities tend to mirror those of the long-term male residents of the community at large. This situation would also appear to hold true for the smaller vessel catcher processor sectors based in the various Alaska regions. For the larger vessel catcher processor and mothership sectors, those are, to a large degree, associated with the Washington region (with the caveat that ownership patterns have been changing in recent years and the percentage of Alaska-based ownership in general and Alaska CDQ ownership in particular has increased, as discussed at length elsewhere in this document), and crews tend to be drawn from a wide area rather than a particular community. These factors are discussed in a separate section below. For the large processing plants that utilize groundfish, the demographics of the workforce and the relation to the host communities tend to be more complex, have substantial environmental justice implications, and are discussed at length below.

In some Alaska groundfish communities, processing plants tend to be industrial enclaves somewhat separate from the rest of the community, while for others there is no apparent differentiation between the processing workforce and the rest of the regional or local labor pool. A further complication for attribution of socioeconomic impacts to a regional base is the fact that for many workers in many of the sectors, groundfish-related work is performed in a region or community that is separate from where they have a number of other socioeconomic ties. It is not uncommon for fishery-related workers to spend relatively little money in their work region and to send pay home to another community or region. In this sense, regional employment is indicative of a volume of economic activity, if not a specific level of labor activity directly comparable to other industries.

The importance of this flow varies from region to region and from sector to sector, but is most apparent within communities that are most heavily engaged in the processing aspect of the groundfish fishery. For the purposes of this environmental justice analysis, however, these populations will be characterized as being resident in their residential workplace communities, consistent with U.S. Census methodology. One of the current limitations of U.S. Census data, however, is that not all of the 2000 data relevant to this environmental justice analysis have been released. Ethnicity by housing type (e.g., ethnicity by group quarters and non-group quarters), particularly useful for examining resident processing workforce numbers in Alaska coastal communities for this analysis, is not available, so data from the 1990 U.S. Census are presented, keeping with the established practice of using federal census data for environmental justice analysis.

Unfortunately for this analysis, however, the groundfish fishery has changed a great deal since 1990 in many ways, including the size and distribution of the workforce. This being the case, the 1990 census data were supplemented with data gathered from industry sources that characterize their workforce demographics for 2000. These data suggest that the workforce has come to include a much larger minority population component than was the case a decade earlier and reflected in the 1990 census information.

Some caution must be given in the comparison of the two different 1990 and 2000 resident workforce related data types. In order to supplement the dated 1990 U.S. Census information that is being used to infer the structure of the locally present or resident fishery-associated workforce, industry was asked to provide 2000 workforce demographics for their individual groundfish processing operations.[28] These data were not collected using a methodology similar to that used for the U.S. Census data, and this should be taken into account in the interpretation of the information. These data are self-reported and, like other self-reported data, there may be a degree of inherent self-interest bias within the information. Whatever bias exists is considered likely to be relatively small and not sufficient to materially alter the overall assessment of whether or not the local seafood processing workforce represents a population segment that is "meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis" such as the specific community or region. Further, in each relevant Alaska region, these data are supplemented with age and sex data from the 1990 and 2000 U.S. Census that allow a cross-check on both the gross and relative changes in the industrial population segment in the communities.

The demographic composition of the greater Seattle area is markedly different than that seen in the Alaska groundfish communities, and the same type of demarcation between the industrial fishing operations and the resident population is not apparent. Seattle is, in absolute terms, the community most engaged in the groundfish fishery among many of the important indices of involvement, but it is also the least engaged in terms of the relative importance of the fishery to the overall population and economy of the community (as discussed in detail elsewhere [NPFMC 2002d]). Summary information relevant to environmental justice considerations for Seattle is presented at the end of this section.

The CDQ region presents yet another type of environmental justice context. Environmental justice issues are salient in this region due to the nature of the demographic and economic structure of the region, and the nature of the participation of this region and its communities in the fishery through various mechanisms of the CDQ program. The specific attributes of participation vary as the program has been implemented differently in various subregions by different CDQ groups, but in general this program has been designed to foster economic development in minority (Native Alaskan) and economically underdeveloped communities. As such, any impacts to the CDQ program and its communities are, essentially by definition, potentially environmental justice impacts. The existing conditions in this region and the attributes of the program are discussed in detail in Section 3.9.4.

Another type of environmental justice context concerns subsistence issues. While not only Alaska Natives participate in subsistence activities, areas in which subsistence activities are practiced that may be impacted by groundfish management alternatives are predominately Alaska Native. Therefore, impacts to subsistence are also, in general, potentially environmental justice impacts. Existing conditions for relevant subsistence associated populations are discussed in detail in Section 3.9.5. A summary of past/present effects of actions and events on environmental justice is presented in Table 3.9-127.

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[28] There has been some question in the past as to whether or not environmental justice provisions applied to non-U.S. citizens, and this has relevance for the analysis, given that a substantial number of resident aliens work in the local seafood processing plants. If it is assumed that EO 12898 is premised on the application of the equal protection clause, then it should not matter whether the affected population consists entirely or primarily of citizens or resident aliens. Further, available guidance for the implementation of EO 12898 recommends the use of U.S. Census data, and the methodology of the Census, i.e., where all persons are counted, argues strongly for the inclusion of foreign nationals in the environmental justice analysis. As noted by the EPA, however, census data alone may not always prove sufficient for a thorough analysis, "in part because the level of aggregation may not offer a fine enough mesh to identify the existence of minority and/or low-income populations." In this specific Programmatic SEIS instance, industry provided data are used to identify such 'pockets' of minority populations within various groundfish communities that are relevant to the analysis of the proposed alternatives.

3.9.6.3 Regional Summaries

Alaska Peninsula/Aleutian Islands region

General Community Population Attributes

Alaska Peninsula/Aleutian Island region communities with the strongest direct engagement in, and dependence upon, the North Pacific groundfish fishery are Unalaska, Akutan, Sand Point, and King Cove.[29] These four communities, and their specific ties to the groundfish fishery, were summarized in Section 3.9.3. In this section, community level information relevant to environmental justice analysis is summarized.

Table 3.9-98 provides ethnicity information from the 2000 census for each of the four communities.[30] As shown, these communities vary widely in their population structure. For example, Unalaska is the largest community, but has the lowest Alaska Native population percentage, and King Cove and Sand Point have a much higher Alaska Native population component than either of the other two communities. (While Akutan has a relatively low Alaska Native population percentage, the Alaska Native population is highly concentrated in one area and generally insulated from commercial groundfish related activity and its associated non-Native population. Thus, the Alaska Native portion of the community at least in some ways bears the most resemblance to "village life" from an earlier era among the four communities.) Unalaska has a far higher white or non-minority population percentage than the other three communities. Asian residents represent the largest population segment in Akutan, and the second largest in Unalaska (behind whites) and in King Cove (behind Alaska Natives), and the third largest in Sand Point (behind Alaska Natives and whites). These communities have quite different histories with respect to the growth of the different population segments present in the community in 2000. Each is summarized briefly below. One important constant across all of these communities is that each is a *minority community* in the sense that minorities make up a majority of the population in each community.

Unalaska may be described as a plural or complex community in terms of the ethnic composition of its population. Although Unalaska was traditionally an Aleut community, the ethnic composition has changed with people moving into the community on both a short-term and long-term basis. Not surprisingly, in the latter half of the 20th century, population fluctuations have coincided with periods of resource exploitation and scarcity.[31]

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[29] As noted in an earlier section, there are also ties between the fishery to Adak, Chignik, False Pass, and St. Paul. However, these ties are far less pervasive and do not have the historical depth of the ties seen in Unalaska, Akutan, Sand Point, and King Cove. Due to these differences in existing conditions, the communities of Adak, Chignik, False Pass, and St. Paul are not detailed in this section, but each may experience impacts resulting from management actions under the various alternatives, as discussed in Section 4, if not to the degree seen in Unalaska, Akutan, Sand Point, and King Cove.

[30] As a methodological note, community populations vary quite a bit throughout the year as seasonal workers are brought in to the smaller Alaska communities to provide an adequate workforce for peak seafood processing demand. U.S. Census data do not take yearly averages, but rather represent a one time count. During the 1990 census, for example, information for rural Alaska communities was collected during the months of January through April1990 according to the Institute for Social and Economic Research at the University of Alaska. Although these data cannot represent the complexity of groundfish community the population dynamics, they do represent the best available data set that is comparable across communities and regions.

[31] The most dramatic population shift of this century was brought about by World War II. The story of the War, and the implications for the Aleut population of Unalaska and the other Aleut communities of Unalaska Island, is too complex and profound for treatment in this limited community profile. It may be fairly stated that the events associated with World War II, including the

For example, the economic and demographic expansion associated with the king crab boom in the late 1970s and early 1980s brought many non-Aleuts to Unalaska, including Euro-Americans, Filipinos, Vietnamese, Koreans, and Hispanics. The Euro-American population shows a distinct change over the years, comprising around 30 percent of the population in 1970, over 60 percent in 1980 and 1990, and then back to 44 percent in 2000. The growth of Asian/Pacific Islander population (over 30 percent by 2000) is closely associated with the increasingly residential nature of the seafood processing sector workforce.

Apart from the war years (1941 to 1945), prior to the growth of the current commercial-fisheries-based economy Unalaska was an Aleut community. Since this development, however, the change over the period of 1970 to 1990 is striking. In 1970, Aleut individuals made up slightly over 60 percent of the total community population (and Alaska Natives accounted for a total of 63 percent of the population). In 1980, Alaska Natives, including Aleuts, accounted for 15 percent of the population; by 1990, Aleuts comprised only 7 percent of the total community population (with Alaska Natives as a whole accounting for 8 percent of the population). Overall representation was similar in 2000. This population shift is largely attributable to fisheries and fisheries-related economic development and associated immigration.[32]

Akutan is a unique community in terms of its relationship to the Bering Sea groundfish fishery. It is the site of one of the largest shoreplants in the region, but it is also the site of a village that is geographically and socially distinct from the shoreplant. This duality of structure has had marked consequences for the relationship of Akutan to the fishery. One example of this may be found in Akutan's status as a CDQ community. Initially (in 1992), Akutan was (along with Unalaska) deemed not eligible for participation in the CDQ program based upon the fact that the community was home to "previously developed harvesting or processing capability sufficient to support substantial groundfish participation in the BSAI . . .," though they met all other qualifying criteria. The Akutan Traditional Council initiated action to show that the community of Akutan, per se, was separate and distinct from the seafood processing plant some distance away from the residential community site, that interactions between the community and the plant were of a limited nature, and that the plant was not incorporated in the fabric of the community such that little opportunity existed for Akutan residents to participate meaningfully in the Bering Sea pollock fishery. That is, it was argued that the plant was essentially an industrial enclave or worksite separate and distinct from the traditional community of Akutan and that few, if any, Akutan residents worked at the plant).

With the support of the APICDA and others, Akutan was successful in a subsequent attempt to become a CDQ community and obtained CDQ status in 1996. This action highlights the fundamentally different nature of Akutan and Unalaska. Akutan, while deriving economic benefits from the presence of a large shoreplant near the community proper, has not articulated large-scale commercial fishing activity with the daily life of the community as has Unalaska, nor has it developed the type of support economy that is a central part of the socioeconomic structure of Unalaska. While US Census figures show Akutan had a population of 589

Aleut evacuation and the consolidation of the outlying villages, forever changed the community and Aleut sociocultural structure.

[32] The fact that there is a "core" Aleut population of the community with a historical continuity to the past also has implications for contemporary fishery management issues. These include the activities of the Unalaska Native Fishermen's Association and active local involvement in the regional CDQ program (through participation as an ex officio member as well as being actively engaged in group sponsored training programs, among other activities). While neither of these undertakings exclude non-Aleuts, Aleut individuals are disproportionately actively involved (relative to their overall representation in the community population).

in 1990 and 713 in 2000, the Traditional Council considers the *local* resident population of the community to be around 80 persons, with the balance being considered *non-resident employees* of the seafood plant. This definition, obviously, differs from census, state, and electoral definitions of residency, but is reflective of the social reality of Akutan. The residents of the village of Akutan, proper, are almost all Aleut.

Sand Point and King Cove share a more or less common development history, but one quite different from either Unalaska or Akutan. Sand Point was founded in 1898 by a San Francisco fishing company as a trading post and cod fishing station. Aleuts from surrounding villages and Scandinavian fishermen were the first residents of the community. King Cove was founded in 1911 when Pacific American Fisheries built a salmon cannery. Early settlers were Scandinavian, European, and Aleut fishermen. Historically, both of these communities saw a large influx of non-resident fish tenders, seafood processing workers, fishers, and crew members each summer. For the last several decades, both communities were primarily involved in the commercial salmon fisheries of the area, but with the decline of the salmon fishery, plants in both communities have diversified into other species. In more recent years, the processing plants in both communities have become heavily involved in the groundfish fishery, although their structural relationships to the fishery have diverged since the passage of the AFA. As discussed elsewhere (NPFMC 2002d), processing facilities in both communities qualified as AFA entities; however, King Cove qualified for a locally based catcher vessel co-op while Sand Point did not.

Three tables present information on income, employment, and poverty for the relevant groundfish communities of the region based on U.S. Census data. Table 3.9-99 displays basic information on community housing, households, families, and median household and family income. As shown, the income range is large for the communities shown, with the median family income in Akutan being roughly half of that in Unalaska. This does not reflect the entire range for the region, however, as two communities in the region (Atka and Nikolski) have a lower median family income than Akutan.

Table 3.9-100 displays data on employment and poverty[33] information for the relevant communities for 1990 and Table 3.9-101 shows comparable information for 2000. These tables show large differences between 1990 and 2000, and a comparison of the two tables may be used to point out some potentially problematic aspects of the 2000 data.

As shown in Table 3.9-100, in 1990 there was virtually no unemployment in these communities, no doubt due in large to the presence of fishery-related employment opportunities. Percentage of poverty varies between the communities, but these communities do not represent the range of regional variation. In 1990, Atka had the highest unemployment in the region at 25.7 percent, whereas Cold Bay, False Pass, Nelson Lagoon, and Nikolski had no employment as all members of the workforce (a subset of the total population) that were seeking employment were actually employed. This figure is somewhat misleading; in some communities a large portion of the adult population may not be working and not seeking employment. In 1990, Nelson Lagoon was the extreme example of this with 81 percent of the adults not working. In 1990, percent of poverty in the region ranged from 0 percent in Cold Bay to 42 percent in St. George. Data do not

[33]Poverty figures in this section are based on U.S. Census information which, in turn, is based on the federal government's official poverty definition. Families and persons are classified as below poverty if their total family income or unrelated individual income was less than the poverty threshold specified for the applicable family size, age of householder, and number of related children under age 18 present. The poverty thresholds are the same for all parts of the country and are not adjusted for regional, state, or local variations in the cost of living. The poverty thresholds are updated every year to reflect changes in the Consumer Price Index.

vary consistently with the presence or absence of commercial fishery development as might be expected. For example, Atka shows a very high rate of unemployment and percent of adults not working, yet there is a smaller percentage of persons in poverty than in Akutan, a community with an unemployment rate of less that one percent. This is attributable, in part, to the fundamentally different natures of the communities, with Atka being a small village and Akutan being a community with a large processing facility adjacent to the traditional village site. False Pass, Nelson Lagoon, Nikolski, and St. George, none of which had fish processing facilities at the time of the census, all had over 50 percent of the adults in the community not working.

The contrast between these and the other communities is reflective of both lack of economic development in these communities and the nature of the workforce population in communities with shoreplants, where large numbers of processing workers are present, tend not to have non-working adult family members present with them, and tend to be in the community exclusively for employment purposes.

Table 3.9-101 shows a very different picture in 2000 than was seen in 1990, and a working knowledge of the fishing industry would seem to indicate the 2000 data are anomalous. For example, in 2000 the U.S. Census lists a total of 505 unemployed persons in Akutan. Given that the traditional village of Akutan consists of less than 100 persons (including all age groups, not just adults in the labor pool who could qualify as employed or unemployed), the overwhelming majority of persons enumerated as unemployed must have been idled seafood processing workers.

While this unemployment may have been real in the sense that processing workers were present and not actively working when the census was taken, it is most likely an artifact of the timing of the census. Processing workers are not typically present in the community when the plant is idle for any extended period of time. Under normal conditions, there are no unemployed seafood processing workers present in the community (by design). These workers are transported to and from the community by their employer to meet labor demand at the plant. As part of the employment agreement, seafood processors typically provide room and board for workers, so it is uneconomic to have idled workers at the site unless the plant downtime is relatively brief (i.e., the cost of housing and feeding the employees during the idle interval does not exceed transportation, recruiting, training and other costs associated with sending workers out and bringing them back in, including some level of turnover that always occurs in these situations). The same type of data problem may be occurring in Sand Point and Unalaska, but this is not as clear as is the case for Akutan.

It is also important to note that some Alaska Native communities in the region that do not directly participate in the commercial groundfish fishery derive direct benefits from the fishery outside of the CDQ program. Primary examples of this are the smaller communities of the Aleutians East Borough. In this case, CDQ communities receive direct and indirect benefits of non-CDQ community (King Cove and Sand Point) participation in the fishery. Both King Cove and Sand Point are part of the Aleutians East Borough, and revenue that derives from landings in these communities (along with landings in Akutan), significantly benefit smaller Alaska Native communities in the Aleutians East Borough, such as False Pass and Nelson Lagoon. In this way, adverse impacts to the fishery that are seen in King Cove and Sand Point are also seen in False Pass and Nelson Lagoon, and may impact everything from school funding to basic service provision.

Population Attributes of the Resident Groundfish Fishery Workforce

Beyond the overall population, income, and employment figures for the individual communities, it is important for the purposes of environmental justice analysis to examine information on the residential groundfish fishery workforces. It is likely that employment and income losses or gains associated with at least some of the alternatives would be felt among the local seafood processing workers, and these workers do not comprise a representative cross-section of the community demography. One method to examine the relative demographic composition of the local processing workforces is to utilize group quarter housing data from the U.S. Census (keeping with the established practice of using U.S. Census data for environmental justice analysis). The group ethnicity-by-housing type data are drawn from both the 1990 census and the 2000 census (and a subsequent section augments this information with industry-provided figures for 2000, see below). This is supplemented by age and sex data from the 1990 and 2000 U.S. Census to provide a cross check of census (and industry-provided) data and the population structure over this period. (This approach is applied to other regions subsequently discussed as well.)

Tables 3.9-102 and 3.9-103 provide information on group housing and ethnicity for Unalaska for 1990 and 2000, respectively. Group housing in the community is largely associated with the processing workforce. As shown in Table 3.9-102, 52 percent of the population lived in group housing in 1990. Also as shown in that same table, the total minority population proportion was substantially higher in group quarters (49 percent) than in non-group quarters (31 percent). The 2000 figures (Table 3.9-103) show a similar overall split between group quarters (51 percent of community population total) and non-group quarters populations (49 percent of the total), but the minority population distribution between and within housing types changed substantially in the 1990 to 2000 period. For example, "white" residents of Unalaska comprised 54 percent of the group quarters population in 1990, but only 30 percent in 2000 (and declined, to a lesser but still substantial degree, from 71 percent to 59 percent of the population within non-group quarters housing). Although demographic categories changed somewhat between the 1990 and 2000 census, some relatively large changes are readily apparent. For example, in 1990, the "Asian or Pacific Islander" category accounted for 27 percent of group quarters population, but 42 percent by 2000. In general, in 2000 Unalaska had a substantially greater minority population in absolute and relative terms than it did in 1990, and this is readily apparent within the group quarters population that is largely associated with seafood processing workers. In other words, environmental justice is potentially a large concern if there is the potential for processing worker displacement, and one that has grown through time.

With the population growth seen in association with the development of the commercial fishing industry, Unalaska's population has had significantly more men than women. Historically, this has been attributed to the importance of the fishing industry in bringing in transient laborers, most of whom were young males. Table 3.9-104 portrays the changes in proportion of males and females in the population for the years 1970, 1980, 1990, and 2000. Census data from the period 1970-1990 showed a climb in median age from 26.3 years to 30.3 years and then a further jump to 36.5 years in 2000. This is commonly attributed to an increase in relative size of the workforce (both fishery and non-direct fishery-related) in comparison to resident families. (Although some who come to Unalaska for employment opportunities bring children into the community, it is apparent that many do not, which drives up the median age.)

Table 3.9-105 provides information on group housing and ethnicity for Akutan for 1990, and similar information for 2000 is presented in Table 3.9-106. Group housing in the community is almost exclusively associated with the processing workforce. As shown, 85 percent of the population lived in group housing in

1990, which represents the extreme of the four communities considered in this region. In 2000, this figure was over 89 percent. Also as shown, the ethnic composition of the group and non-group housing segments were markedly different, with the non-group housing population being predominately Alaska Native (83 percent and 87 percent in 1990 and 2000, respectively), and the group housing population having little Alaska Native/Native American representation (1 percent in 1990, 7 percent in 2000). Like Unalaska, overall minority population representation was higher in absolute and relative terms in the community as a whole and in both group and non-group quarters in 2000 than in 1990.

Table 3.9-107 shows the population composition of Akutan by sex in 1990 and 2000. These data are clearly indicative of a male-dominated industrial site rather than a typical residential community.

Table 3.9-108 provides information on group housing and ethnicity for King Cove in 1990, and similar information for 2000 is presented in Table 3.9-109. As with the other communities, group housing in the community is largely associated with the processing workforce. As shown, 42 percent of the population lived in group housing in 1990 and 38 percent in 2000. The distribution of ethnicity between housing types is striking. In 1990, the Alaska Natives/Native Americans comprised 67 percent of the non-group quarters population in the community, and the analogous figure for 2000 was 75 percent. For both 1990 and 2000, there was only one Alaska Native/Native American individual living in group quarters in the community (about one-half of one percent of the total group quarters population).

Shifts in ethnic populations are also apparent between 1990 and 2000, with the "Asian" group comprising over 64 percent of the group quarters population in 2000, up substantially from 1990. The "White" component of the population was smaller in absolute and relative terms in 2000 than in 1990 for the community as a whole and in group quarters. Among non-group quarters residents, the number of "White" residents was larger in 2000 than in 1990, but still represented a smaller proportion of the non-group quarters population in 2000 than in 1990. In other words, environmental justice is clearly an issue of potential concern for the community as a whole and for the seafood processing associated group quarters population in particular, and census counts suggest that minority representation has substantially increased over the period 1990 to 2000.

Table 3.9-110 presents information on the male to female ratio for King Cove for 1990 and 2000. The disproportional representation of males within the overall population is indicative of the transient nature of much of the workforce.

Table 3.9-111 provides information on group housing and ethnicity for Sand Point for 1990, and similar information for 2000 is provided in Table 3.9-112. As shown, 21 percent of the population lived in group housing in 1990, which was the lowest figure for the four communities detailed within this region. In 2000 this figure was 36 percent, which was greater than the King Cove figure for that same year. In 2000, no Alaska Natives/Native Americans lived in group quarters in the community, but comprised 66 percent of the population living outside of group quarters. As shown, the ethnic diversity among group quarter residents is, in general, substantially less in 2000 than in 1990, but detailed comparison of individual groups (other than White, Alaska Native/Native American, and Asian) is problematic due to missing data (the "unknown" category). Asians comprised over 60 percent of all persons living in group quarters in 2000 with persons of Hispanic origin accounting for about two-thirds of the remaining 40 percent of group quarter residents.

Table 3.9-113 presents information on age and sex of Sand Point's population for 1990 and 2000. As shown, the significant male-to-female imbalance seen in other large regional groundfish communities is present in Sand Point as well.

Industry Provided Data

Information on 2000 workforce demographics was obtained for four of the six major groundfish shoreplants in the Alaska Peninsula/Aleutian Islands region, as well as one of the two floating processors that are classified as inshore plants. At least some of the entities voluntarily providing these data consider them confidential or proprietary business information, but agreed to provide the information if it was aggregated with data supplied by others such that details about individual operations were not disclosed. As a result of these concerns, communities cannot be discussed individually. It can be stated that the total combined reported processing (and administrative) workforce of 2,364 persons was classified as 22.5 percent white or non-minority, and 77.5 percent minority. Reporting shoreplants ranged from having a three-quarters minority workforce to an over 90 percent minority workforce.

It is worth noting that different firms provided different levels of detail in the breakout of the internal composition of the minority component of their workforce. For some plants, the total minority figure was not disaggregated, and too few plants within this region provided detailed data to allow region-specific discussion. In general, however, all of the shoreplants in this region that provided detailed data have workforces that are 5 percent or less Black or African American and 5 percent or less Alaska Native/Native American (a pattern also seen in the detailed data from Kodiak plants). More variability was seen among other minority population components. The group classified as Asian/Pacific Islander was the largest minority group in two-thirds of the plants in any region reporting detailed data, and the group classified as Hispanic was the largest minority group in the remaining one-third. Two entities provided time series data. One provided data spanning a 10-year period, while the other provided information covering a four-year span. For the former, the minority workforce component increased over time; for the latter no unidirectional trend existed.

Regional Summary

The communities in the region that are most engaged in, and dependent upon, the groundfish fishery are those with populations comprised of more minority residents than non-minority residents. The structure of the minority population component varies from community to community, as does the proportion of the community population that is comprised of Alaska Native residents. Further, the workforce at the processing plants that would likely feel the impacts of the alternatives is overwhelmingly comprised of minority workers. While no systematic quantitative data are known, field observations would suggest that for a very substantial portion of the workforce, English is a second language (this is reinforced by data from local schools such as Unalaska, where 47 percent of the entering kindergarten students in 2000-2001 were English as a second language students) and languages other than English are commonly utilized in the workplace among processing crews. These factors, along with limited opportunity to acquire job skills in other economic sectors, would tend to indicate that these populations would be less able to easily acquire alternative employment outside of the seafood industry if there were widespread job reductions as a result of the alternatives. However, information on the level of job turnover/rates of rehire (discussed elsewhere [NPFMC2002d]) suggests that there is a fair degree of mobility among at least part of this workforce.

Kodiak Island Region

General Community Population Attributes

Within the Kodiak region, the City of Kodiak is the location of virtually all of the direct links with the groundfish fishery. Given these circumstances, it will be the only regional community discussed in detail.[34]

Kodiak is a complex community in terms of the ethnic composition of its population. Sugpiaqs (Koniags) were the original inhabitants of Kodiak Island. Beyond earlier development, fishing and military buildup associated with World War II brought many non-Natives to Kodiak, primarily Caucasians but also a substantial number of non-Native minorities, at least initially associated primarily with fish processing employment. Detailed information on community growth and the relative growth of different population segments is available elsewhere (NPFMC 2002d). The Alaskan Native population has remained at approximately the same percentage since the 1970s, but the white (non-minority) population has declined in terms of percentage over time. Overall, there has thus been a gradual, long-term shift in ethnic composition, with Asian and Pacific Islanders increasing in percentage. Census data from 2000 detailing ethnicity are presented in Table 3.9-114. As shown, the majority of Kodiak's population is comprised of minority residents.

The following two tables present information on income, employment, and poverty for the City of Kodiak and the Kodiak Island Borough and are based on 2000 U.S. Census data. Table 3.9-115 displays basic information on community housing, households, families, and median household and family income. As shown, the City of Kodiak is above the borough income averages. For example, median family income in Kodiak itself is about 3 percent higher than the borough as a whole. Compared to all communities in the region, the City of Kodiak places at the upper end of the range. In 2000 the highest median family income in the region was in the community of Chiniak, with a figure of $75,067, while the lowest figure was $19,167 for Karluk.

Table 3.9-116 displays data on employment and poverty for the City of Kodiak and the Kodiak Island Borough for 2000. As shown, there was very little unemployment in these jurisdictions, presumably due in part to the presence of fishery-related employment opportunities, and also due to the fact that the Kodiak economy is relatively diversified by rural Alaska standards (and particularly in comparison to the Aleutian region communities). The City of Kodiak had the second lowest unemployment of any civilian community in the region (3.6 percent compared to 2.1 percent in Port Lions), whereas the village of Old Harbor had the highest unemployment in the region at 12.5 percent. Proportions of the population considered to be below the poverty threshold varied between the communities, but as was the case in the Aleutian region, this is somewhat misleading. For example, Ouzinkie had the lowest poverty rate (6 percent) of any community in the region in 2000, but at the same time 48 percent of the adults in the community were not working. Old Harbor has the highest poverty rate in the region at 29.5 percent.

[34] Processing data does show that groundfish are also run at Alitak, but this is a relatively specialized operation and very small relative to the aggregated operations associated with the City of Kodiak.

Population Attributes of the Resident Groundfish Fishery Workforce

Table 3.9-117 provides information on group housing and ethnicity for Kodiak for 1990, and similar information for 2000 is presented in Table 3.9-118. Group housing in the community is largely associated with the processing workforce, but not to the nearly exclusive degree seen in the Aleutian communities. The institutional base and range of housing types in Kodiak is more complex. As shown, only 6 percent of the population lived in group housing in 1990, and only about 2 percent in 2000. This is a much lower percentage of population residing in group quarters than in the other communities profiled, and is consistent with a processing workforce more heavily drawn from the local labor pool. In 1990, while there was a significant difference between the group quarter and non-group quarter demographics (with the group quarter population being a higher minority group than the community population as a whole), the differences are not as sharp in general or for particular groups as seen in the Aleutian region communities. A similar pattern is seen in the 2000 data; however, the small numbers of persons involved make conclusions about the proportionality or trends of change between groups somewhat tenuous.

The male to female imbalance is present in the community, as shown in Table 3.9-119, but it is of a lesser magnitude than seen in the Aleutian region groundfish communities. This is consistent with Kodiak's fishery-related workforce being drawn more from the local community labor pool than is the case in the Aleutian communities.

Industry Provided Data

Given the nature of the relationship between the processing workforce and the local communities, industry information comparable to that of the Aleutians region was not systematically collected from Kodiak region entities. The information received was not sufficient to be able to disclose precise community level information due to confidentiality concerns. As a generality, the 2000 data received indicated that at least some shoreplants in this region have workforces with a greater minority population component than the Aleutian regional average (77.5 percent). This is despite the fact that, as a rule of thumb, the Kodiak processing workforce is drawn to a larger degree from a local labor pool than is the case for the Aleutian communities.

As was the case for the Aleutian region, different firms provided different levels of detail in the breakout of the internal composition of the minority component of their workforce. For some plants the total minority figure was not disaggregated, and not enough plants within this region provided detailed data to allow region-specific discussion. However, as mentioned in the Aleutian region discussion, all of the shoreplants in any region that provided detailed data have workforces 5 percent or less Black or African American and 5 percent or less Alaska Native/Native American. For the Kodiak region, the group classified as Asian/Pacific Islander was the largest minority group noted within the limited detailed data received.

Regional Summary

The community in the region that is most engaged in and dependent upon the groundfish fishery (Kodiak) is comprised of more minority residents than non-minority residents. While systematic data do not exist, the data that are available suggest that the workforce at the processing plants that would likely feel the impacts of the alternatives are primarily comprised of minority workers.

Southcentral and Southeast Alaska Regions

Environmental justice is likely to be much less of an issue in the southcentral and southeast Alaska region communities than in the Alaska Peninsula/Aleutian Islands and Kodiak Island regions, for several reasons. Of primary importance among these is the nature of the communities most directly engaged in the commercial groundfish fishery. As described in Section 3.9.3, the communities most engaged in the groundfish fishery in southcentral Alaska, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities, especially compared to the Alaska Peninsula/Aleutian Islands groundfish communities. The same holds true for the southeast Alaska region, with the exception of Yakutat.

A second factor is the relatively low level of processing employment directly attributable to groundfish in these regions that could potentially be at risk under at least some of the groundfish management alternatives. For example, in 2001, there were only an estimated 106 FTE groundfish processing jobs among all of the communities in the entire southeast Alaska region (or about 33 times fewer groundfish processing FTEs than in the Alaska Peninsula/Aleutian Islands region). While the potential loss of these positions would, of course, be of consequence for the individuals and operations involved, the diversity of processing operations, size and diversity of community populations, and the availability of alternative economic opportunities would serve to dampen the environmental justice dimension of any impacts realized at the community or regional level.

Similarly, in 2001 among all of the communities in the southcentral Alaska region, there were an estimated 150 groundfish processing FTEs, or about one-quarter the number found in Kodiak alone. These community and workforce factors, especially in combination, mean that, in general, the type of environmental justice concerns seen in the Alaska Peninsula/Aleutian Islands and Kodiak Island regions are largely absent. Further, environmental justice concerns linked to Steller sea lion and salmon subsistence activities are also largely absent in these two regions. As a result, detailed environmental justice existing conditions information has not been developed for these regions. The regional data presented in Section 3.9.3 are considered sufficient for analytical needs.

Washington Inland Waters Region

General Community Population Attributes

The greater Seattle area is the center for much of the economic activity related to the North Pacific groundfish fishery, but the geographic footprint of those activities is difficult to define. The boundaries cannot be attributed to specific communities or neighborhoods in the same manner as Alaska communities may be linked to the fishery, as discussed in detail elsewhere (NPFMC 2002d). For comparative purposes, and so that the information on the Seattle-based catcher processor sector described below can be compared to the greater Seattle population base, Table 3.9-120 provides ethnicity data for the Seattle-Tacoma Consolidated Metropolitan Statistical Area (CMSA) as defined by the U.S. Bureau of the Census.[35] As

[35] A Consolidated Metropolitan Statistical Area (CMSA) consists of two or more contiguous MSAs The Seattle-Tacoma WA CMSA consists of Seattle, WA PMSA (1) King and Snohomish Counties, and (2) Tacoma (Pierce County). A Metropolitan Statistical Area can be defined as a city of over 50,000 inhabitants together with the county in which it is located and contiguous counties which are economically and socially integrated with the central city. It may also consist of an urbanized area of 50,000 with

shown, unlike the Alaska groundfish communities, the white portion of the population comprises a large majority of the overall population (i.e., racial or ethnic groups classified as minorities are mathematical minorities within the local overall population, unlike the relevant Alaska communities).

Information on household income and employment and poverty information for the Seattle-Tacoma CMSA comparable to that provided for the relevant Alaska groundfish communities is not presented here. These types of data at the CMSA level are not meaningful for this environmental justice analysis due to their high level of aggregation.

Population Attributes of the Resident Groundfish Fishery Workforce

Given the nature of engagement with the fishery, the Washington inland waters region does not have the same type of resident workforce focused in individual communities in a manner comparable to that seen in Alaska communities, as discussed above. Rather, this environmental justice analysis will focus on industry provided sector data as described below.

Industry Provided Data

As noted in the introductory discussion, catcher vessel ownership and crews are assumed to reflect the overall demographic make up of the male working age population in their home communities. Although systematic demographic data were not collected for the groundfish catcher vessel crews in the Washington inland waters region, interviews with local sector association personnel suggest that minority population representation within this sector does not exceed the proportion of minority representation in the general population; therefore, environmental justice is not an issue with respect to potential impacts to this sector.

Shore processing plants are not present in this region, and the mothership sector data cannot be presented due to confidentiality restrictions based on the small number of entities. As a working assumption, it is assumed that the mothership employment structure is similar to that of the catcher processor sector, although the catcher processor sector may have a somewhat higher minority representation in the workforce due to more consistent targeted hiring in rural Alaska.

Information on catcher processor workforce demographics for 2000 was obtained from seven entities that together account for almost all (99 percent) of the non-CDQ target pollock caught by trawl catcher processors in the BSAI as well as 86 percent of the CDQ pollock. (While these entities also catch a significant amount of Pacific cod, catch among catcher processors in the Pacific cod fishery is more dispersed over a larger group of participating entities.) Different firms provided different levels of detail in the breakout of the internal composition of the minority component of their workforce, but the detailed information provided encompassed 1,906 out of the 2,126 persons reported, or 90 percent of the total reported workforce. Table 3.9-121 provides ethnicity information for those entities reporting detailed breakouts.

As shown, the portion of the workforce within the detailed reporting set was 36.9 percent white or non-minority and 63.1 percent minority. Adding the more highly aggregated data does not significantly change the overall minority/non-minority ratio. Within the total set of responding entities, individual entity

a total metropolitan area population of at least 100,000.

workforces ranged from a 36 percent minority workforce to an 85 percent minority workforce. Among entities reporting detailed data, Hispanic was the largest minority component in every entity's minority workforce segment, with one exception (in which case the largest minority segment was Asian/Pacific Islander, and Hispanic was second). Apart from the entity where Asian/Pacific Islander workers were the largest minority worker segment, Asian/Pacific Islanders were the second largest minority group represented for all but one of reporting entities (in which case the second largest group was Alaska Native/Native American).

Regional Summary

For reasons discussed earlier, environmental justice is not a regional or community level issue for North Pacific groundfish management initiatives for the Washington inland waters region or the greater Seattle area. Although quantitative data are not available to confirm this, based on interview data it does not appear to be an issue for the regionally based catcher vessel fleet either. As there are no Alaska groundfish shore-based processing entities in this region, the types of environmental justice issues associated with these workforces seen in some of the Alaska regions are not present in this region. Industry-provided data for the catcher processor sector, however, show that environmental justice is a potential issue among that sector's workforce. While the population of the greater Seattle area was 23 percent minority in 2000, this workforce was 63 percent minority for that same year. If substantial job losses in this sector were to occur under various management alternatives, they would disproportionately accrue to minority populations. As noted elsewhere (NPFMC 2002d), while most of the hiring for catcher processor entities is done out of the greater Seattle area, there are targeted hiring efforts directed at Alaska residents in general and Alaska Native residents in particular. In addition to CDQ-related employment issues associated with this sector and discussed separately, loss of other Alaska Native held jobs in the catcher processor sector is also a potential environmental justice issue, but not for the Washington inland waters region.

Oregon Coast Region

There is no indication from available information that environmental justice will be an issue in the Oregon coast region. No BSAI groundfish processing plants operate in this region, nor are any owned by residents of this region, so populations associated with this sector are not a concern. As detailed elsewhere (Section 3.9.3), this region is engaged in the Alaska groundfish fishery primarily through the catcher vessel sector. While demographic data on catcher vessel owners and crews are not available, discussions with industry sources and familiarity with the fishery would seem to indicate that this group is not disproportionately comprised of individuals from minority populations.

3.9.6.4 Other Alaska Native Specific Environmental Justice Issues: Community Development Quota Regions, Subsistence, and Community Outreach

Two main socioeconomic issue areas discussed elsewhere in this document are central to environmental justice considerations. For reasons noted below, impacts to the CDQ program and its associated communities as well as impacts to subsistence (and the relevant associated communities) are likely to raise environmental justice concerns. In addition to these two issue areas that potentially involve specific impacts to minority populations and low-income populations, addressing environmental justice concerns also involves a proactive dissemination of information to minority populations and low-income populations that may otherwise be under-represented in the public involvement process. To address this type of concern, a concerted effort was made to contact a large number of Alaska Native entities, as summarized below.

The CDQ region of western Alaska is a specific area of concern for environmental justice issues with respect to the potential fishery management alternatives covered by this Programmatic SEIS. The CDQ program was explicitly designed to foster fishery participation among, and to direct fishery benefits toward, minority populations (87 percent of total population in these villages is comprised of Alaska Native residents) and low-income populations in the economically underdeveloped communities in western Alaska. To the extent that the CDQ program has achieved these objectives, negative impacts to the CDQ program and communities are essentially, by definition, environmental justice impacts. CDQ region existing conditions are discussed in Section 3.9.4 and in greater detail elsewhere (NPFMC 2002d).

Subsistence impacts are also potential environmental justice issues, given the disproportionate involvement of Alaska Natives in subsistence activities. Relevant existing conditions information for subsistence is summarized in Section 3.9.5. As noted in that section, there is the potential for subsistence activities to experience impacts associated with various management alternatives in the areas of groundfish subsistence (through direct competition for the resource), subsistence use of Steller sea lions (through indirect impacts to Steller sea lion populations), joint production subsistence opportunities (through curtailment of the ability to effectively utilize commercial vessels or gear for subsistence purposes), and some subsistence salmon fisheries (through at-sea bycatch interception of chinook and chum salmon).

The geographic area of potential impact to subsistence (and therefore the communities potentially involved) varies by type of subsistence activity. Joint production impacts are, by definition, limited to areas that are directly engaged in the commercial fishery. On the other hand, vast tracts of the Interior of Alaska with dozens of villages are engaged in the relevant subsistence salmon fisheries. In addition to impacts to subsistence potentially qualifying as an environmental justice issues as a result of disproportional Alaska Native (minority population) involvement, impacts to subsistence are also likely to be environmental justice impacts. For a number of the relevant communities, subsistence is an important aspect of community economic life where commercial economic opportunities are limited and incomes are relatively low (i.e., low-income populations are involved in subsistence in some areas). Not only would an impact to subsistence potentially be a disproportionate impact to a low-income population, the impact would make a low-income population even worse off in economic terms than under existing conditions. Information on existing conditions in the areas and communities involved in the relevant subsistence activities may be found in Section 3.9.5.

The Executive Order on environmental justice (EO 12898) specifies that it shall apply equally to Native American programs and calls for consultation with Federally-recognized Indian Tribes. In terms of specific outreach to include Alaska Native entities and populations in this Programmatic SEIS process, contacts appropriate for government-to-government consultations (pursuant specifically to EO 13175) were made, and Alaska Native groups were contacted individually over and above the regular scoping process notifications. This was to ensure the opportunity for these entities to provide input and receive information consistent with the notification and disclosure intent of environmental justice concerns. Specific notification of Alaska Native communities and entities was conducted utilizing a contact list developed during the original North Pacific groundfish Programmatic SEIS effort. During that effort, NOAA Fisheries obtained from the Bureau of Indian Affairs a list of all entities that are formally recognized by the federal government as tribal governments in Alaska. A subset of this state-wide list was created by employing (and extending) the CDQ eligibility criteria, including use of a 50-nautical-mile buffer from the coast. Additional entities were added to the list by using this methodology not only in the BSAIs area (like the CDQ program itself), but also by applying it to the entire Alaskan GOA coast as well. All of the approximately 250 entities on the Bureau of Indian Affairs list that fell within this 50-nautical-mile wide coastal swath were placed on the contact list. These entities were contacted regarding the Programmatic SEIS process and public involvement opportunities, and encouraged to begin correspondence with NOAA Fisheries. This targeted process encompasses an area and set of Alaska Native entities and communities in the coastal region larger than those directly involved in the fishery, the CDQ region, or the subsistence activities of concern noted above (with the possible exception of some Interior subsistence salmon communities).

3.9.7 Market Channels and Benefits to U.S. Consumers

3.9.7.1 Groundfish Products and Market Channels

This section first provides a summary of the primary products derived from the Alaska groundfish fisheries and a brief overview of secondary processing and product distribution activities. Next, the difficulties of tracking the movement of groundfish products to their final point of sale are examined. Lastly, available data are used to summarize the product flows and markets for pollock, Pacific cod, sole, and rockfish.

Primary Products

Groundfish harvested in the Alaska fisheries are processed at a variety of inshore facilities and on motherships and catcher processors (Section 3.9.2). The groundfish are made into a wide range of primary products. In this analysis, primary product is defined as the product form after the initial stage of processing.[36] By this definition, all products produced directly from raw fish are considered primary products. These products may be table-ready or final product, but more often they are reprocessed before they are sent to retail markets or foodservice establishments. Secondary processing is defined as any processing that occurs after the primary products have been transferred to a different facility. Secondary processing includes the production of kamaboko from surimi and the production of breaded fish sticks from fillets.

Table 3.9-122 shows the various primary products by weight made from Alaska groundfish during the 1992-2001 period. Table 3.9-123 shows the various primary products by wholesale value for the same period. Atka mackerel (a member of the A-R-S-O species group) is primarily produced as a headed and gutted or whole product. Most flatfish by volume are also headed and gutted, often with the roe left intact. A large percentage of flatfish are frozen whole, while a small percentage, primarily yellowfin sole, are made into kirimi, a steak-like product. Almost all sablefish are produced into head-and-gut product. Most of the product made from Pacific cod is headed and gutted, but a significant proportion is also made into fillets. Comparing products by weight can be misleading. Fillets are typically skinless and boneless product. A 5-pound Pacific cod might yield 1.25 pounds of fillets. The price per pound for fillets is higher than for head-and-gut product, primarily because fillets require less secondary processing. Surimi constitutes the largest portion of pollock

[36] This definition of primary processing differs from definitions used by processors when they report production to NOAA Fisheries in Weekly Processor Reports. In weekly reports processors differentiate primary products, such as fillets or surimi, from ancillary products, such as roe and fish meal.

product, with fillets accounting for the next largest percentage. Pollock roe, which accounts for only 4 percent of total product by weight, is extremely important to processors because of its high price in Japan. Substantial amounts of meal and oil are also produced from pollock, although these are generally ancillary products made from bones, skin, and trimmings.

Overview of Secondary Processing Activities

During the period covered in this analysis (1992-2001), there were no major secondary processors operating in Alaska. Almost all product was shipped out of Alaska in primary form. Recently, Alaska Seafood International Company began operations in a seafood processing facility constructed in Anchorage in 2000 and is preparing table-ready products from a variety of Alaska fish, including some groundfish. The Alaska Industrial Development and Export Authority, a state agency, has invested $50 million in the processing plant and owns the title to the company's buildings and land. To date, the enterprise has sent shipments of processed salmon, halibut and Pacific cod to markets in England and the Lower 48.

Groundfish harvested in Alaska is most often exported as primary product, although some leaves in a raw form, such as whole frozen fish. While most of the groundfish products are exported to Asia and Europe, some are shipped to the Lower 48. How much remain in the U.S. and how much are shipped abroad varies from year to year. Products shipped to the Lower 48 may either be reprocessed (primarily in the Washington inland waters region) or re-sorted and exported as a primary product. Companies such as Icicle and Trident have primary production capacity in Alaska and secondary processing plants in the Puget Sound area. In these cases it would be possible to track how much Alaska product is used in secondary processing facilities and the related number of workers. However, numerous other food manufacturers take primary groundfish product from Alaska to make a variety of table-ready foods and other products. For example, Gorton's has secondary processing facilities that reprocess groundfish products from Alaska and other areas. Data on the number of workers in all such facilities and the percentage of primary product at these facilities that originates in Alaska are not available.

Transportation Facilities

Groundfish are transported from Alaska to domestic ports (primarily in the Washington inland waters region) by a number of different carriers, depending on where the fish is processed. For example, the primary carriers operating in western Alaska include CSX Lines, Coastal Transport, Samson Tug and Barge, and Northland Services. The primary carriers in central Alaska include Totem Ocean Trailer Express as well as those operating in western Alaska.

Groundfish transported from Alaska to foreign ports typically are carried by foreign tramper vessels. Product carried from the Pacific Northwest to foreign ports can be carried by foreign trampers or steamships. In the past, some product transported from the U.S. to foreign ports was carried by American-owned and American-flagged companies, such as American President Lines and Sea Land. However, Sea Land is no longer American-owned or flagged and American President Lines is not American-owned. Such changes in ownership and flagging limit the role domestic companies play in the movement of Alaska groundfish and, therefore, limit the scope of potential impacts on U.S. shipping lines from any changes in the groundfish fisheries.

Data Limitations

Sufficient data are not readily available to analyze the volume or value of groundfish shipments from Alaska (in primary or any other form) to the Lower 48 or to foreign markets. Purchasing detailed shipping data from commercial vendors such as the Port Import Export Report Service was beyond the scope of the project. Other data limitations include aggregation levels too broad for a meaningful analysis, confidentiality constraints and different species and product groupings across data sources. For example, the U.S. Seafood Trade Report tracks annual seafood production and export volumes by fish species. How much cod was actually produced in Alaska can not be determined from a category such as "frozen cod fillets." Commercial Fisheries Entry Commission data provide insights into how much primary product, by species or product type, comes from Alaska. Unfortunately, it is not always possible to combine data from different databases because the categories often differ from one database to the next. NOAA technical memorandums are also available that focus on the production of fish products and exports of edible fishery products. These reports show the volume and value of groundfish products exported each year from the Pacific Northwest. For some species, such as Alaska pollock, it is clear where the product originated, and time-series data are available to chart changes in production and export patterns over time. However, for other species the origin is uncertain.

Market forces and variation in product forms also make it difficult to track the flow of groundfish products to a particular destination. The final destination of a primary or secondary product depends on the quality of the product, food prices and many other factors. Decisions about what to produce and where to ship it are made by fish buyers and brokers and may not be made until a fishing vessel reports the type of species being harvested, as well as the size, quality and other information.

Product Flows and Markets for Selected Groundfish Products

Notwithstanding the data problems described above, it is possible to summarize product flows for major groundfish products. The following sections present case studies of product flows for pollock, Pacific cod, sole and rockfish harvested in the Alaska groundfish fisheries. Using the official data available and anecdotal information, these case studies are intended to provide a general sense of the types of products made from Alaska groundfish and the movement of those products to their final point of sale.

Pollock

The following sections summarize the major markets for pollock and the principal primary and secondary processors, market developments and transportation issues related to pollock.

Major Markets. Roughly two-thirds of the pollock caught in the Alaska groundfish fisheries is made into surimi, a fish paste product that can be used to make kamaboko (a traditional Japanese food) and numerous other products. In the United States surimi is used to make imitation seafood products such as artificial crabmeat. Most of the surimi is produced for Asian markets, with Japan being the single largest market. The United States is by far the leading country providing pollock surimi to the Japanese market (NMFS 2001b). Pollock roe is harvested as an ancillary product during the winter spawning season. The roe is frozen or salted and commands premium prices in Japan. After the roe is stripped from the pollock the fish is further processed into surimi or fillets (NMFS 2001b).

The primary market for pollock fillets is the domestic market. Around 15 percent of the total pollock harvest is made into deep skin blocks (fillets with the skin and fat removed), primarily for U.S. fast food restaurants, including McDonald's, Long John Silver's and Burger King. Most processing for this market occurs at the primary processing level. Approximately 3 to 5 percent of the total pollock harvest results in individually quick frozen blocks for the U.S. foodservice industry. This product serves as a substitute for other whitefish fillets. Most of the remainder of the harvest is typically made into traditional blocks that can be used in the European market. All other pollock products, including minced fish, fish headed and gutted, whole fish and oil, account for just 7 percent of the primary product value. Pollock is a fragile fish that deteriorates rather quickly after harvest, so very little is sold fresh (NMFS 2001b).

The volume of production of surimi, roe and fillets has fluctuated from year to year, reflecting differences in total harvest volume, the mix of products produced by processors, and product utilization rates. Figure 3.9-18 shows the destination of exports of surimi made from pollock in 1995 and 2001. Most of these exports are to Japan, although there is a small but growing amount exported to South Korea. The balance of exports reach select ethnic markets in primarily European countries (NMFS 2001b). Figure 3.9-19 shows that the destination of exported pollock fillets changed considerably between 1995 and 2001.

Principal Primary and Secondary Processors. The most significant primary processors are the inshore plants, motherships, and catcher processors described in the earlier sector analyses (Section 3.9.2). The secondary processors are more difficult to describe. Several companies with ownership positions in primary processing facilities also have secondary processing facilities. At the same time, many other companies with secondary processing facilities have no direct connection with the primary processing facilities.

The only U.S. secondary processing facilities producing surimi products are in Washington State. One facility is owned by Icicle and the other by Trident. Both facilities make surimi products for export and for use by U.S. food manufacturers. The Icicle facility (which produces kamaboko from surimi) is located in Bellingham and has 115 full-time employees. Icicle purchased the *Northern Victor*, a FLP, and expects all surimi used in the Bellingham plant in the future to be made from Alaska pollock (in the past, some surimi produced at the facility was made from locally-harvested hake/whiting).

Market Developments. As noted above, surimi from Alaska is sold primarily to markets in Japan. Surimi made from pollock is considered to be superior to most, if not all, other surimi; there are no close substitutes (NMFS 2001b). Some surimi exported to Japan is made from Pacific whiting harvested off the coast of Oregon and Washington. It is generally acknowledged that the surimi made from Pacific whiting is of lower quality and serves a different niche market (NMFS 2001b). Consequently, pollock surimi exports to Japan are price inelastic – the demand for this surimi does not soften much in response to a modest price increase. The effects of price for intermediate products such as surimi may also be cushioned by supply contracts and vertical integration among surimi processors, wholesalers, and retailers in Japan (NMFS 2001b).

The demand for traditional surimi products, such as kamaboko, may be declining in Japan. One possible reason is that much of the demand comes from older Japanese. The younger generation in Japan and many other Asian countries appears to prefer western foods. On the other hand, surimi can be used in the production of a variety of foods. The net effect of a decline in demand for kamaboko may not necessarily be a decline in overall demand or production of surimi. Instead, the effect could be a shift in how surimi is used and where it is shipped. A fish buyer interviewed for this analysis stated that food manufacturers in the U.S. may find new uses for surimi because it is a good binder in processed foods and retains water.

As recent as the late 1980s, domestic quick service and seafood restaurant chains mainly used Atlantic cod (NMFS 2001b). When Atlantic cod harvests in Canada and the United States declined significantly in the early 1990s, chains such as McDonald's and Long John Silver's moved to the more consistently available Alaska pollock as their primary source of fillets. However, the United States does not supply all the fillets demanded by domestic consumers (NMFS 2001b). The balance is made up from imports of Alaska pollock blocks. China is the biggest supplier of U.S. imports of pollock, followed by Russia. Most of the imports from China are of Alaska pollock harvested in Russian waters by both Russian and foreign fleets. Wholesale prices for U.S. produced single-frozen fillets and fillet blocks peaked in 1999 and have since fallen dramatically. In contrast, prices of imported double-frozen fillets and fillet blocks have been much lower and more stable. Since 1999, prices of U.S. products have fallen to close to the levels of imported products. Contributing to the sharp decline in prices for U.S. product has been a dramatic increase in U.S. imports of pollock, which are primarily frozen fillets and frozen fillet blocks.

Transportation. Primary products from pollock that are produced at sea are offloaded to trampers, which take the products directly to secondary processors in Asia, the Lower 48 (Puget Sound area) or Europe. Primary products produced in shoreside facilities typically are shipped by one of the primary marine carriers to Japan or Puget Sound. Marine shippers have charged the same price to ship products from Dutch Harbor to Japan, whether routed through Seattle or not. The price has been the same for the different routes because of the lower cost of cold storage in the Bellingham and Seattle areas. This fact underscores the significance of factors such as size of inventories and cost of storage in determining product flows from Alaska.

Pacific Cod

The following sections summarize the major markets for Pacific cod and the principal primary and secondary processors and market developments related to Pacific cod.

Major Markets. Pacific cod harvested in the Alaska groundfish fisheries enters an international market, but much of it remains in the United States for use in the foodservice industry. Pacific cod fillets are destined primarily for the domestic market. Foreign consumers, especially China, Japan, and Europe, purchase headed and gutted cod for further processing, including the production of salt cod. Salt cod is very popular in Europe, parts of Africa, and Latin America. Although most of the Pacific cod that becomes salt cod is processed outside the U.S., some U.S. processors are once again producing the product domestically for export, as they have at times in the past.

The production levels, mix of primary products, and amount of product exported from Alaska change from year to year for Pacific cod products. Products from other groundfish species show a similar range of variability in product type and distribution paths. Moreover, the final destination of a given product can change dramatically, making it almost impossible to predict the future market for a given product.

Principal Primary and Secondary Processors. No rules of thumb exist for how much Pacific cod is processed in particular facilities because the amount depends on how much cod was harvested by different gear types. In general, freezer longline vessels produce the highest quality product, which goes to salt cod markets. There is a new secondary processing plant in Seattle for salt cod, and additional product is stored in the Seattle area and shipped east. The majority of this product, however, is destined for overseas markets by way of Korea. Pacific cod processed as head-and-gut product or whole fish is exported to Korea, where it is containerized for shipment to Norway and other countries. This product may or may not be reprocessed in Korea. Some of the product that moves through Korea returns to markets in the United States (especially through Boston), but most goes to the major cod markets in Norway, Spain and Portugal for secondary processing or final consumption. Most product sold in Europe and the United States is boneless. Bone-in product (pin bones in) is sold in European markets on an "order only" basis.

Market Developments. Product flows for Pacific cod have changed dramatically in recent years, following the decline of Atlantic cod harvests in the Barents Sea. For example, buyers from Norway and Portugal are now purchasing Pacific cod from Alaska for the first time. Historically, Pacific cod has been considered an inferior product compared to Atlantic cod, but the lack of Atlantic cod has made Pacific cod more acceptable. As a result, prices for head-and-gut cod products from Alaska have doubled in the last three years, and the demand for these products is also increasing in Japan.

With recent declines in the Alaska crab fishery, other gear types harvesting Alaska cod have included pot vessels. Cod harvested by these fishermen typically is brought to shoreplants, where it is made into fillets or head-and-gut product. Pot vessels have a reputation for harvesting high-quality cod, enabling shoreplants to make a high-value primary product.

Sole and Rockfish

The following sections summarize the major markets for sole and rockfish and the principal primary and secondary processors and market developments related to sole and rockfish. Sole and rockfish are combined in this section because fish buyers and cold storage operators interviewed for this analysis discussed sole and rockfish together.

Major Markets. Approximately 80 to 90 percent of the sole and rockfish harvested in the Alaska groundfish fisheries is shipped to Asia. A portion of this harvest goes from Asia to Europe, and a very small amount is sometimes shipped directly from Alaska to Europe.

Principal Primary and Secondary Processors. Sole and rockfish processed offshore typically are shipped to Asia in headed and gutted or round form. Shore plants produce fillets as well as other products, with some products going to Asia and others remaining in the United States.

The relatively small fillets of sole and rockfish have a high labor cost per pound. This high labor cost makes it more attractive to ship the fish to China, where labor costs tend to be relatively low for secondary processing. Readily available data for sole and rockfish do not indicate the product type or amount exported from Alaska.

Market Developments. A wide range of species of sole and rockfish is harvested in Alaska, some of which are unnamed in the United States. This variety and the lack of name recognition is an issue with U.S. consumers who tend to prefer known products and reinforces the tradition of shipping sole and rockfish products to Asia. Consumers in Asia tend to be less name-sensitive with fish species.

Rockfish from Iceland and Norway has historically been considered superior to most Alaska rockfish. Only select species of rockfish found in Alaska are considered high-quality and easily marketed in countries such as Japan. Very little of the product goes to the Lower 48. Much of the sole and rockfish sold in U.S. East Coast markets, such as New England and Florida, comes from Indonesia. One cold storage manager in Seattle said he expects secondary processing facilities in the United States to handle Alaska sole and rockfish in the future and believes more of this product will move from Alaska to the Lower 48 rather than to Asia.

3.9.7.2 Benefits to U.S. Seafood Consumers

In the past two decades U.S. consumers have been eating more seafood—averaging around 15 pounds per person in the last four years, up from less than 12 pounds prior to1980 (NMFS 2002g). In 2002, the consumption of seafood by U.S. consumers was 4.5 billion pounds — 15.6 pounds per person. Of this, 11 pounds were fresh or frozen fish or shellfish, 4.3 pounds were canned seafood, and 0.3 pounds were cured. The National Fisheries Institute recently ranked the most popular varieties of seafood, with shrimp holding first place for the second straight year at 3.7 pounds per person. Canned tuna held second place. Next came salmon, pollock, catfish and cod. Seafood sales to the domestic foodservice sector have risen every year since 1995 (H.M. Johnson & Associates 2001). Seafood now represents 20 percent of menu entrees at the nation's top 200 restaurant chains (Seafood.com 2001). Much of the increase in the demand for seafood stems from its perceived healthful properties. In recent years, seafood has been credited with having ingredients that reduce heart disease, arthritis and depression and enhance sexual performance (Seafood.com 2001). A major impetus in seafood consumption recently occurred when the American Heart Association recommended that people eat fish twice a week for its health benefits.

Products obtained from the Alaska groundfish fisheries have undoubtedly played a major role in meeting this domestic demand for seafood. However, the data limitations outlined in Section 3.9.6.2 make it difficult to estimate the final domestic market value of Alaska groundfish products. For example, NMFS (2001b) reported that Alaska pollock ranked fourth overall at 1.57 pounds, after tuna, shrimp, and salmon, in per capita consumption in 1999, but it is not possible to accurately determine how much of the pollock that U.S. consumers purchased was produced in the Alaska groundfish fisheries. Still less information is available on the value of Alaska groundfish products as measured by the level of consumer surplus (i.e., the difference between the amount consumers are willing to pay for a good or service and the amount they actually pay) accruing to the American public from the consumption of those products.

Nevertheless, it is known that the market for Alaska pollock fillets and Pacific cod fillets is mostly a domestic market, and the demand within the United States far exceeds the available supply (NMFS 2001b). The Alaska pollock harvest supplies most of the frozen whitefish, fish sticks, fish patties and imitation crab meat (surimi) purchased at stores and restaurants around the United States (Alaska Seafood Marketing Institute undated[a]). The delicate texture, white color and mild flavor of the pollock's flesh have proven ideal for every segment of the foodservice market from fast food to white tablecloth restaurants. What's more, its stable supply enables restaurants to maintain consistent menu pricing throughout the year. Pacific cod is also a popular item in the foodservice sector because of its versatility, abundance and year-round availability (Alaska Seafood Marketing Institute undated[b]). Most of the product is used in finer and casual restaurants, institutions and retail fish markets.

Despite the high demand for certain groundfish products among U.S. consumers, numerous past studies have indicated that the price elasticity of demand for those products, especially fillets, is fairly high (NMFS 2001b). In other words, market price is not appreciably affected by the quantity supplied. This is because the domestic fillet market is competitive in terms of product form (individually quick frozen, block, and twice-frozen), supplying country (Russia and China play major roles), and fillets from other species, including hake and hoki. The U.S. market for all fillets, particularly cod, has also been influenced by the increased production of aquaculture-grown whitefish (NMFS 2001b). The species of greatest significance is catfish, but in recent years there have been increases in both domestically produced and imported tilapia. The domestic production of catfish increased from 208,000 mt in 1993 to 271,000 mt in 2001,virtually all of it consumed domestically. Furthermore, seafood, in general, must compete with other animal protein sources in the American diet such as chicken, pork and beef. Consequently, the per unit price for pollock or Pacific cod fillets would probably rise only if there were a large decrease in the amount of pollock or Pacific cod fillets supplied to the domestic marketplace by U.S. firms.

The most likely result of a decrease in the domestic production of fillets would be a negative effect on the trade balance, as more fillets are imported to offset the reduced supply. For example, a significant share of domestic pollock fillet demand is presently satisfied by imports. U.S. imports of Alaska pollock more than doubled during the 1990s (NMFS 2001b). China, in particular, has emerged as a major supplier of Alaska pollock fillets. Imports of frozen fillets and blocks from China were less than 5,000 mt in 1991 but increased to about 68,000 mt by 2000. The role of China in supplying Alaska pollock fillets to the U.S. market could continue to expand. The "twice-frozen" fillets and blocks from China are generally lower in quality than "single-frozen" U.S. product, but are often substituted for the latter because of their competitive price (NMFS 2001b). If retail market supplies are not expected to change due to ready availability of imports, a given regulatory action may have little or no impact on American consumers. Also, the dollar amount of the consumer surplus associated with the domestic consumption of Alaska groundfish likely represents a small fraction of the total net benefits that U.S. consumers receive from all goods and services they purchase or even from all seafood products they consume.

Seafood products obtained from the Alaska groundfish fisheries are also distributed to U.S. consumers outside of established market channels. Amendment 28 to the Fishery Management Plan for Bering Sea and Aleutian Islands groundfish and Amendment 29 to the Fishery Management Plan for GOA groundfish authorize a voluntary donation program for fish taken as bycatch in the groundfish trawl fisheries off Alaska. The seafood is distributed to economically disadvantaged individuals by tax-exempt organizations through a NOAA Fisheries-authorized distributor. Currently, the authorized distributor is Northwest Food Strategies, a 501(c)) 3 non-profit organization. Northwest Food Strategies accesses seafood products for distribution to the America's Second Harvest network of 200 food banks and food-rescue organizations (Northwest Food Strategies undated). Since it's inception in 1994, Northwest Food Strategies has grown into the leading supplier of seafood to hunger-relief organizations in the country. The fish voluntarily donated by the groundfish fishing industry to Northwest Food Strategies are salmon and halibut that are part of the groundfish fishery prohibited species catch. The salmon and halibut retained and donated under the NOAA Fisheries Prohibited Species Donation Program represent a small, but significant portion of the seafood distributed by Northwest Food Strategies. It is estimated that catcher processor companies donate one million seafood meals annually to provide hunger relief. A summary of past/present effects of actions and events on market channels and benefits to consumers is presented in Table 3.9-126.

3.9.8 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (Including Non-Consumptive and Non-Use Benefits)

Examples include the seafood produced in commercial fisheries. In addition, some non-consumptive activities such as those associated with eco-tourism may also produce goods and services with observable prices (e.g., wildlife tours). A marine ecosystem and individual species associated with that ecosystem may provide a range of benefits to humans (NRC 2001). These benefits span a spectrum from direct on-site user benefits to benefits accruing to individuals who do not use the marine ecosystem but who derive value from knowing it is being protected. Direct, on-site uses of the marine environment are typically associated with consumptive activities (commercial and sport fisheries, resource extraction from the sea bed, etc.); however, non-consumptive activities such as tourism, diving, bird and whale watching, and appreciating the general aesthetics of wild areas are also valuable to humans. The benefits of consumptive activities that produce goods and services exchanged in markets are comparatively easy to evaluate, as the goods and services generated have observable prices. Examples include the seafood produced in commercial fisheries. In addition, some non-consumptive activities such as those associated with eco-tourism may also produce goods and services with observable prices (e.g., wildlife tours).

However, marine ecosystems may also provide goods and services that are not exchanged through markets and do not receive market prices (NMFS 2000c). These are referred to by economists as non-market goods and services. Examples include recreational fishing experiences and opportunities for subsistence activities. The values accredited to non-market goods and services, like the values assigned to market goods and services, are variable across a population and may change over time for a given individual. Including non-market goods and services in economic analyses of fishery management decisions is particularly important when considering habitat, ecosystem and many marine mammal issues (NMFS 2000c).

This discussion of the range of possible potential benefits provided by the GOA and Bering Sea marine ecosystems and associated species consists of five subsections. The first subsection outlines the array of economic values that individuals may attribute to environmental assets and amenities. The next three subsections examine the various value categories as they relate to the Bering Sea and GOA ecosystems as a whole and to two components of these ecosystems: groundfish and the Steller sea lion. The fifth section discusses values that lie outside the categories of values subject to economic investigation but that may be relevant to decision-making. These values are presented by their proponents as moral imperatives and, thus, do not lend themselves to analyses of economic tradeoffs. This discussion of the range of possible potential benefits provided by the GOA and Bering Sea marine ecosystems and associated species consists of five subsections.

Giving special consideration to the benefits derived from the Bering Sea and GOA marine ecosystems is consistent with the directive of NEPA to consider the significance of potential effects in terms of their intensity or severity of impact (15 CFR 1508.27). Among the factors listed by NEPA that should be considered in evaluating intensity are the unique characteristics of the geographic area such as proximity to ecologically critical areas (15 CFR 1508.27(b)(3)). The Bering Sea and GOA marine ecosystems are among the most productive in the world, and any modification of these ecosystems may have a dramatic effect on the quality of the human environment. Giving special consideration to the benefits derived from the Bering Sea and GOA marine ecosystems is consistent with the directive of NEPA to consider the significance of potential effects in terms of their intensity or severity of impact (15 CFR 1508.27). Among the factors listed by NEPA that should be considered in evaluating intensity are the unique characteristics of the geographic area such as proximity to ecologically critical areas (15 CFR 1508.27(b)(3)). Alaska's healthy ecosystems are scarce and valuable natural assets (Colt 2001). As human population, economic development and other pressures increase worldwide, the relative scarcity– and hence the value– of these ecosystems is almost certain to increase significantly. The Bering Sea and GOA marine ecosystems are among Alaska's most important ecosystems. They may be most productive marine areas in the world, and any modification of these ecosystems may have a dramatic effect on the quality of the human environment.

Devoting particular attention to the endangered Steller sea lion is also consistent with the directive of NEPA to consider the intensity of potential effects. A second factor that NEPA states should be considered in evaluating intensity is the degree to which an action may adversely affect an endangered or threatened species or its habitat (15 CFR 1508.27(b)(9)). In 2001, NOAA Fisheries prepared a SEIS on Steller sea lion protection measures, together with a biological opinion. The biological opinion concluded that the effects of the BSAI and GOA groundfish fisheries, as modified by the proposed action implemented by the preferred alternative of the SEIS would not likely jeopardize the continued existence of the western population of Steller sea lions and would not likely adversely modify its critical habitat. However, the continuing controversy about potential impacts of the groundfish fisheries on the Steller sea lion and the availability of additional information on the economic value of the Steller sea lion since the SEIS and biological opinion were completed suggest that further analysis of the possible benefits attributed to this particular endangered species is warranted. Furthermore, it is likely that the perceived benefits of preserving the Steller sea lion also apply to other endangered and non-endangered species associated with the Bering Sea and GOA ecosystems (e.g., various species of whales, dolphins, and seabirds).

3.9.8.1 Categories of Economic Values

Resource economists have developed a taxonomy of wildlife and ecosystem preservation values, although they have divergent opinions of the definitions of some benefits. Moreover, categories of benefits within a given list may overlap. Typically, economists divide the total value an environmental asset may generate into use values and non-use values. Use values involve either in situ contact with the environmental asset in question or personal consumption of products or services derived from the asset (Bishop 1987). Use values include consumptive use values, non-consumptive use values, indirect use values, and scientific values (Table 3.9-124). A summary of past/present effects of actions and events on non-consumptive use values is presented in Table 3.9-126.

Consumptive direct use values can be subdivided into commercial value if the purpose of the extractive activity is to sell products to others; recreational value if the purpose is recreational enjoyment; and subsistence value if the purpose is to provide one's family, or others, with food and no remuneration is involved. Extractive activities that are engaged in for their recreational or subsistence value typically are non-market in nature, but exceptions include certain recreational activities such as charter fishing. The non-consumptive direct use benefits derived from observing wildlife may be non-market in nature or may be purchased from commercial ventures such as those associated with eco-tourism. Consumptive direct use values can be subdivided into commercial value if the purpose of the extractive activity is to sell products to others; recreational value if the purpose is recreational enjoyment; and subsistence value if the purpose is to provide one's family, or others, with food and no remuneration is involved. Extractive activities that are engaged in for their recreational or subsistence value typically are not produced and traded in the private enterprise market economy, but exceptions include certain recreational activities such as charter fishing. Similarly, the non-consumptive direct use benefits derived from observing wildlife may or may not be traded in markets, an example of the former being the benefits associated with eco-tourism.

In contrast to use values, non-use values are always non-market in nature. Non-use values, also referred to as passive-use values, may include bequest or existence values (Table 3.9-124). These values do not involve personal consumption of derived products nor in situ contact. They are generated from people's inter-generational altruistic concerns or from the utility people receive from knowing that a particular asset exists or is being preserved (Bishop 1987). Existence value may be highly sensitive to the amount of information acquired, i.e., small changes in information or knowledge about a species may produce large shifts in existence value for that species (Stevens *et al.* 1991). It follows, therefore, that improvements in communication technology may lead to significant increases in existence value. For example, the arrival of the Internet has greatly enhanced the ability of the general public to access, at low cost, information about endangered species and other environmental assets.

Resource economists have taken the decomposition of the basic components of value in a species or ecosystem a step further by incorporating uncertainty into an individual's choice. For example, individuals may be willing to pay a premium for retaining an option for future use of a good or service, although they may not currently use it. This so-called option value exists under conditions of uncertainty about the future demand of an environmental asset. An extension of option value known as quasi-option value represents the value derived from postponing a decision about preserving a species or ecosystem in order to gain more knowledge in the future. The MSA acknowledges the uncertainty inherent in fisheries by stating that the term "conservation and management" refers, in part, to measures designed to assure that "...irreversible or long-term adverse effects on fishery resources and the marine environment are avoided; and there will be a multiplicity of options available with respect to future uses of these resources...." (Section 3(5)).

While it is important to recognize that the opportunity costs of management decisions that result in irreversible species or ecosystem losses may be particularly high, it is also important to note that some individuals may hold a positive value for avoiding losses of part of a species' population even if recovery is fairly rapid (Bishop and Welsh 1992) – witness the opposition by some members of the public to the recent gray whale hunt by the Micah people of the Pacific Northwest, despite the fact that NOAA Fisheries deemed the gray whale (*Eschrichtius robustus*) stock to be in good condition and capable of withstanding a restricted harvest. It is likely that for some opponents to the whale hunt the harvest of even a single whale is one too many because of the value of the special qualities they ascribe to a living whale or because of the sympathy or empathy they hold for animals in general.

3.9.8.2 Possible Economic Values Assigned to the Bering Sea and Gulf of Alaska Ecosystems

In this section, possible economic values ascribed to the Bering Sea and GOA ecosystems as a whole are discussed. To date, there has been no attempt to measure all of these values. A management decision that preserves sufficient area of habitat to conserve the ecosystem of which the endangered Steller sea lion is a part would tend to increase the probability of the species' survival. Consequently, an implicit value of protecting the Bering Sea and GOA ecosystems may be the value that people assign to preservation of the Steller sea lion (Section 3.9.8.4). Of course, preserving habitat would also help safeguard populations of other types of animals, and one would expect this habitat protection to be worth more than just the benefits provided to a single endangered species. Similarly, the value of the Bering Sea and GOA ecosystems is much greater than the value of groundfish fisheries (Section 3.9.8.3).

Due to the interconnectedness of the various elements of an ecosystem and the variety and complexity of ecological outputs, the tools of economic analysis may be of only limited usefulness. Marine ecosystems world-wide provide important services to humans, such as food production, climate regulation and nutrient storage and cycling. These ecosystem benefits may not be independent from one another. Further, the specific functions of the physical, chemical and biological processes occurring in a given ecosystem, and the beneficial outcomes for people that result from these functions, are often poorly understood. These problems, in addition to the lack of market prices, raise formidable challenges to the estimation of benefits.

Nevertheless, it is still possible to broadly characterize in qualitative terms possible benefits of the Bering Sea and GOA ecosystems.

Consumptive Direct Use Value

The Bering Sea is the most productive marine ecosystem off the United States and one of the most productive in the world (NMFS 1998e). The northern GOA is also one of the world's most productive ecosystems (EVOS undated). As would be expected in such productive ecosystems, the consumptive direct uses are highly valued. These uses include harvesting various marine and anadromous species for commercial, recreational and subsistence purposes.

The Bering Sea and GOA ecosystems encompass the harvesting areas, spawning grounds, recruitment areas and/or migration paths of nearly all of the fish, marine mammal and invertebrate species of consumptive value in Alaska. In 1995, seafood as a commodity statewide contributed $1.4 billion to the Gross State Product (4 percent of the total Gross State Product) and generated 7 percent of total employment statewide. The Alaska Sport Fish Harvest Survey shows that more than 432,000 anglers fished about 2.6 million angler-days and harvested almost 3.3 million fish in 2000 (Walker *et al.* 2001). Subsistence fishing and hunting continue to figure prominently in the household economies and social welfare of some Alaskan residents, particularly among those living in small, rural villages (Wolfe and Walker 1987). Of the estimated 43.7 million pounds of wild foods harvested in rural Alaska communities annually, subsistence fisheries contribute about 62 percent – 60 percent from finfish and 2 percent from shellfish. On average, this subsistence fisheries harvest provides about 230 pounds of food per person per year in rural Alaska (Wolfe 2000). Further, subsistence remains the basis for Alaska Native culture and community. In rural Alaska, subsistence activities are often central to many aspects of human existence, from patterns of family life to artistic expression and community religious and celebratory activities. Additional information on subsistence activities in Alaska is provided in Section 3.9.5.The Bering Sea and GOA ecosystems encompass the harvesting areas, spawning grounds, recruitment areas and/or migration paths of nearly all of the fish, marine mammal and invertebrate species of consumptive value in Alaska. In 1995, seafood as a commodity statewide contributed $1.4 billion to the Gross State Product (four percent of the total GSP) and generated seven percent of total employment statewide. Colt (2001) estimates that commercial fishing and fish processing in Alaska has annually generated more than 33,000 full time equivalent jobs and $1 billion in labor income in recent years. The fishing industry is particularly important to rural Alaska. More than 50 percent of limited entry permit holders reside in rural areas of the state (Colt 2001). For many small coastal and river communities, commercial fishing is a major source of income, both to individuals and to local governments.

The Alaska Sport Fish Harvest Survey shows that more than 432,000 anglers fished about 2.6 million angler-days and harvested almost 3.3 million fish in 2000 (Walker *et al.* 2001). In 1993, 70 percent of all Alaska households contained at least one person who had been sport fishing within the past three years (Colt 2001). In that year, residents and nonresidents spent $600 million (in 1998 dollars) in Alaska on goods and services attributable to sport fishing (Colt 2001). Of this total, residents spent $379 million, or 63 percent, and nonresidents spent $221 million. Subsistence fishing and hunting continue to figure prominently in the household economies and social welfare of some Alaskan residents, particularly among those living in small, rural villages (Wolfe and Walker 1987). Of the estimated 43.7 million pounds of wild foods harvested in rural Alaska communities annually, subsistence fisheries contribute about 62 percent – 60 percent from finfish and 2 percent from shellfish. On average, this subsistence fisheries harvest provides about 230 pounds of food per person per year in rural Alaska (Wolfe 2000). Further, subsistence remains the basis for Alaska

Native culture and community. In rural Alaska, subsistence activities are often central to many aspects of human existence, from patterns of family life to artistic expression and community religious and celebratory activities. Additional information on subsistence activities in Alaska is provided in Section 3.9.5.

Non-Consumptive Direct Use Value

The non-consumptive direct use benefits of healthy marine ecosystems are important to many Alaska residents. They may value these ecosystems for recreational, aesthetic, and spiritual reasons. For some individuals, they may be a key benefit to living in the state and integral to a "sense of place." One indication that some Alaskans view relatively pristine ecosystems as a quality of life benefit available in Alaska is their participation in wildlife viewing. For example, a major mail survey of Alaska voters conducted in 1991 found that 14 percent of Alaskans took at least one overnight trip with the primary purpose of viewing wildlife (McCollum and Miller 1994). Colt (2001) estimated that Alaskans took more than 107,000 "person-trips" in 1999 with the main purpose of wildlife viewing. Colt further estimated that residents participating in this activity spent a total of $82.3 million on miscellaneous equipment and an additional $63.4 million on trip-related expenditures.

Non-consumptive direct uses of the marine environment may also be important to visitors to Alaska. For example, an increasing number of tourists are arriving in Alaska aboard cruise ships. The proportion of summer visitors entering Alaska by this mode of access increased from 26 percent in 1989 to 42 percent in 2001 (Northern Economics, Inc. 2002). An integral part of the cruise ship experience is viewing the state's scenic coastal environment. According to one cruise ship line, vessel passengers can "enjoy stunning vistas of snow-capped mountains, majestic blue-ice glaciers, and an abundance of wildlife" (Carnival Cruise Lines undated).

On the other hand, it is uncertain how important a pristine marine ecosystem is to Alaska's tourism industry. To paraphrase one observer, "Do passengers on a cruise ship need know that the food web is intact [in order for Alaska's marine environment to continue to be a major tourist attraction]?" (Colt and Huntington 2002). The speed and height of cruise ships and their distance from shore limit close views of natural features and wildlife. Furthermore, cruise ships provide a range of onboard activities unrelated to a particular location. It is probable that visitor expectations and experiences differ among various groups. For example, the non-consumptive value of the Bering Sea and GOA ecosystems may be substantial only for certain tourists, such as those who purchase kayaking tours, wildlife viewing excursions and similar services that afford individuals a closer look at marine wildlife and other local fauna. At present, information about the expectations or degree of satisfaction of tourists visiting Alaska is limited.

Existence Value

A significant component of the overall benefit of Bering Sea and GOA ecosystems may be from existence (non-use) value. For example, the following excerpt from a recent publication of the World Wildlife Fund and Beringia Conservation Program suggests that the Bering Sea ecosystem may have significant existence value due to its distinctive qualities:

> "*On every scale, in all its complex dynamics, the Bering Sea is one of our planet's most spectacular ecological regions – that rare place where nature's creatures and biological processes are still providing a wealth of benefits that attract and sustain an extraordinarily*

abundant diversity of life (World Wildlife Fund and Beringia Conservation Program undated).”

The abundant waters of the Bering Sea and GOA support the richest assemblages of marine mammals and seabirds in the northern hemisphere (NPFMC 1994). The benthic invertebrate community off Alaska consists of at least 472 species of invertebrates making up the macroinfauna (Low *et al.* undated). More than 100 million birds of over 100 species depend on Alaska marine ecosystems during some part of their life cycle. At least three-fourths of these species breed in Alaska, and the rest are visitors from a wide variety of locations throughout the Pacific Ocean. In addition, the Alaska marine environment has 37 stocks of more than 25 species of marine mammals (Low *et al.* undated).

It is likely that some people derive pleasure from the contemplation of the varied life forms existing in the Bering Sea and GOA ecosystems and would be willing to pay to preserve the structure and integrity of those biological communities even if they never directly experience them. For these individuals, the knowledge that these communities exist, relatively free of human disturbance, is enough.

3.9.8.3 Possible Economic Values Assigned to Groundfish

The most evident economic value of BSAI and GOA groundfish resources are their consumptive direct use value in a commercial context. This value accrues to the different members of society who make a living harvesting, processing and distributing groundfish products and who purchase and consume these products. The economic value firms and communities derived from the commercial harvest and processing of groundfish are described is Sections 3.9.2 through 3.9.4. The value accruing to distributors and consumers of groundfish products is described in Section 3.9.7. The groundfish products produced and consumed are market goods since they are bought and sold in normal commerce and their value is revealed in market prices.

In comparison to the commercial consumptive value of groundfish, the non-commercial consumptive value of these resources is very small. While no groundfish recreational harvest data for the EEZ are compiled, it would not be unreasonable to assert that the total recreational harvest in the BSAI and GOA is trivial. This is so for several reasons.

First, for the vast majority of the geographic area adjacent to the BSAI and GOA EEZ, local human populations are quite small and relatively isolated. In these remote areas of Alaska, most of the non-commercial take of groundfish would more appropriately be regarded as subsistence harvests rather than recreational fishing. In general, groundfish harvests play a minor role in subsistence activities. Additional information on the subsistence use of groundfish is presented in Section 3.9.5.

Second, the physical environment of much of the BSAI and GOA EEZ limits recreational fishing for groundfish to near shore areas in the vicinity of population centers. All such fishing activity would be expected to occur within state waters, and thus, would be managed by the ADF&G.

Third, most of the BSAI and GOA groundfish harvest is composed of species (e.g., pollock) that generally are not regarded as sport fish.

Aside from its consumptive direct use value, groundfish may have an indirect value. For example, juvenile pollock and other groundfish may be important prey for other species that people value, such as the Steller sea lion. Moreover, groundfish may play a crucial role in the overall function and stability of the Bering Sea and GOA marine ecosystems.

3.9.8.4 Possible Economic Values Assigned to the Steller Sea Lion

Consumptive Direct Use Value

Although there are exceptions, endangered species generally have little or no consumptive direct use value because of their low numbers. Commercial hunting of the Steller sea lion, which took large numbers of the animals until as recently as the 1970s, no longer takes place. Steller sea lions were historically a primary source of food for inhabitants of the Aleutian Islands. In addition, clothing, boots, and boat coverings were made from skins. The Subsistence Division of the ADF&G has surveyed subsistence hunters about their Steller sea lion harvests since 1992. According to the ADF&G, statewide subsistence harvests of Steller sea lions have reportedly dropped, from an estimated 549 animals in 1992, to an estimated 178 animals in 1998. Almost all of these harvests are from the western population and the majority are made by Aleut hunters in the Aleutian and Pribilof Islands. Subsistence analysts at ADF&G suggest that the decline in Steller sea lion harvest is connected to (a) increased scarcity and consequent reductions in subsistence harvest success per unit of effort, and (b) conservation related concerns about the health of Steller populations among subsistence hunters (NMFS 2001b). Given the continuing decline of the western population of Steller sea lions, the consumptive value of these animals is likely to remain low. Additional information on the subsistence use of the Steller sea lion is available in Section 3.9.5.

Non-Consumptive Direct Use Value

The rookeries and haulouts of the Steller sea lion are usually located on relatively remote islands. Furthermore, buffer zones have been established near the largest breeding islands, and vessels are not permitted to go closer than three miles to these rookeries. Consequently, the opportunities for people other than scientists to observe a live Steller sea lion in the wild are somewhat limited. However, this species occurs in a number of national parks in Alaska (Kenai Fjords National Park, Glacier Bay National Park and Preserve, and Katmai National Park and Preserve), and a number of private companies offer boat tours in or around the parks that let visitors view Steller sea lions and other types of Alaska wildlife. The non-consumptive value that direct encounters with the Steller sea lion might generate are likely similar to those described by Ching (1994:36) for the Hawaiian monk seal (*Monachus schauinslandi*), another endangered pinniped:

> *"Events like those …are precious indeed as many people are experiencing the joy of watching monk seals in the wild without causing them stress. Something magical happens when people actually get to see an endangered animal in real life. It instills within them a sense of protective enthusiasm, thus strengthening conservation efforts."*

Scientific Value

The Steller sea lion may be perceived by some as having some yet unrealized biomedical value that renders it worth preserving (i.e., the species has a quasi-option value). Several current lines of research indicate that some pinnipeds may be useful in human medicine. To cite some examples, an examination of the physiological factors that render the internal organs of seals resistant to anoxia may improve human organ transplants (Kooyman 1981); studies of the Weddell seal's (*Leptonychotes weddelli*) ability to routinely recover from near total lung collapse during deep dives may prove useful in understanding sudden infant death syndrome (Kooyman 1981); and investigations of what are apparently normal sleep apneas in the northern elephant seal (*Mirounga angustirostris*) may provide insights into similar but more pathological events seen in humans (Castellini 1994). These potential benefits may suggest to some individuals that the Steller sea lion could also have some valuable biomedical use in the future.

Indirect Value

The complexity of ecosystem relationships and interconnectedness of the various elements may cause the removal or disturbance of one part of the ecosystem to affect the functioning of many other components of the ecosystem. For example, the Steller sea lion may be an important component of the food web, serving as prey for larger species. The exact role that the Steller sea lion plays in maintaining the integrity of the GOA and Bering Sea ecosystems is uncertain. Such uncertainty is not unusual; knowledge of ecosystem relationships are often incomplete, and the results of disturbance are thus to some extent unpredictable. To have indirect value the Steller sea lion does not necessarily have to be a "keystone species" on which the persistence of a large number of other species in the ecosystem depends. As Ehrlich and Ehrlich (1981) have noted, the removal of any particular species may in itself not be catastrophic, but its occurrence increases the likelihood that the next extinction could unravel the whole ecosystem.

Existence Value

Non-use values may be the most important benefit derived from some endangered species, simply because species become endangered due to their small populations, which means that many people are unlikely to have seen or had much tangible experience regarding these species. People demonstrate their existence values in the marketplace by donating funds to private organizations that support activities to preserve endangered species.

However, whether people enjoy existence values of resources is not contingent upon whether they donate money to support a cause. The fact that some individuals are willing to donate money is just the most obvious manifestation of these existence values.

The discussion by Metrick and Weitzman (1996) of possible factors that affect the magnitude of existence value can be used as a basis for speculating about the nature and relative magnitude of the existence value of the Steller sea lion. First, the authors note that people often speak of the large amount of attention paid to "charismatic megafauna." Presumably, therefore, the existence value of a species may be a function of its charisma. Metrick and Weitzman were unable to identify a satisfactory measure of charisma in the context of endangered species, but they note that eye-size or eye-body ratio have been suggested. Based on these eye-related criteria the Steller sea lion would be rated as highly charismatic. In any case, Steller sea lions are large mammals, and sea lion pups have a "cute and furry" visage – characteristics that are typical of some high-profile threatened and endangered species that people are willing to protect.

Another factor that may influence the magnitude of existence value is the degree to which a species is considered to be a higher form of life and possibly possess (anthropomorphic) capabilities for feeling, thought and pain (Metrick and Weitzman 1996, Kellert 1986). Certain characteristics of sea lions, such as the maternal care that the female provides for her pup, the playful behavior of young sea lions or the ability of the sea lions to vocalize and communicate with each other, may be perceived by some people as indicators of a higher life form. While none of these attributes proves that the Steller sea lion possesses human-like intelligence or emotions, people may identify with these characteristics and interpret them to mean that sea lions do, in fact, represent a relatively advanced form of life.

Finally, Metrick and Weitzman argue that, since we may have existence value for biodiversity as a whole, some measure of the amount that a species adds to this diversity may play a role in deciding how much people are willing to pay to preserve it. Genetic distinctiveness means the number of genes acquired since the species split off from its nearest common ancestor. For Steller sea lions, the question might be, how genetically distinct are the eastern and western stocks that occur in U.S. waters. NOAA Fisheries recognized the two distinct population segments in 1997 based on geographic distribution, differences in population dynamics and mitochondrial DNA data. Other unique characteristics of the Steller sea lion may also influence people's perceptions that these animals should be valued for their contribution to biodiversity. For example, the Steller sea lion is the largest of the sea lions, with males reaching over 1,700 pounds in weight and 10 ft in length.

An Estimate of the Economic Value of an Expanded Steller Sea Lion Recovery Program

As noted previously, market prices express the value of environmental assets in monetary terms if these assets are bought and sold. However, because other benefits of environmental assets are less readily translated into dollar values, resource economists have developed an array of valuation techniques that do not rely on market data. One such technique is the contingent valuation method (CVM). CVM employs survey techniques to ask people about the values they would place on certain environmental assets or other non-market commodities if markets did exist or if other means of payment were in effect. It is called "contingent" valuation because people are asked to state their ‘willingness to pay', contingent on a specific hypothetical scenario and description of the environmental service.

CVM allows for the estimation of the full range of species and ecosystem preservation values set forth in Table 3.9-124, and it is the only method available for estimating non-use values directly. When individuals are asked in CVM studies to evaluate an environmental asset they make a holistic judgment based on the configuration of benefits they believe will accrue to them (Mitchell and Carson 1989). In other words, the value expressed by a respondent represents the sum of all the types of use and non-use values he or she assigns to the good or service in question. Generally, researchers applying CVM do not attempt to assess each separate type of value. It is also important to note that respondents may make associations among environmental goods that the researcher had not intended. For example, a valuation of a particular species may include implicit valuation of the components of the ecosystem that support that species (Loomis and White 1996).

A recent CVM study provides an empirical point estimate of the total economic value attributable to protection (and enhancement) of the western Steller sea lion stock (Turcin and Giraud 2001; Giraud *et al.* 2002). This study constructed and administered a questionnaire survey that included a closed-ended CVM question formatted similarly to a typical public goods referendum.

Specifically, the survey described a hypothetical expanded Federal Steller sea lion recovery program that would double research funding and increase the restrictions of commercial fishing around the western stock of the Steller sea lion's critical habitat in the GOA, Bering Sea and North Pacific Ocean. The survey noted potential impacts to Alaskan coastal communities that depend on the fishing industry as well as potential benefits from the expanded program. However, the survey explicitly stated that biologists are unsure why the sea lion populations have been declining and gave no guarantee that the expanded program would ensure species recovery.

This information was followed by the question, "If the Expanded Federal Steller Sea Lion Recovery Program was the only issue on the next ballot and it would cost your household $X in additional Federal taxes every year for the next Y year(s), would you vote in favor of it?" The dollar amount and payment duration were filled in by the analysts prior to administering the questionnaire. By varying the printed dollar amount across the sample of respondents, the voter referendum format allowed the analysts to statistically trace out a demand-like relationship between the probability of a "yes" response and the dollar amount. The researchers have not yet investigated temporal elasticity of ‘willingness to pay' estimates, and only a one-year payment duration was analyzed.

The survey was administered to a sample of households in three study areas: 1) the Alaskan boroughs that contain Steller sea lion critical habitat, 2) the entire state of Alaska; and 3) the entire United States. Because the benefits of preserving Federally listed threatened and endangered species are national in scope, both the value per household and number of households to aggregate over should include all U.S. households (Loomis and White 1996).

The Steller sea lion CVM study found that the value of an expanded recovery program for the species in the United States sample was positive and substantial. The estimated mean one-time payment was $100.22 per household. If the average value per household is adjusted to account for non-responses with the assumption that they represented a zero willingness-to-pay, the mean benefit is $61.13. With 101,562,700 households throughout the nation, and $61.13 value per household, willingness-to-pay totals about $6.2 billion for the expanded Federal protection program for the western stock of the Steller sea lion. The 95 percent confidence interval is from $5.8 billion to $16.17 billion. This economic value estimate of an expanded recovery program may be conservative, as the valuation responses were treated as household responses rather than individual responses. Treating the responses as individual responses would increase benefits substantially.

The results of CVM are often highly sensitive to what people believe they are being asked to value, as well as the context that is described in the survey. Given the vague outcome of the Steller sea lion protection program described in the above CVM study, it is somewhat uncertain what respondents were evaluating. A more definitive value of the Steller sea lion might have been obtained if a link had been established between an expanded protection program and a well-defined discrete outcome, such as a specific probability that the western Steller sea lion population would recover.

Economists acknowledge that, in general, questions of validity, bias and reliability persist in the use of CVM to evaluate environmental assets. In 1992, NOAA commissioned a blue ribbon panel to advise the agency on the use of CVM for measuring non-use values (Arrow *et al.* 1993). The panel concluded that CVM studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages, including loss of non-use values, as long as certain sampling and survey design guidelines are adhered to. It is beyond the scope of this analysis to critique the methodology employed by Turcin and Giraud (2001) and Giraud *et al.* (2002) to evaluate the benefits of an expanded program to preserve the Steller sea lion, but the use by these analysts of a willingness-to-pay and dichotomous choice format is consistent with guidelines set forth by Arrow *et al.* (1993). Nevertheless, it is important to emphasize that CVM is based on asking people questions, as opposed to observing their actual behavior, which is a source of considerable controversy among economists, policy makers, and others. The conceptual, empirical, and practical problems associated with developing dollar estimates of economic value on the basis of how people respond to hypothetical questions about hypothetical market situations are a continuing source of debate.

3.9.8.5 Alternative Value Paradigms

Apart from debates about the technical acceptability of CVM with respect to its validity and reliability, there are criticisms of the economic-utilitarian paradigm underlying the economic valuation of at-risk species and ecosystems. A number of these criticisms contend that economic valuation methods such as CVM are inherently inadequate because they capture only the instrumental value to current members of society. For example, Berrens *et al.* (1998) note that irreversible species or ecosystem losses involve inter-generational equity issues since they constrict the choice sets of future generations. Economic valuations are based on the preferences of the current generation and neglect the ethical issue of the inter-generational allocation of natural endowments. Preserving species where positive net benefits are to be earned is obviously a good idea, but preserving species only when doing so meets economic efficiency criteria may place future generations in a disadvantaged position (Bishop 1993).

Other critics focus on the fact that economic valuations are rooted in anthropocentric or human-centered benefits, that is, these valuations rest on the basic assumption that value derives from what people find useful. However, some would argue that human uses and the values to which they give rise are not deserving of any special consideration when it comes to a decision on whether to preserve a species and its habitat (Albers *et al.* 1996). According to one interpretation of this view, nature has rights; to exploit nature is just as wrong as to exploit people (Nash 1989). Another interpretation is that non-human species are intrinsically valuable, independent of any use they may be to humans (Callicott 1986). The latter conviction may be related to religious principles, such as a belief in the sacredness of all or certain life forms.

All of these moral arguments are inconsistent with the economic paradigm of trade-offs between money and wildlife species or ecosystems because they present individuals with the moral imperative that we ought to preserve plants and animals (Stevens *et al.* 1991). As Costanza *et al.* (1997) and Pearce and Moran (1994) note, concerns about the preferences of future generations or ideas of intrinsic value translate the valuation of environmental assets into a set of dimensions outside the realm of economics.

It is difficult to gauge how prevalent such ethically motivated values are among members of the general public. For example, according to a 1997 public opinion poll conducted in the U.S., only 6 percent of the respondents who advocated an end to the harvest of the Minke whale (*Balaenoptera acutorostrata*) indicated that their opposition to whaling stemmed from animal rights concerns (Aron *et al.* 2000). On the other hand, when a recent Gallup poll asked Americans to indicate the degree to which they agree or disagree with the goals of the animal rights movement, 29 percent expressed strong agreement, 43 percent indicated some agreement and only 25 percent were strongly or somewhat opposed (The Gallup Organization 2000). Additional in-depth public surveys are needed before we can better understand people's motivations for supporting efforts to protect endangered species such as the Steller sea lion and ecosystems such as those of the Bering Sea and GOA.

3.9.9 Socioeconomic Comparative Baseline

3.9.9.1 Harvesting and Processing Sectors

As indicated in Section 3.9.2, the harvesting and processing sectors of the Alaska groundfish fisheries consist f catcher vessels, catcher processors, shoreside processors, stationary floating processors, and motherships. The size, composition, and economic performance of these sectors have been influenced by a variety of factors. Some of these factors are of an economic nature, such as the domestic and foreign demand for seafood products, the costs of harvesting and processing inputs such as fuel and labor, and changes in fishing technology. Foreign and domestic demand, in turn, is a function of such factors as consumer preferences, the supply of competing products, foreign exchange rates, international trade agreements, demographics, and national income levels (Kinoshita *et al.* 1993). For instance, with the large amount of groundfish that is exported from the fisheries off Alaska to Japan, the strength of the Japanese yen relative to the U.S. dollar can be a powerful force in the market for groundfish and other Alaska seafood products.

Changes in the condition of fisheries far removed from Alaska have also had a substantial economic effect on the Alaska groundfish fisheries. For example, the price of Pacific cod products increased in the 1990s due to reduced Atlantic cod harvests from the Barents Sea.

Other factors that have affected Alaska groundfish fisheries are regulatory in nature. In particular, fishery management measures have dramatically affected the economic condition of the Alaska groundfish industry as a whole or segments of that industry. These management measures include those implemented to prevent overfishing of fish stocks and to protect endangered species and marine ecosystems. In 2000, for example, Steller sea lion protection measures resulted in a decrease in pollock harvests during the C/D fishing seasons and a consequent temporary closure of several shoreside processing plants.

Some management measures are designed to allocate the TAC among various user groups. One of the first such measures that significantly shaped Alaska groundfish fisheries was an allocation between the inshore/offshore sectors of the BSAI pollock fishery. In 1992, one half of the pollock reserve (7.5 percent of the TAC) was allocated to communities eligible to participate in the western Alaska CDQ program. The remainder of the TAC was divided among vessels delivering pollock to shoreside processors (inshore sector) and vessels processing pollock at-sea (offshore sector), with the former sector receiving 35 percent of the remaining TAC and the latter receiving 65 percent. The American Fisheries Act of 1998 modified specific allocations of the BSAI pollock quota as follows: 10 percent to the western Alaska CDQ program, with the remainder allocated 50 percent to the inshore sector, 40 percent to the offshore sector, and 10 percent to a newly created mothership sector.

Alaska groundfish fisheries have also been affected by management measures intended to enhance the economic efficiency of fisheries. A primary objective of these measures is to reduce the so-called race for fish. In a race for fish, fishermen are compelled to apply an excessive level of operating inputs (e.g., labor, fuel, time) and capital inputs (e.g., vessel and gear improvements) as they compete with each other for shares of the TAC. Fishery management programs designed to end the race for fish and reduce overcapitalization are said by economists to lead to “rationalization” of fisheries, i.e., toward an allocation of capital and labor between fishing and other industries that maximizes the net value of production from the economy as a whole (Anderson 1977).

Measures intended to attenuate the race for fish and increase economic efficiency include an ITQ program established for the sablefish and halibut longline fishery in 1995, whereby a certain portion of the annual TAC is allocated to individual vessels in the form of quota shares, and a vessel moratorium on new entrants to fisheries in the BSAI and GOA groundfish fisheries imposed in 1996. (A license limitation program that further limited participation in these fisheries was implemented in 2000.)

A more recent economic efficiency-enhancing measure was the AFA. The AFA was implemented in phases beginning in 1999 and continuing into 2000. To immediately decrease the number of participants in the pollock fishery, a buyout of nine catcher (at-sea) processors was supported by federally appropriated funds and a federal loan to the fishing industry. The buyout resulted in the permanent removal of nine large vessels from the catcher processor fleet. In addition, the AFA also established the authority and mechanisms by which the remaining pollock fleet can form fishing cooperatives. Within each cooperative, each member company is contractually allocated a percentage share of the total cooperative allocation based on its historical catch (or processing) levels. In practice, the cooperative system is similar to an ITQ program except that the distribution of quota shares and the system for trading, selling or enforcing them are decided by members of the separate cooperatives. Since the AFA was enacted, the BSAI pollock fleet has grown smaller as vessels with marginal activity reduce their level of participation in the fishery (NMFS 2002a).

It is also important to note that the AFA includes provisions that protect the interests of shoreside processors. Specifically, the AFA and implementing rules require each catcher vessel that joins a cooperative and delivers inshore to bring a share of the total allowable pollock catch (TAC) to that cooperative proportional to its historical catch. The vessels, in aggregate, have to agree to deliver 90 percent of their TAC allocation to the processing firm associated with that cooperative. This requirement sought to address concerns raised by processors that the formation of cooperatives would economically disadvantage them during price negotiations unless they received compensation through a restricted processing class.

In general, not enough time has passed since the full implementation of the provisions of the AFA for all likely impacts to have become manifest (NMFS 2002a). Pollock deliveries to shoreside processors increased substantially due to the AFA reallocation of pollock quota to the inshore sector as well as increases in the overall TAC itself. In addition, processors have benefitted from the slower-paced pollock fishery under cooperatives. With more moderate and regular harvests, both catcher processors and shoreside processors have been able to significantly increase their production of higher value products, such as fillets.

While some shoreside processing plants have reported minor cutbacks in personnel as a result of the slowing down or spreading out of pollock processing activity, for the most part employee levels have stayed almost the same because of the need for a full complement of staff to run the plants (NMFS 2002a). What has changed is that workers are working fewer hours per day and working for longer periods than was the case before the enactment of the AFA.

On the other hand, with the consolidation of the fishing fleet and the elimination of the race for fish in the BSAI pollock fishery, there has been a lessening of seasonal peak demands for associated shoreside services (NMFS 2002a). One consequence of this reduced demand appears to be a decline in the number of shoreside support businesses in some communities (although the range of services available locally does not appear to have changed). Many of the support firms that remain in business report employment reductions, either in the form of having fewer year-round personnel or in cutting back on the number of seasonal hires during peak demand.

3.9.9.2 Regional Engagement and Dependency on Groundfish Fisheries

Baseline engagement and dependency on the groundfish fishery vary widely across Alaska regions, and between Alaska and portions of the Pacific Northwest. Section 3.9.3 presents information on the distribution of the sectors across regions, and comparative information on the population, employment and income, processing, processing ownership, and catcher vessel ownership and activity across and among the regions engaged in the fishery.

The population of the regions varies considerably. In Alaska, the Alaska Peninsula/Aleutian Islands region had a 2000 population of approximately 6,000; the Kodiak Island region had approximately 14,000 residents; and the southcentral and southeast Alaska regions had populations of about 367,000 and 75,000, respectively. In the Pacific Northwest, the Washington inland waters region had about 3.9 million residents and the Oregon coast region had a population of about 105,000. Beyond overall population, the types of communities in the different regions also vary considerably. The Alaska regions contain very small relatively isolated traditional communities, as well as the largest community in the state, Anchorage, which along with its surrounding area contains nearly half of the state's population. In the Pacific Northwest, the regions include the greater Seattle metropolitan area as well as relatively small coastal fishing communities.

The population structure of the regions also varies considerably. As discussed in the individual regional profiles, the fishery has an impact on the male-female population balance for some of the Alaskan communities that are the focus of intensive groundfish processing. This type of direct impact on population structure attributable to groundfish is seen in few communities, but these tend to be the communities with the highest level of groundfish-related processing activities. Within Alaska, particularly in the Aleutian and Kodiak Island regions, there is also a relationship between percentage of Alaska Native population and commercial fisheries development, with communities that have developed as large commercial fishing communities becoming less Native in composition over time compared to other communities in the region. This varies considerably from place to place and is not as apparent in the Alaska southcentral and southeast regions as in the more western regions.

Employment and income (payments to labor) information for the processing sector in each region provides a look at types and levels of economic engagement with the groundfish fishery. During 2001, primary or direct Alaska groundfish processing employment ranged from none in the Oregon coast region to more than 3,500 persons in the Alaska Peninsula/Aleutian Islands region and nearly 3,800 persons in the Washington inland waters region. Interpretation of these data in terms of engagement with the community is less straightforward for some regions than for others. For some, processing plants tend to be industrial enclaves that are somewhat separate from the rest of the community, while for others there is no apparent differentiation between the processing workforce and the rest of the regional or local labor pool. For the Washington inland waters region, Alaskan groundfish processing work is at sea, so in some respects it does not take place in a community at all. In all cases, however, processing employment tends to be seasonal in nature. A further complication for attribution of socioeconomic impacts to a regional base is the fact that many workers in many sectors perform groundfish-related work in a region or community other than the locations where they have other (primary) socioeconomic ties. The importance of associated economic flow varies from region to region and from sector to sector, but it is most apparent for the communities that are most heavily engaged in the processing aspect of the groundfish fishery.

For communities (and boroughs) in the western Alaska regions, a local fish tax is often a significant source of local revenue. For other regions, direct revenue benefits are more closely tied to the state fish tax. Information is provided for each region on shared taxes and the role of state shared fish tax in relation to these other taxes. Again, there is considerable variability from region to region. Also apparent is the regional differentiation in the importance of the relatively new fishery resource landing tax. This source of revenue comes from the offshore sectors of the fishery, is designed to capture some of the economic benefits of offshore activity for adjacent coastal Alaska regions, and is far more important to the revenue structure of the Alaska Peninsula/Aleutian Islands region than for any other region.

Inshore groundfish processing information is presented in Section 3.9.3 for each region to facilitate analysis of the volume and value of the groundfish that are landed in a region. The information is broken out by species, and historical information is provided on utilization rate, product value, and value per ton. When examined on a region-by-region basis, these data point out that the groundfish fishery varies widely from one region to another. For example, in 2001, for the Alaska Peninsula/Aleutian Islands region, local groundfish processing activity is relatively focused on pollock, while in the southeast Alaska region, the fishery is focused much more on the non-pollock, non-cod, non-flatfish, "other" (A-R-S-O) species. Therefore, sharp differences exist in value per ton (about six times greater in the southeast Alaska region) and in volume (greater in the Alaska Peninsula/Aleutian Islands region, which accounts for about 88 percent of the total volume for the state). These differences correspond with differences in a number of other factors, including the extent to which a local labor force is used in processing and the degree to which a local fleet is harvesting the resource (both measures are high in the southeast Alaska region, but low in the Alaska Peninsula/Aleutian Islands region). Ownership patterns also have a large influence on economic flow between regions. For example, the Alaska Peninsula/Aleutian Islands region has the greatest volume and value processed inshore among all the regions, but ownership of shore processing facilities in this region is highly concentrated among individuals and firms located in the Washington inland waters region. The large mobile processors that work the Bering Sea have varying catch and processing locations and at least some ties to adjacent Alaska regions (through CDQ group ownership interest, for example), but ownership again clearly shows predominant ties to the Pacific Northwest. For all types of processors (inshore, mothership, and offshore), processors owned by Washington inland waters region residents accounted for 97 percent of total reported tons and 95 percent estimated wholesale value of all North Pacific groundfish processed in 2001.

Resources from FMP subregions adjacent to the Alaska Peninsula/Aleutian Islands, Kodiak Island, and other Alaska regions are not uniformly harvested by catcher vessels from those regions. Different regions have varying combinations of local harvesting activity, local processing activity, and ownership of both harvesting and processing entities, and all of these have implications for the role of the groundfish fishery in the local socioeconomic context. For example, in terms of groundfish harvest value and volume, the Alaska Peninsula/Aleutian Islands region features a mostly nonresidential fleet, except for some of the smaller vessel classes. While the highest volume and value of groundfish resources harvest occur near this region, the catcher vessels accounting for most of this activity are from elsewhere (primarily the Washington inland waters and Oregon coast regions). As a rule of thumb, the higher the catcher vessel harvest volume in a given area, the less local the fleet tends to be. Regions vary widely in how local the catch effort really is by the local fleet. For example, catcher vessels in the southeast Alaska region have a very high concentration of effort in the Eastern Gulf of Alaska FMP area, while efforts of catcher vessels based in Kodiak are more wide-ranging.

Section 3.9.4 also presents information on how groundfish has fit into overall fishing effort for groundfish catcher vessels over the last several years so that the relative role of groundfish can be seen over time. This information is abstracted for this document and clearly shows that the relative importance illustrates marked differences between regions. For each of the regions a section on community rankings by catcher vessel ownership is provided. While most of the rest of the data are regional in nature, the top communities (to the 95th percentile) for vessel ownership are listed to provide a sense of subregional distribution of engagement with the groundfish fishery from the harvest perspective. Diversity information similar to that presented for catcher vessels is also presented for processors for each of the regions to allow at least a general-level consideration of the relative importance of groundfish. For the larger Bering Sea pollock inshore plants, for example, groundfish accounted for more than 60 percent of total ex-vessel value over the period 1995-1997, while in the southeast Alaska region, analogous value ranged from 10 to 35 percent over the period from 1991to1998.

Beyond the regional differences in baseline conditions brought about by a wide range of factors, communities and regions within Alaska have been affected in a number of distinct ways by the growth of the domestic groundfish fishery itself:

- On a regional basis, and specifically with respect to the high-volume, formerly foreign fleet fisheries, the primary regions that have been affected are the Alaska Peninsula/Aleutian Islands region and the Kodiak Island region.

- Within the Alaska Peninsula/Aleutian Islands region, the growth of the domestic groundfish fishery has caused profound changes in the communities of Unalaska and Akutan. In Unalaska, in recent years, it has provided the mainstay of the fisheries-based portion of the economy and generally reversed the local economic decline that followed the crash of the king crab fishery. Both inshore and offshore sectors have contributed to the local tax base and the economic climate that has fostered the development of a significant support services sector. In Akutan, the groundfish fishery, primarily in the form of a large groundfish-oriented shore plant, has transformed the community from a small primarily Native community to a much larger predominantly non-Native community. The implications of this change should be interpreted with caution, however, as the processor (as an enclave type of development) and the rest of the community remain separate in a number of different ways. Lesser changes have been seen in Sand Point and King Cove, although both have experienced a significant growth in local groundfish processing in recent years. Sand Point's residential catcher vessel fleet has benefitted disproportionately from the development of the groundfish fishery in comparison to other communities in the region. Communities in the Aleutians East Borough with no direct involvement in the groundfish fishery have also benefitted from the borough's fish tax. Other CDQ communities in the region have benefitted in yet other ways.

- In the Kodiak Island region, the City of Kodiak has been the prime beneficiary of the development of the groundfish fishery. It has served as an important buffer for variation in other fisheries, especially after the decline of the locally important shrimp and crab fisheries, as well as the Bering Sea crab fisheries.

- The Alaska southcentral and southeast regions have not seen the level of changes experienced by communities in the Alaska Peninsula/Aleutian Islands region and the Kodiak Island region. The fishing communities in these regions tend to be quite diversified, although groundfish is an important component of this mix for some communities.

- It should also be noted that the development of the domestic groundfish fishery has also been important for regions and communities outside of Alaska, particularly for the Oregon (primarily Newport) catcher vessel sector, and the Washington (primarily Seattle) distant water fleet (catcher vessels, motherships, and catcher processors) and regionally based processing and support entities active in the Alaskan groundfish fishery.

A number of historic trends or patterns in management actions or approaches are also serving to shape the regional comparative baseline:

- Beyond the overall development of the domestic fishery, certain fisheries management changes have had significant impacts on the regions and communities.

- With the Joint Venture era, expertise in the groundfish fishery was gained, and the foundation was laid for more complete domestic development of the fishery.

- Concerns regarding overcapitalization of the fishery and growth of the offshore sector in the late 1980s led to management actions to avoid precluding the participation of different sectors. This, in turn, had a number of impacts in both Alaskan and Pacific Northwest regions. Inshore/Offshore allocative splits changed the fishery in both the Gulf of Alaska and Bering Sea.

- Implementation of IFQ-based management for sablefish profoundly changed that part of the groundfish fishery.

- License limitation served to limit entries into the fishery but did not stabilize ownership patterns.

- The evolution of the CDQ program has served to involve entire regions in the groundfish fishery that were not directly involved in the groundfish fishery prior to implementation of the program.

- The American Fisheries Act (AFA) changed the nature of quota allocations between and among sectors. Co-ops were recently formed both offshore (1999) and onshore (2000), and fishery participants are still adapting to the new context. Significant capital was removed (i.e., vessels retired) from the offshore fleet, the race for fish was essentially eliminated, and new types of operational relationships were formed between processors and their harvesting fleets. Ownership structures changed, with increased American ownership overall, and a specific trend of note has been increased investments in the fishery by CDQ groups. In terms of regional or community-based impacts, the beneficial economic impacts of eliminating the race for fish have accrued to most participants, but perhaps especially to those from the Washington inland waters region, due to the ownership patterns and basic operational structure of the sector. Some adverse support sector impacts have been felt in Unalaska due to lessening of seasonal peak demands. In general, not enough time has passed since the full implementation of the provisions of AFA for all likely impacts to be manifest.

- Management measures directed toward Steller sea lion protection have made a significant impact on the fishery. Some of the more restrictive measures were imposed in 2000, and a full suite of alternative measures were analyzed by NMFS in 2001. Given the recency of these developments and the interactive nature of Steller sea lion-related management changes with other management initiatives, impacts are still unfolding and are expected to vary significantly from community to community and region to region.

In sum, the Alaska groundfish fisheries are taking place in a dynamic socioeconomic context, and one that has proven particularly volatile in the past few years with respect to changes within the groundfish fishery itself, as well as with respect to other fisheries that, in turn, have interacted with the groundfish fisheries . These factors resulted in a baseline or 'status quo' that is by no means a set of static conditions.

3.9.9.3 Community Development Quota

The Community Development Quota (CDQ) program has had a major influence on regional participation in groundfish fisheries. In 1992, the CDQ program was developed to facilitate the participation of Bering Sea and Aleutian Island (BSAI) community residents in the fisheries offshore of communities , as a means to develop a local community infrastructure and increase general community and individual economic and social well-being. The CDQ program was established in perpetuity through the Magnuson-Stevens Act authorized by the U.S. Congress in 1996. The State of Alaska is responsible for the administration and monitoring of the program. The state administers the program jointly through the Alaska Department of Community and Economic Development (the lead agency) and the Alaska Department of Fish and Game.

The CDQ program allocates a portion of the TAC (or GHL, as appropriate) for federally managed BSAI species to eligible communities in western Alaska. Originally involving only the pollock fishery, the program has in recent years expanded to become multi-species in nature. The CDQ program includes such species as pollock, Pacific cod, Atka mackerel, flatfish, sablefish, and other groundfish, along with halibut and crab. Currently, the CDQ program receives allocations of the groundfish TACs that range from 10 percent for pollock to 7.5 percent for most other species. The CDQ program has contributed to infrastructure development projects in the region, as well as loan programs and investment opportunities for local fishermen. In recent years the program has provided more than 1,000 jobs annually for the region's residents, and yearly wages have exceeded $8 million.

Sixty-five Alaska Native Claims Settlement Act (ANCSA) villages near the Bering Sea have established eligibility under federal and state regulations, and these villages formed a total of six non-profit regional groups through which they participate in the program. The six CDQ groups are Aleutian Pribilof Island Community Development Association (APICDA); Bristol Bay Economic Development Corporation (BBEDC); Central Bering Sea Fishermen's Association (CBSFA); Coastal Villages Region Fund (CVRF); Norton Sound Economic Development Corporation (NSEDC); and Yukon Delta Fisheries Development Association (YDFDA). The State of Alaska and the National Marine Fisheries Service periodically allocate percentages of the TAC for each species, based upon evaluation of the Community Development Plans submitted by individual CDQ groups. The groups have established partnerships with fishing corporations. Local hire and reinvestment of proceeds in fishery development projects are a required part of the program.

Since it's inception, the CDQ program has contributed to fisheries infrastructure development. According to the ADCED, approximately 9,000 jobs have been created with wages totaling more than $60 million during the period that the CDQ program has been in operation. As annual royalties grow, the revenue streams have permitted development and accumulation of considerable savings and investment capital within the CDQ groups, for use in a variety of future investments. Data suggest that CDQ groups, when taken as a whole, have retained almost half of their gross revenues in some form of equity, whether infrastructure projects, vessel ownership, or cash. Since 1992, CDQ group's equity growth has averaged 37 percent per annum, or slightly more than $10 million each year. It has been reported by the State of Alaska that, by 1997, CDQ groups had more than 200 people employed in the pollock fishing industry alone, 846 individuals in CDQ training, and a total expenditure of $1,041,309.

3.9.9.4 Subsistence

Ths subsistence use of natural resources by Alaska Native peoples stretches back to prehistoric times. Despite changes in technology and society, subsistence activities continue to be a central element in contemporary village life and culture, providing both physical sustenance and a sense of group identity and individual well-being. Subsistence is also important to many of Alaska's non-Native residents, despite differences in the cultural context of subsistence. Alaska residents involved in subsistence life styles, Native and non-Native alike, may feel the impact of commercial use of the same or interrelated natural resources.

The commercial groundfish fishery overlaps with a number of subsistence resources and activities, such as subsistence use of groundfish, salmon, and Steller sea lions, as well as creating opportunities for joint commercial and subsistence production.

Groundfish subsistence fishing occurs over a very large geographic area, but as detailed in Section 3.9.5.2, the subsistence use of groundfish is low in comparison to other subsistence resources , and in relation to other fish resources in particular. There is little, if any, indication that subsistence groundfish use is experiencing adverse direct impacts under current groundfish management approaches, or would be likely to experience direct impacts under any of the currently contemplated commercial groundfish fishery management alternatives, but a potential exists for joint production type of impacts where commercial and subsistence activities overlap. With available data, it is not possible to differentiate between subsistence use of groundfish retained from commercial catches, and groundfish taken during exclusively subsistence fishing.

As detailed elsewhere in this document, a substantial amount of effort has been devoted to determining the relationship of Steller sea lion population dynamics to commercial groundfish fisheries. Steller sea lions are also a subsistence resource species taken by a number of methods throughout the year. Unlike other subsistence activities that many members of a community participate in, hunting for sea lions is a relatively specialized activity, and a relatively small core of highly productive hunters from a limited number of households account for most of the harvest. For the relatively few recent years for which survey data are available, individuals from 20 to 29 percent of all households in the relevant communities actually hunted sea lion (Wolfe 2001). Once harvested, sea lion is distributed among a much wider range of households (Wolfe and Hutchinson-Scarbrough 1999, Wolfe 2001).

Some changes in harvesting regions and techniques have occurred over recent years. For Kodiak Island communities, the sea lion harvest used to take place at haulouts, and 20 or 30 animals were transported at a time aboard purse seiners. Thus, one or two hunters could supply an entire village. Currently, hunting sea lions involves two or three individuals using skiffs to hunt sea lions swimming in open water. The hauling capacity of such skiffs is one or two animals, and Kodiak hunters prefer to take young adults of medium size rather than large bulls or young pups. Peak months for harvest are October through December (Hayes and Mishler 1991).

Hunting methods vary somewhat in the Aleutians and Pribilof Islands and are documented in Wolfe and Mishler (1995). Pribilof Island residents hunt sea lions almost exclusively from the shore and target swimming juvenile (mid-size) males. Hunters will at times hunt from skiffs in calm weather. Sea lion hunting on St. Paul occurs mainly from September through May. Sea lion hunting on St. George is similar to that of St. Paul, being predominantly shore-based. Harvest occurs mainly from January through May. Sea lion harvest in the Aleutian Chain (Atka, Unalaska, Akutan, and Nikolski) occurs mostly from skiffs in open water, and hunters target both sexes. Aleutian Chain hunters will concentrate effort near haulout locations and take more adult and female animals than do Pribilof Island hunters. Seasonality of sea lion harvest is quite variable and appears to be dependent on sea lion abundance and distribution. For Atka, Akutan, Saint George, and Saint Paul (and perhaps Unalaska and several other communities), Steller sea lions have in the past represented a very significant subsistence resource in terms of relative contribution to overall community subsistence resource consumption but, as discussed in Section 3.9.5.3, the available data lacks precision . What is evident, however, is that the area of heaviest subsistence use of Steller sea lions is in southwestern Alaska and is concentrated in a relatively few communities.

The communities of the Bering Sea and Gulf of Alaska regions engage in a wide range of subsistence activities other than direct groundfish and Steller sea lion harvest, these other activities may be directly or indirectly affected by the existing groundfish fishery (or future management actions). These activities include subsistence salmon fishing (potentially affected by salmon bycatch in the groundfish fishery), as well as a wide range of subsistence activities that are facilitated by engagement in the groundfish fishery, either through joint production (using commercial groundfish vessels or gear for subsistence) or by applying income derived from the commercial fishery towards subsistence pursuits.

Current Alaska groundfish fishery management includes provisions for the minimization of salmon bycatch, but salmon bycatch has remained a concern, particularly with respect to potential ongoing impacts to subsistence salmon fisheries. This issue has also been repeatedly noted in the public comment process for this PSEIS. The species of most concern as bycatch in the groundfish fishery are chinook and chum; of these two, chinook is considered a much larger potential problem. The largest subsistence harvests of chinook salmon in 1999 (the last full year for which data are available) occurred in the Kuskokwim area (77,660 salmon; 50%), followed by Yukon (50,515 salmon; 33%), Bristol Bay (13,009 salmon; 8%); and Northwest (6,242 salmon; 4%). As discussed in Section 3.9.5.4, although the numbers of salmon bycatch by groundfish trawl fisheries and associated impacts to western Alaska stocks under baseline conditions would appear relatively low, salmon bycatch is nonetheless a contentious issue given the current state of some of the salmon fisheries.

Joint production refers to the use of commercial fishing vessels and/or gear in the pursuit of subsistence. Subsistence fish can be retained during what are otherwise commercial trips, or separate trips (using the commercial vessel and gear) exclusively for subsistence fishing. In general, there is a paucity of information on joint production within the groundfish fishery. Some, but not all, vessels in the commercial groundfish fishery are used for subsistence in addition to commercial fishing. As a general rule, trips specifically dedicated to subsistence are uneconomic for the larger vessels engaged in the groundfish fishery. Larger vessels also tend to fish further from the community of residence of owner, skipper, and crew; therefore, subsistence use is not practical even during what could otherwise be combined commercial/subsistence trips.

For the largest vessels participating in the fishery, there is no indication of any subsistence utilization in any form. Smaller vessels are most likely to be involved in joint production. The proportion of the total subsistence production for individual communities that results from joint production from these particular vessels during the groundfish fishery is unknown. As a general rule of thumb, however, the smaller vessel classes are less likely to be narrowly specialized than the larger vessels. In practical terms, joint production opportunities vary by gear type as well as vessel size. Although quantitative data are few, knowledge of the industry would suggest that little subsistence takes place using trawl vessels compared to other gear types. Among the fixed gear classes, much more time is directed toward sablefish, salmon, and herring than to groundfish; therefore, the joint production opportunities in this class would remain relatively high independent of the groundfish management alternative chosen.

3.9.9.5 Environmental Justice

NEPA Compliance with an Executive Order regarding Environmental Justice is a development that has occurred in the last 10 years. Executive Order 12898 (Environmental Justice, 59 Fed. Reg. 7629 [1994]), requires each federal agency to achieve environmental justice by addressing "disproportionately high and adverse human health and environmental effects on minority populations and low-income populations." The population structure of the regions engaged in the groundfish fishery varies considerably. As discussed in Section 3.9.6 and elaborated on in the detailed groundfish regional and community profiles recently produced for the North Pacific Fishery Management Council (NPFMC 2002d), within Alaska, and particularly in the Aleutian and Kodiak Island regions, there is a relationship between the percentage of Alaska Native population and commercial fisheries development. Specifically, communities that have developed as large commercial fishing communities have become less Native in composition over time compared to other communities in the region.

The fishery has also had an impact on the male-female population balance for some of the Alaskan communities that are the focus of intensive groundfish processing. This is because processing workers reside within these communities for varying durations, and this workforce is predominantly male. While this type of direct impact on population structure attributable to groundfish is seen in few communities, these tend to be the communities with the highest level of groundfish-related processing activities and the highest engagement in, and dependence upon, the fishery. The differences in the male/female and Native/non-Native population segments are, to a degree, indicative of the type of structural relationship of the directly fishery-related population with the rest of the community. Again, this varies considerably from place to place and is not as evident in the southcentral and southeast Alaska regions as in the Alaska Peninsula/Aleutian Islands and Kodiak Island regions.

Interpretation of these data, in terms of engagement with the community, is less straightforward for some regions than for others. As detailed in the regional discussions, and in the community profiles available elsewhere (NPFMC 2002d), communities are engaged in, and dependent upon, the fishery in quite different ways through resident catcher vessel fleets, onshore processing facilities, and locally associated catcher processor (and/or mothership) entities. While no consistent data are available, field observations tend to indicate that ownership and crew demographics of the residential catcher vessel fleet for the relevant Alaska groundfish communities mirror those of the long-term male residents of the community at large. This situation would also appear to hold true for the smaller vessel catcher processor sectors based in the various Alaska regions. The larger vessel catcher processor and mothership sectors are, to a large degree, associated with the Washington region (with the caveat that ownership patterns have been changing in recent years and the percentage of Alaska-based ownership in general and Alaska CDQ ownership in particular has increased, as discussed at length elsewhere in this document), and crews tend to be drawn from a wide area rather than a particular community.

For the large groundfish processing plants the demographics of the workforce and the relation to the 'host' communities tend to be more complex, and have substantial environmental justice implications as the large majority of processing workers comprise a minority (although non-Alaska Native) population sector. In some Alaska groundfish communities, processing plants tend to be industrial enclaves somewhat separate from the rest of the community, while for others there is no apparent differentiation between the processing workforce and the rest of the regional or local labor pool.

A further complication for attribution of socioeconomic impacts to a regional base is the fact that for many workers in many of the sectors, groundfish-related work is performed in a region or community that is separate from where they have a other socioeconomic ties.

The demographic composition of the greater Seattle area is markedly different than Alaska groundfish communities, and the same type of demarcation between the industrial fishing operations and the resident population is not apparent. Workers on the larger at-sea operations based out of Seattle, however, tend to be drawn from minority populations.

The CDQ region presents yet another type of environmental justice context. Environmental justice issues are salient in this region due to the nature of the demographic and economic structure of the region, and the nature of the participation of this region and its communities in the fishery through the CDQ program. The specific attributes of participation varies as the program has been implemented differently in various subregions by different CDQ groups, but in general this program has been designed to foster economic development in minority (Alaska Native) and economically underdeveloped communities. As such, any impacts to the CDQ program or its communities are, essentially by definition, potentially environmental justice impacts. The existing conditions in this region and the attributes of the program are discussed in detail in Section 3.9.4.

Another type of environmental justice context concerns subsistence issues. While not only Alaska Natives participate in subsistence activities, areas in which subsistence activities are practiced that may be impacted by groundfish management alternatives are predominantly Alaska Native. Therefore, impacts to subsistence are also, in general, potentially environmental justice impacts. Existing conditions for relevant subsistence-associated populations are discussed in detail in Section 3.9.5.

3.9.9.6 Market Channels and U.S. Consumers of Groundfish Products

There are many factors that have influenced U.S. consumer preferences and the domestic demand for products of the Alaska groundfish fisheries. Health-related issues have been especially significant factors in recent years. Much of the increase in the demand for seafood, in general, stems from its perceived healthful properties. Seafood has recently been credited with having ingredients that reduce heart disease, arthritis, and depression and enhance sexual performance (Seafood.com 2001). A major impetus in seafood consumption occurred in 2000, when the American Heart Association recommended that people eat fish twice a week for its health benefits. Products obtained from the Alaska groundfish fisheries have undoubtedly played a major role in meeting this domestic demand for seafood. For example, it is known that the market for Alaska pollock fillets and Pacific cod fillets is mostly a domestic market, and the demand within the United States far exceeds the available supply (NMFS 2001b).

Despite the high demand for certain groundfish products among U.S. consumers, numerous past studies have indicated that the price elasticity of demand for those products, especially fillets, is fairly high (NMFS 2001b). In other words, market price is not appreciably affected by the quantity supplied. This is because the domestic fillet market is competitive in terms of product form (individually quick frozen, block, and twice-frozen), supplying country (Russia and China play major roles), and fillets from other species, including hake and hoki. The U.S. market for all fillets, particularly cod, has also been influenced by the increased production of aquaculture-grown whitefish (NMFS 2001b). The species of greatest significance is catfish, but in recent years there have been increases in both domestically produced and imported tilapia. Furthermore, seafood, in general, has had to compete with other animal protein sources in the American diet such as chicken, pork, and beef.

3.9.9.7 The Value of the Bering Sea and GOA Marine Ecosystems (Including Non-Consumptive and Non-Use Benefits)

Alaska's healthy ecosystems are valuable natural assets (Colt 2001). As human population, economic development, and other pressures have increase worldwide, such ecosystems grow more scarce, and hence their value increases significantly. The Bering Sea and GOA marine ecosystems are among Alaska's most important ecosystems. U.S. citizens derive a wide range of benefits from these ecosystems, including direct, on-site uses associated with consumptive activities (e.g., commercial and recreational fisheries) and non-consumptive activities (e.g., tourism, bird and whale watching, and simply appreciating the general aesthetics of wild areas). Benefits also accrue to individuals who do not use these marine ecosystems but who derive value from knowing they are being protected (i.e., existence value).

Because the Bering Sea and GOA marine ecosystems are so productive and provide such a wide range of highly-valued goods and services, any major modification of these ecosystems and associated species has likely had a dramatic effect on the quality of the human environment. Details on the baseline for these marine ecosystems are provided in Section 3.10. Moreover, existence value may be highly sensitive to the amount of information acquired, i.e., small changes in information or knowledge about a species may produce large shifts in existence value for that species (Stevens *et al.* 1991). It follows, therefore, that improvements in communication technology have led to significant increases in existence value. For example, the arrival of the internet has greatly enhanced the ability of the general public to access at low cost information about endangered species and other environmental assets, including those that occur in the Bering Sea and GOA.

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3.10 Ecosystem

This section discusses the affected environment at the ecosystem level. It provides three kinds of information:

1. It summarizes relevant historical information and recent scientific data on the North Pacific Ocean ecosystem;

2. It discusses interactions among climate, commercial fishing, and ecosystem relationships in the North Pacific Ocean from a multi-species perspective, including climatic processes that may act as forcing agents on the BSAI and GOA ecosystems, producing background changes that are independent of human activities such as commercial fishing; and

3. It reviews indicators of the present status of the BSAI and GOA ecosystems that help to form the baseline for assessing and comparing potential future environmental consequences of the alternatives, including cumulative effects, in Chapter 4.

The section is subdivided as follows:

Section 3.10.1 presents a historical overview of the regional ecosystem, distinguishing the BSAI and GOA where records permit. The overview begins at the environmental reference point of 1740, the year before Vitus Bering's first expedition to Alaska, and continues to the present. It includes observational information from the eighteenth, nineteenth, and early twentieth centuries, as well as data collected after passage of the Magnuson Fishery Conservation and Management Act of 1976 (now the Magnuson-Stevens Fishery Conservation and Management Act, referred to as the MSA).

Section 3.10.2 summarizes interactions among climate, commercial fishing, and ecosystem characteristics in the North Pacific Ocean.

Section 3.10.3 evaluates the current status of the North Pacific Ocean ecosystem using indicators from three broad categories: predator-prey relationships, energy removal and flow, and biodiversity.

The main conclusions of this section are as follows:

1. The North Pacific Ocean ecosystem is within the bounds of natural variability with respect to predator-prey relationships, energy removal and flow, and biodiversity.

2. Fish and wildlife populations within the North Pacific Ocean ecosystem are naturally dynamic: at any point in history, some species are increasing in abundance while others are declining.

3. Climatic forcing agents exert a powerful influence on marine fish and wildlife populations of the BSAI and GOA. Gathering and incorporating knowledge about these forcing agents may increase their predictability and enhance the effectiveness of future fishery and wildlife management.

3.10.1 The North Pacific Ocean Ecosystem from 1740 to Present

This section reviews available historical information on the BSAI and GOA ecosystems and changes since 1740, the environmental reference point for the ecosystem analysis. While much of the earlier information is anecdotal, particularly accounts from the eighteenth and nineteenth centuries, it represents the best available observational data on the North Pacific Ocean ecosystem from those periods. More information on the history of North Pacific Ocean commercial fisheries and their management is presented in Appendix B. Detailed life history information on fish, birds, and marine mammals is presented in the individual species accounts (Sections 3.5 through 3.8).

Establishing an environmental reference point as the starting place for the historical review follows USEPA guidance for the consideration of cumulative effects (USEPA 1999). The historical review serves as the source for information about past external effects, natural and manmade, on the North Pacific Ocean ecosystem. In this case, the environmental reference point is set at 1740 because this was the year preceding Bering's first voyage, with naturalist Georg Wilhelm Steller, to BSAI and GOA waters (Steller 1743).

For this analysis, it is assumed that the BSAI and GOA ecosystems in 1740, one year prior to first contact, represent an ecologically sustainable condition. As defined by USEPA, an ecologically sustainable system "supports biological processes, maintains its level of biological productivity, functions with minimal external management, and repairs itself when stressed" (USEPA 1999). This definition allows the possibility that a sustainable ecosystem may change with respect to the details of its component parts–for example, as populations of individual species cyclically increase and decrease over time–but that the ecosystem-level characteristics with regard to overall productivity and ability to maintain structure and patterns of behavior in the face of disturbance continue without being intensively managed.

3.10.1.1 Eighteenth Century

The first fish and wildlife observations by non-indigenous visitors to what are now called the Bering Sea, Aleutian Islands, and Gulf of Alaska were made by Steller aboard the St. Peter in 1741 during Bering's first voyage to Alaskan waters. Steller's journals (Steller 1743) indicate that marine furbearers, birds, and fishes were abundant and easily observed at the time of first contact. In addition to whales, fishes, and many seabirds and terrestrial birds, Steller described abundant occurrences of four North Pacific marine mammal species: sea otter, sea lion, fur seal, and sea cow (*Hydrodamalis gigas*, a large manatee hunted to extinction by 1768). He collected thousands of botanical specimens and first described hundreds of plant species unknown in Europe. Having learned from indigenous people the value of certain plants (e.g., *Cochlearia officinalis*) in preventing and curing scurvy, Steller was the first European known to administer antiscorbutics to ships' crews, saving many lives.

During the half-century following Bering's first voyage, Russian traders killed large numbers of the abundant marine mammals, as well as arctic and red foxes, river otters, and other mammals for their pelts. The pelts were sold at high prices in Europe and China. Walrus were killed in large numbers for their ivory tusks. Sea otter harvests, which began in 1743, were particularly high, but mercantile records of the period have not been widely published. Some of the most complete records in English can be found in Bancroft (1886); these are summarized in Table 3.10-1.

Intensive harvesting of sea otters in the BSAI and GOA, including the waters of Prince William Sound and Cook Inlet, had been underway for 45 years by the time Gerassim Pribilof first reached the island of St. George, named for his ship, in June 1786. Bancroft described the scene as follows:

> *"The shores of St. George literally swarmed with sea-otters, which undisturbed so far by human beings could be killed as easily as those of Bering Island during the first winter after its discovery. Large numbers of walrus were secured on the ice and upon the adjoining small islands; arctic foxes could be caught by hand, and with the approach of summer the fur-seals made their appearance by thousands (p. 192)."*

Fur seals had been previously harvested from the Commander Islands and elsewhere, with Shelikof having imported 70,000 skins prior to 1780 (Bancroft 1886). However, the Russian acquisitions of St. George and St. Paul, which Pribilof reached in 1787, immediately opened a major new trade in fur seal skins at a time when sea otter populations, having sustained consistently high annual mortality rates for decades, were rapidly declining. Veniaminov (1840) stated that at the time of first contact with the Pribilof Islands in 1786, sea otters were so abundant that their numbers in the water physically impeded access to the islands. Within six years, not a single otter was observed in nearshore waters. Veniaminov unambiguously attributed these declines to direct mortality from fur harvesting. The new, seemingly inexhaustible supply of fur seals from the Pribilofs provided a timely substitute for the declining sea otters. Bancroft (1886) recounted a letter by Shelikof, dated 1789, describing the first fur harvest following Russian occupation of the Pribilofs: "[D]uring the first year the hunters obtained on the newly discovered islands 40,000 fur seal skins, 2,000 sea otters, 400 pounds [14,400 lbs.] of walrus ivory, and more whalebone [baleen] than the ship could carry."

In the late eighteenth century, BSAI and GOA sea otter populations had declined to the point that supplies of pelts were nearly exhausted. At the same time, the growing Russian settlement of coastal Alaska led to an expansion of the furbearer trade to include the trapping of terrestrial mammals such as mink, pine marten, and foxes, while fur seal killings continued in the Pribilofs. Concerns among the established Russian merchants to stabilize and protect their dwindling fur supplies as a growing number of competing rivals entered the market led to organization of the Russian American Company in 1799 (Bancroft 1886).

By the close of the eighteenth century, nearly 60 years of intensive fur harvesting had caused major declines in the marine mammals of the BSAI and GOA, and the Steller sea cow had been gone since 1768, hunted to extinction for meat. It is not known whether these high mortalities led to other changes to the marine ecosystem or how deeply the changes penetrated the food web. Major human impacts to upper trophic levels of the BSAI and GOA ecosystems were occurring as long as 250 years ago.

3.10.1.2 Nineteenth Century

In the early nineteenth century, the fur seal trade dominated Russian mercantile activities in Alaska. Fur seal harvest levels prior to 1817, while unrecorded, were estimated at 90,000-110,000 per year by Veniaminov (1840), who stated that the annual harvest was often undertaken without foresight. In 1803, for example, the accumulated store of fur seal skins in the Pribilofs reached 800,000, more than 700,000 of which were burned or thrown into the sea because of poor market conditions due to the Napoleonic wars.

Quantitative data on annual fur seal harvests in the Pribilof Islands were recorded from 1817 through 1837 (Table 3.10-2). The harvest declined from 60,188 in 1817 to 6,802 in 1837, a decrease by nearly 90 percent over two decades. Veniaminov (1840) wrote:

> *"The cause of the decrease in the number of fur seals is evident, and one can only wonder how they have survived up to the present, considering how mercilessly they have been killed year after year, that they produce but one offspring each year, and that, in addition to known perils encountered in their migrations, [they] must also be subject to some unknown ones (p. 147)."*

As noted in Section 3.10.1.1, Veniaminov stated that at the time of first contact with the Pribilof Islands, sea otters were so abundant that their numbers physically impeded access to the islands; within six years, not a single otter was observed in nearshore waters. Within three decades, by 1811, none was seen in offshore waters of the Pribilofs. In the Unalashka District, over 1,000 sea otters were harvested annually in the late eighteenth and early nineteenth centuries. By 1840, 70 to 150 were taken annually (Veniaminov 1840).

Similarly, Steller sea lions had been killed in great numbers during the latter two decades of the eighteenth century, and this trend continued into the nineteenth century. By 1840, about 2,000, including young, were harvested annually from St. George, and sea lions had been entirely absent from St. Paul for many years (Veniaminov 1840).

Although quantitative data were not available, Veniaminov states that seabird populations, very numerous at the time of first contact, were greatly reduced by 1840, and that only by instituting harvest prohibitions and controls could they be conserved or increased.

Economically important groundfish populations were observed to decline. At Unalashka, several hundred cod were harvested daily during earlier decades, but by 1825 and 1826, no cod were caught. Fluctuations in cod populations are reflected in the Eastern Aleut name for the fish, which translates as "the fish that stops" (Black 1993).

Seasonal migratory fish (e.g., salmon and Dolly Varden) were harvested annually in the hundreds of thousands in the early decades following first contact. By 1840, however, annual salmon harvests at Makushin village had declined from hundreds of thousands to tens of thousands, and Veniaminov observed that:

> *"The same situation obtains everywhere (p. 39)."*

Veniaminov attributed declines in groundfish populations to undersea volcanic activity. In 1825, immediately before a major eruption in the Unimak Range, dying cod and sculpin were observed floating in great numbers on the surface and were absent until after 1827 when a gradual recovery began. He attributed declines in salmon to the pollution of river mouths by refuse disposal and to changes brought by volcanic activity.

Following the purchase of Alaska by the United States in 1867, institution of regulatory controls on resource management began. In 1868, the U.S. Treasury Department sent agents to Alaska to protect fur seals and administer a lease to the Alaska Commercial Company for harvesting seals in the Pribilof Islands. As the Alaska salmon industry developed, government agents collected taxes on processed salmon products (Fredin 1987). Commercial fisheries for salmon and halibut expanded as technologies for large-scale canning, iced storage, and rail trans shipment developed. Salmon canneries were established in Alaska for the first time in 1878 (Cooley 1963).

Commercial fishing in the BSAI and GOA for cod and other groundfish, however, was unregulated and proceeded on a common-pool basis in which fishery resources were available to all participants. During the final three decades of the nineteenth century, expanding commercial groundfish harvests continued on a laissez-faire basis, open to any entrants and without noteworthy federal oversight. Cod stations were established in the late 1880s throughout the Aleutians to exploit the abundant resource, an indication that the cod population had rebounded substantially since Veniaminov's observations in the 1830s (Morgan 1980).

3.10.1.3 Twentieth Century Prior to Magnuson-Stevens Act

During the first three quarters of the twentieth century, the growth of commercial fishing, whaling, and fur seal harvesting put pressures on the North Pacific Ocean ecosystem by targeting important components of the food web, including top predators. A variety of policy instruments were put in place to moderate these pressures. Prior to passage of the MSA in 1976, commercial fishing was conducted in the North Pacific Ocean, including United States territorial waters, by fleets from many nations operating within a complex framework of multilateral and bilateral agreements. Under these agreements, international commercial harvests of groundfish rose to unprecedented volumes after the 1950s. Appendix B summarizes the history of the North Pacific Ocean groundfish fisheries and their management prior to 1976.

Similarly, commercial whaling increased greatly in the North Pacific Ocean region during the first half of the twentieth century, as Atlantic and South Pacific stocks became depleted. In 1946, the International Convention for the Regulation of Whaling, signed by 14 nations including the United States, established the IWC to conserve whale stocks and regulate commercial whaling. Under IWC oversight, commercial whaling in the North Pacific Ocean continued to increase, reaching its maximum level in the 1950s and 1960s. After this, concerns over stock depletions led the IWC to establish increasingly restrictive whaling quotas and to ban all commercial whaling in 1986. Small subsistence quotas for aboriginal peoples, including Alaska Natives, remain in effect and are adjusted periodically in accordance with whale population data. These limited harvests are not thought to affect whale population characteristics. For species-specific information on the life histories and current status of the whales, see Sections 3.8.11-25.

As previously noted, the commercial harvesting of northern fur seals began on the Pribilof Islands in the 1780s and continued through the nineteenth century, with protections starting to be imposed after the acquisition of Alaska by the United States in 1867. From 1786 to 1828, roughly 100,000 northern fur seals per year, primarily pups, were killed (Baird and Hanson 1997). Commercial harvesting during this early period, which included pregnant females, is generally believed to have caused the large reductions in population size observed in the late 1800s and early 1900s. From 1912, pregnant females were excluded from the harvest, and the fur seal population grew through the 1940s. In an effort to move the population toward a level where productivity would be maximized, approximately 300,000 females were killed between 1956 and 1968. The population did not respond as expected at the time, however, and pup production decreased (York and Hartley 1981).

In 1957, the United States, Canada, Japan, and the Soviet Union signed the Interim Convention on the Conservation of North Pacific Fur Seals, which established the North Pacific Fur Seal Commission. The

Interim Convention prohibited the hunting of fur seals at sea, but allowed the annual harvest on the Pribilof Islands to continue under the oversight of the Commission. The annual harvest continued through 1966, when Congress passed the Fur Seal Act prohibiting the taking of fur seals on United States lands and waters, with the exception of Native American subsistence use. The Interim Convention expired in 1984 because it was no longer supported by the United States, which had its own protective laws in place. The northern fur seal is now managed by NOAA Fisheries under the authority of the Marine Mammal Protection Act.

As the ecosystem concept gained currency in the 1960s and later, the ongoing large, international commercial harvests of groundfish, whales, and northern fur seals discussed above were considered likely to produce changes at the ecosystem level (Trites *et al.* 1999). As discussed in Section 3.10.2, the populations of some species in the EBS showed major alterations between the 1950s and the 1980s. Among the best documented were the declines of Steller sea lions (Section 3.8.1) and northern fur seals (Section 3.8.2), and the apparent increase and dominance of groundfish, particularly pollock and large flatfish (Section 3.5.1). Trites *et al.* (1999) proposed two hypotheses to account for these changes. First, the he removal of top predators from the food web through commercial harvesting was proposed as the mechanism for change. Second, a climate-related shift in physical oceanographic characteristics was implicated (for a review of physical oceanographic processes, see Section 3.3).

To test these hypotheses, Trites *et al.* (1999) used two inter-related software packages (Ecopath and Ecosim) to compare quantitatively the EBS ecosystem as it was during the 1950s, before large-scale commercial fisheries were underway, and during the 1980s, after many marine mammal populations had declined. They consolidated the hundreds of species that make up the EBS ecosystem into 25 functional groups. Some ecosystem indices derived from the two models suggested that the EBS ecosystem was more mature (that is, had more fully developed and diverse biological guilds and communities) in the 1950s than in the 1980s. However, the actual condition of the EBS in the 1950s was uncertain because of the relative paucity of data from that time. The ecosystem indices for both the 1950s and 1980s models suggested that the EBS was resilient and resistant to perturbations such as those from the commercial harvests described above. For example, removing whales from the 1950s ecosystem had a positive effect on pollock by reducing competition for food. However, commercial whaling alone was insufficient to explain the 400 percent increase in pollock biomass thought to have occurred between the 1950s and the 1980s. Nor did commercial fisheries account for the observed changes. Indeed, the magnitude of changes that occurred in the biomass estimates of all major groups in the EBS ecosystem could not be explained solely through trophic interactions influenced by commercial harvests. Instead, it was suggested that a climatic regime shift affecting hydrographic features such as the distribution of seawater temperatures was likely to be responsible (Trites *et al.* 1999). These findings are supported by traditional knowledge from many sources. For example, older residents of Sand Point and King Cove noted during the scoping process for this Programmatic SEIS that sudden decreases in marine fish and mammal populations occurred in the late 1940s and mid-1950s. Although they did not mention climate changes, these observations seem consistent with more recent scientific findings linking fish abundance to climatological conditions (e.g., Anderson and Piatt 1999, see Section 3.10.1.5). This is due to the finding that there was a large negative shift in the values of the Pacific Decadal Oscillation Index, which measures changes in North Pacific sea surface temperature variability, from the 1940s to mid-1950s. The negative phase of this index is associated with enhanced coastal productivity along Oregon and Washington and inhibited productivity in Alaska (NPFMC 2002c).

3.10.1.4 Ecosystem Trends under MSA Fishery Management Plans and Amendments

The BSAI and GOA currently support some of the largest and most productive commercial fisheries in the world. Under policies instituted by FMPs and their sequential amendments since passage of the MSA in 1976, the biological and oceanographic dynamics of these regions have been monitored to detect trends and potential sources of problems, such as overfishing or fishery-induced declines in species not targeted by commercial fisheries. The following two subsections summarize information on recent ecosystem trends in the BSAI and GOA management areas, respectively.

Ecosystem Trends in the BSAI Management Area

In a review of fishery trends and potential fishery-related impacts within the BSAI ecosystem, Livingston *et al.* (1999) examined historical biomass trends of three different trophic guilds to see if there was a relationship between fishing or climate and changes in total guild biomass or changes in species composition within guilds. For example, large fishing removals of one guild species might result in increases in other members of that guild as competitive pressures ease. Similarly, if fishing removes large numbers of a prey species important to all members of the guild, an overall decrease in the abundance of all the guild species might be observed, as well as decreased mean size at age of predators relying on that prey. Alternatively, if the factor inducing the observed change is environmental, trends in abundance or in mean size at age that correlate positively or negatively with temperature or other physical oceanographic factors might be seen. Three trophic guilds were examined:

1. offshore fish, mammals, and seabirds that consume small pelagic fish;

2. inshore fish, crabs, and other benthic epifauna that primarily consume infauna; and

3. a ubiquitous group that feeds on crab and fish (Figure 3.10-1).

Despite conservative exploitation rates, a variety of species in diverse trophic groups (e.g., arrowtooth flounder, Greenland turbot, some seabirds, and marine mammals) showed either increasing or decreasing long-term trends in abundance, and both fished and unfished species (pollock, cod, crabs, sea stars, and others) showed cyclic fluctuations in abundance over the two decades from 1979 to 1999. No link was found between species declines and prey abundance. The timing of some species declines, e.g., marine birds, was actually correlated with increases in the adult populations of their main prey species–in this case, pollock. Similarly, the timing of increases in some guild member biomass values did not relate to fishing intensity on other guild members (e.g., skate versus cod). The Livingston *et al.* study, however, did not consider spatial changes in prey abundance or availability that could occur, and these factors cannot be ruled out as potential causal links to changes in predator abundance.

Physical oceanographic factors, particularly northward or southward shifts in regional climatic regimes, were correlated with the recruitment of some guild members (see Sections 3.3.4 and 3.10.1.5), and decreases in individual growth of some species (rock sole) were linked to increases in rock sole biomass. Diversity changes in some trophic guilds were related to increases in a dominant guild member (e.g., pollock in the pelagic fish consumer guild, and rock sole in the benthic infauna consumer guild) rather than to fishing-induced changes in diversity.

The study by Livingston *et al.* (1999) showed a stable trophic level of catch and stable populations overall. The trophic level of the Bering Sea harvest has risen slightly since the early 1950s and appears to have stabilized as of 1994.

Modeling Biological Interactions Among Multiple Species

Livingston and Jurado-Molina (1999) have developed a computer-based model of predator-prey interactions among the dominant groundfish species in the EBS. Three goals have directed the development of this multi-species model: 1) to examine trends in mortality due to predation, 2) to examine the relative importance of predation versus climate in influencing fish recruitment, and 3) to provide a basis for evaluating how future changes in fishing intensity might affect the groundfish community. The model uses information on historical catch estimates and predation among the species to estimate numbers at age and predation mortality of groundfish populations. The following species are modeled as predators: walleye pollock, Pacific cod, Greenland turbot, yellowfin sole, arrowtooth flounder, and northern fur seal. Arrowtooth flounder and northern fur seal are considered "other predators," which means that population and mortality estimates are not made directly for these species. However, it is feasible to estimate the impact of their predation on other species in the model. Prey species are walleye pollock, Pacific cod, Greenland turbot, yellowfin sole, rock sole, and Pacific herring.

Results from the modeling indicate that most predation mortality occurs on juveniles, particularly juvenile walleye pollock. This juvenile mortality varies over time, and recruitment of juveniles into the adult population also varies. Cannibalism by adult pollock explains some of the recruitment variation, but it appears that much of the variability is related to climatic variation (see Section 3.10.1.5). Understanding of predation and climate as structuring forces on groundfish communities will be advanced when multi-species predation models like these are linked to climate models that predict survival rates of larval fish before they are vulnerable to predation.

Output from this predation model can be used to evaluate the multi-species implications of various fishing strategies. One question asked about the BSAI by groundfish stock assessment biologists is: What effects might uneven groundfish harvesting rates have on groundfish community dynamics? For example, some species, such as pollock, are fished up to the recommended level of ABC, while others, such as rock sole and yellowfin sole, are fished at levels below ABC for economic and bycatch reasons. Using a multi-species model, Jurado-Molina and Livingston (2000) examined what could happen over the long-term future to groundfish population size if species were harvested more evenly or were not harvested at all. They compared these projected changes with model predictions based on current groundfish fishing rates. They also compared the results with predictions using single-species models that did not consider predation interactions.

In the scenario where groundfish were fished more evenly (F_{ABC}) than actually occurs under the present harvesting regime (F_{REF}), the single-species models predicted almost the same population changes that the multi-species model did. The biggest differences between multi-species and single-species models were seen in the predictions for prey species biomasses of herring and rock sole, but even these were not very large (Figure 3.10-2).

Small differences in the predictions are the result of evaluating relatively small changes in fishing intensity. Larger differences between single-species models and the multi-species model are seen when the present fishing strategy (F_{REF}) is compared with a no-fishing strategy (Figure 3.10-3). Here, the main reason for the difference is that the multi-species model predicts that predators increase their consumption of prey when there is no fishing. The model results indicate that when pollock fishing is stopped, the largest beneficiary species is pollock itself. This is because adult pollock consume mostly younger (age 0 and age 1) pollock, while other predators tend to consume mostly older (age 1 and older) pollock. In the long-term, consumers of small pollock get the first opportunity to benefit from the increased abundance of juveniles when fishing stops.

In summary, the results of multi-species predator-prey modeling suggest that implementation of a more even harvesting regime would not produce effects much different from changes predicted by single-species models. The largest difference occurs in predictions under a no-fishing scenario, with the multi-species model predicting smaller increases in prey species such as pollock, rock sole, and herring than those predicted by the single-species models. Increases in predator populations, and thus predation mortality, under a no-fishing scenario are the reason for the lower rate of increase in prey populations in the multi-species model.

Multi-species Technological Interactions

Harvesting can have multi-species implications through technological interactions (i.e., co-occurrence of multiple species in a single target species fishery). When specific fisheries are unable to catch their target species exclusively, their fishing effort imposes some mortality on each species that is taken as bycatch. Bycatch of non-target flatfish species is a particularly important characteristic of several EBS target fisheries, including yellowfin sole, rock sole, flathead sole, and Alaska plaice. These species, along with Pacific halibut, occupy similar habitats on the EBS shelf and co-occur to varying degrees in the harvest. Additionally, the retention of Pacific halibut is prohibited in the federally managed groundfish fishery, and quotas of halibut bycatch—not directed target quotas—have been the main factor in restricting the fishery in recent years.

The total trawling effort for all flatfish fisheries combined imposes a variety of fishing mortality rates on the individual flatfish species. This has been evaluated with a multi-species yield-per-recruit model (Spencer *et al.* 1999). One motivation for such modeling is to consider management options that would increase the total flatfish yield, factoring in the bycatch of flatfish in the various fisheries. A main feature of this model is that a catchability coefficient is computed for each species and fishery, based on recent catch and effort data; the distribution of effort among the various EBS trawl fisheries (defined by species catch composition) is based on the same data. The slope of each line in Figure 3.10-4 is the total catchability for a particular species, resulting from all fisheries that harvest the species. For example, the catchability of yellowfin sole is higher than other species because a significant proportion of total trawling effort is directed toward this fishery, and this species has relatively high catchabilities in several fisheries.

Reaching halibut bycatch quotas early has resulted in early closures of the flatfish fisheries, thus resulting in large differences between fishing levels that would attain the ABC at F_{ABC} (triangles in Figure 3.10-4) and recent average F levels (asterisks) for most fisheries. One way to manage these species that are caught together would be to derive biological reference points for the complex as a whole. The $F_{40\%}$ level for the group combined (squares in Figure 3.10-4) would produce higher yields (in the absence of halibut bycatch quotas) than the single-species approach. This approach for managing flatfish as a group, however, would expose the yellowfin sole population to a higher fishing rate than the rate that would be recommended in a single-species management scheme. Therefore, this strategy might not provide optimal protection for yellowfin sole. If the complex were managed to protect the weakest stock (yellowfin sole), the combined flatfish fisheries would be able to increase effort by only a relatively small amount above the current effort levels (to the level of effort that would reach the yellowfin sole ABC at F_{ABC} (triangle in Figure 3.10-4). There is a relatively small difference between the recent average yellowfin sole F and the yellowfin sole $F_{40\%}$, indicating that there would be no significant change from current practice.

The limitation currently imposed on flatfish fisheries by the halibut bycatch quota has motivated fishermen to develop methods of reducing trawling effort that has high catchability on halibut (Gauvin *et al.* 1995) and also to develop fishing gear with lower halibut catchability (i.e., halibut excluder devices). These gear improvements and the already mandated phasing-in of requirements for retaining flatfish bycatch under the improved retention/improved utilization management approach show promise for producing a fishery management system with increased protection for protected species such as halibut and a large reduction in the levels of flatfish discards in flatfish fisheries. Because the gear improvements and improved retention scheme implementation will change the nature of the effort and multi-species catch characteristics of these target fisheries, the impacts of the improvements must be evaluated before multi-species biological reference points can be developed for target flatfish.

Ecosystem Trends in the GOA Management Area

Meuter (1999) examined GOA groundfish communities using groundfish and shrimp trawl data collected over several years from the eastern and western GOA. To identify spatial and temporal patterns in community structure, the data were analyzed for species richness, diversity, total abundance, and indices of species composition in relation to depth, temperature, salinity, sediment composition, geographic location, and time of sampling. The data were then compared to local and larger scale atmospheric and oceanographic changes. In general, species richness and diversity peaked at water depths of about 200–300 m in the GOA. Higher abundance, lower species richness and diversity, and a different species composition of demersal fishes were found in the western GOA as compared to the eastern GOA. Meuter concluded that these large-scale spatial patterns were related to upwelling differences between the two regions.

With respect to long-term trends, the lowest species richness (number of species per haul) was observed in 1984, whereas the lowest species diversity (as measured by the Shannon-Wiener diversity index) was seen in 1996. It is difficult to tell whether these trends are real because of changes in trawl survey techniques and gear usage during the 12-year sample period. General increases in total groundfish biomass were seen from 1984 to 1996 (Figure 3.10-5), coupled with statistically significant changes in species composition (Figure 3.10-6). Community structure in nearshore areas around Kodiak Island changed during this same period, with decreasing populations of shrimp and small forage fish and increasing populations of large, fish-eating species such as Pacific cod and flatfish.

Meuter found that the total biomass of commercially-fished species in shelf and slope areas had increased since 1984, despite a considerable, concurrent increase in harvest effort. At the same time, the abundances of unexploited (or underexploited) species including skate, some shark species, forage species, arrowtooth flounder, and other flatfish had increased (Figure 3.10-7). Populations of an overexploited species, the Pacific ocean perch, had also rebounded from low population levels. The controlling factor for these increases appeared to be environmental, with changes in community species composition in nearshore areas linked to an increase in advection in the Alaska Coastal Current. Meuter concluded that increased flow around the GOA may have enhanced the supply of nutrients and plankton on the shelf and upper slope areas, resulting in higher productivity.

In addition to Meuter's work, studies by Piatt and Anderson (1996), Anderson and Piatt (1999), Orensanz *et al.* (1998), Robards *et al.* (1999) and others, discussed in Section 3.10.1.5, provide evidence that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA. An important conclusion to be drawn from these studies is that any effects of human activities on the marine environment should be considered in the context of the powerful physical forces that appear to be driving the BSAI and GOA ecosystems.

3.10.1.5 Climate-Implicated Changes in the North Pacific Ocean Ecosystem

Evidence from observations during the past two decades and the results of modeling studies using historical and recent data from the North Pacific Ocean suggest that physical oceanographic processes, particularly climatic regime shifts, might be driving ecosystem-level changes that have been observed in the BSAI and GOA. These physical oceanographic processes are reviewed in Section 3.3. Commercial fishing has not been largely implicated in BSAI and GOA ecosystem changes, but studies of other ecosystems with much larger fishing pressures indicate that fishing, in combination with climate change, can alter ecosystem species composition and productivity (Jennings and Kaiser 1998, Livingston and Tjelmeland 2000).

During 1997 and 1998, a period of warmer-than-usual ambient air temperatures (Hare and Mantua 2000), a number of unusual species occurrences were observed in the BSAI and GOA, including the following examples:

- In 1998, several warm-water fish species, including Pacific barracuda (*Sphyraena argentea*), were observed and/or caught in the GOA. Ocean sunfish (*Mola mola*) and chub mackerel (*Scomber japonicus*), occasionally recorded in southeast Alaskan waters, were documented there in unusually large numbers. Similarly, Pacific sleeper sharks (*Somniosus pacificus*) were caught (and released) in higher than normal levels in Cook Inlet, and salmon sharks (*Lamna ditropis*) were taken in fairly large numbers off Afognak Island (Kevin Brennan, ADF&G, personal communication).

- Spiny dogfish (*Squalus acanthias*) substantially increased in the Kodiak area and in Prince William Sound (Bill Bechtol and Dave Jackson, ADF&G, personal communication). In 1998, this species' inclusion in collection tows increased by more than 40 percent. A corresponding increase in spiny dogfish has been observed in the International Pacific Halibut Commission's GOA halibut longline bycatch surveys (Lee Hulbert, NMFS, personal communication).

- Individuals of several marine mammal species were seen at unusual times and/or places during 1998, including a Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) near Haines and a northern right whale (*Eubalaena glacialis*) off Kodiak Island.

- Unusual bird sightings in the GOA included a gray-tailed tattler (*Heteroscelus brevipes*) south of the Kenai Peninsula and a mallard (*Anas platyrhynchos*) several miles offshore in the open ocean. Common murre (*Uria aalge*) die-offs were reported in Cook Inlet, Kodiak, the eastern Aleutians, Resurrection Bay, and the EBS.

- Three northern elephant seals (*Mirounga angustirostris)* were spotted in nearshore waters around Unalaska during late June and early July, whereas they are usually found farther offshore and at a different time of year.

- There were poor returns of chinook (*Oncorhynchus tshawytscha*) and sockeye (*Oncorhynchus nerka*) salmon to Bristol Bay during both years.

Research on climate shifts as a forcing agent on species and community structure of the North Pacific Ocean can be found in Francis and Hare (1994), Klyashtorin (1998), McGowan *et al.* (1998), Hollowed *et al.* (1998), and Hare and Mantua (2000). The approach used in these studies assesses correlations between past climatic patterns and changes in biomass or recruitment rate for particular marine species. Because cause-and-effect relationships between temporal and spatial patterns of climate change and corresponding patterns of change in biological populations have not been proven for the BSAI and GOA, the correlations must be considered circumstantial. But there are reasons to expect that causal links do exist. For example, stronger recruitment would be expected under more favorable climatic conditions, because more juveniles would be likely to survive to adulthood, whereas harsh conditions would result in weak recruitment because fewer juveniles would survive. In both cases, the recruitment patterns would be reflected in the strength or weakness of the affected age groups within future fisheries.

Francis and Hare (1994) analyzed historical data supporting a climate shift that caused a precipitous decline in the sardine (*Sardinops sagax*) population off Monterey, California in the 1950s. Although it had been widely concluded that this decline resulted solely from overfishing, the data indicate instead that a change in sea surface temperature was closely correlated with the sardines' disappearance, and this related closely to patterns of sardine numbers in marine sediments off Southern California. Consequently, both climate and fishing are now recognized to be implicated in the sardine population decline.

Francis and Hare (1994) related the intensity of the Aleutian low pressure system (Aleutian low), a weather pattern, with production of salmon and zooplankton. Winter ambient air temperatures at Kodiak and the North Pacific Index, an index tracking the intensity of the Aleutian low during the winter, were used as indicators of climatic severity. Strong correlations were found between long-term climatic trends and Alaskan salmon production. Annual weather patterns were found to be closely correlated with changes in zooplankton populations.

For the northeastern North Pacific Ocean, McGowan *et al.* (1998) showed that interannual climatic variations linked to the ENSO and decadal-scale climate shifts can be detected in physical oceanographic data. For instance, the depth of the mixed layer in the California Current and GOA became shallower over time, whereas the mixed-layer depth in the Central Pacific deepened during the same period. This was not, however, reflected in the mass flow of the California Current. Greater depth of the mixed layer during elevated sea surface temperature events was correlated with decreased nutrient availability, plankton abundance, and shifts in community structure. These researchers concluded that climatic events such as ENSO are correlated with changes in biological populations associated with the California Current. Biological processes in the GOA appear to be more strongly influenced by variations in the Aleutian low.

According to McGowan *et al.* (1998), climate-related changes in the biological communities of the California Current system ranged from declines in kelp forests to shifts in the total abundance and dominance of various zooplankton species. Some fish and invertebrate populations declined, and the distributional ranges of species shifted northward. In addition, seabird and marine mammal reproduction were apparently affected by ENSO conditions. Interdecadal changes in community structure also occurred, with intertidal communities becoming dominated by northward-moving southern species and changes in species proportions occurring in most other sectors of the ecosystem.

Interdecadal shifts observed in the northeastern North Pacific Ocean ecosystem have been of the opposite sign from those in the California Current system, with increases in zooplankton biomass and salmon landings observed in the GOA (McGowan *et al.* 1998, Francis and Hare 1994). These shifts have corresponded to the intensity and location of the winter mean Aleutian low, which changes on an interdecadal time scale.

Klyashtorin (1998) linked catch dynamics of Japanese sardines, California sardines, Peruvian sardines, Pacific salmon, Alaska pollock, and Chilean jack mackerel in the Pacific with an atmospheric circulation index that shows trends similar to the North Pacific Index used by other researchers. Other species, such as Pacific herring and Peruvian anchovy, are negatively associated with this index.

Hollowed *et al.* (1998) analyzed oceanographic and climatic data from the eastern North Pacific Ocean and compared those data with information on recruitment for 23 species of groundfish and five non-salmonid species and with catch data for salmon. The fish recruitment data were compared to environmental factors over various time scales and with varying time lags. Hollowed *et al.* (1998) found that, for species such as pollock, cod, and hake, recruitment was generally stronger during ENSO events. Whereas salmon and large-mouthed flatfish such as arrowtooth flounder, Greenland turbot, and Pacific halibut responded more strongly to longer-term events such as decadal-scale climatic regime shifts. Because both ENSO and decadal-scale ecosystem shifts are environmentally controlled, the results of this analysis support climate change as an important controlling factor in ecosystem dynamics.

There is considerable evidence that decadal and basin-scale climatic variability (Section 3.3.4) can affect fish production and ecosystem dynamics. Sudden basin-wide shifts in climatic regime have been observed in the North Pacific Ocean (Mantua *et al.* 1997), apparently due to changes in atmospheric forcing. Eastward- and northward-propagating storm systems dominate the wind stress on surface waters for short periods (less than one month), mixing the upper layers and altering sea surface temperatures (Bond *et al.* 1994). Because fish are very sensitive to ambient water temperature, even changes in surface temperature, if sufficiently frequent or prolonged, can alter fish distribution and reproductive success as well as recruitment (the number of juveniles that survive to enter the adult, reproducing portion of the population).

In a long-term trends analysis by computer, Ingraham and Ebbesmeyer (Ingraham *et al.* 1998) used the OSCURS model to simulate wind-driven surface drift trajectories initiated during winter months (December through February) for the period 1946 to present. The model-generated endpoints of the 3-month drift trajectories shifted in a bimodal pattern to the north and south around the mean. The winter flow during each year was persistent enough to result in a large displacement of surface mixed-layer water. The displacement also varied in a decadal pattern. Using the rule that the present mode is maintained until three concurrent years of the opposite mode occur, four alternating large-scale movements in surface waters were suggested: a southward mode from 1946 to 1956, a northward mode from 1957 to 1963, a southward mode from 1964 to 1974, and a northward mode from 1975 to 1994. As more northern surface water shifts southward, colder conditions prevail farther south, and as southward water moves northward, warmer conditions prevail farther north, both potentially affecting fish distribution and population dynamics.

Real-world evidence that atmospheric forcing alters sea surface temperatures comes from two principal sources: shorter-term ENSO events and longer-term Pacific Decadal Oscillations (Mantua *et al.* 1997). Temperature anomalies in the BSAI and GOA indicate a relatively warm period in the late 1950s, followed by cooling especially in the early 1970s, followed by a rapid temperature increase in the latter part of that decade. Since 1983, the BSAI and GOA have undergone different temperature changes. Sea surface temperatures in the BSAI have been below normal, whereas those in the GOA have been generally above normal. Consequently, the temperature difference between the two bodies of water has jumped from about 1.1°C to about 1.9°C (U.S. GLOBEC 1996).

Subsurface temperatures, potentially an even more important influence on biological processes, have been documented to change in response to climatic drivers. There was a warming trend in subsurface temperatures in the coastal GOA from the early 1970s into the 1980s similar to that observed in GOA sea surface waters (U.S. GLOBEC 1996).

In addition, seawater temperature changes in response to ENSO events occurred, especially at depth, in 1977, 1982, 1983, 1987, and in the 1990s. The 1997-1998 ENSO event, one of the strongest recorded in the twentieth century, substantially changed the distribution of fish stocks off California, Oregon, Washington, and Alaska. The longer-term impacts of the 1997-1998 ENSO event remain to be seen. Francis *et al.* (1998) reviewed the documented ecological effects of this most recent regime shift through lower, secondary, and top trophic levels of the North Pacific Ocean marine ecosystem. Some of the following impacts on higher trophic levels are based on this review:

- Parker *et al.* (1995) demonstrated marked similarities between time series of the lunar nodal tidal cycle and recruitment patterns of Pacific halibut.

- Hollowed and Wooster (1995) examined time series of marine fish recruitment and observed that some marine fish stocks exhibited an apparent preference (measured by the probability of strong year and average production of recruits during the period) for a given climate regime.

- Hare and Francis (1995) found a striking similarity between large-scale atmospheric conditions and salmon production in Alaska.

- Quinn and Niebauer (1995) studied the Bering Sea pollock population and found that high recruitment coincided with years of warm ocean conditions (above normal air and bottom temperatures and reduced ice cover). This fit was improved by accounting for density-dependent processes.

Additional evidence of marine ecosystem impacts linked to climatic forcing comes from Piatt and Anderson (1996), who provided evidence of possible changes in prey abundance due to decadal-scale climate shifts. These authors examined relationships between significant declines in marine birds in the northern GOA during the past 20 years and found that statistically significant declines in common murre populations occurred from the mid- to late 1970s into the early 1990s. They also found a substantial alteration in the diet composition of five seabird species collected in the GOA from 1975 to 1978 and from 1988 to 1991, changing from a capelin-dominated diet in the late 1970s to a diet in which capelin was virtually absent in the later period.

The effects of ten-year regime shifts on the inshore GOA were analyzed using data from 1953 to 1997 (Anderson and Piatt 1999). Three taxonomic groups dominated (approximately 90 percent) the biomass of commercial catches during this period: shrimp, cod and pollock, and flatfish. When the Aleutian low was weak, resulting in colder water, shrimp dominated the catches. When the Aleutian low was strong, water temperatures were higher, and biomass the catches were dominated by cod, pollock, and flatfish. Similar results were reported in very nearshore areas of lower Cook Inlet (Robards *et al.* 1999).

Few patterns were seen in the less-common species over the course of the study. Generally, the transitions in dominance lagged behind the shift in water temperature, strengthening the argument that the forcing agent was environmental. However, different species responded to the temperature shift with differing time lags. This was most evident for species at higher trophic levels, which are typically longer-lived and take longer to exhibit the effects of changes. The evidence suggests that the inshore community was reorganized following the 1977 climate regime shift. Although large fisheries for pandalid shrimp may have hastened the decline for some stocks (Orensanz *et al.* 1998), unfished or lightly fished shrimp stocks showed declines. Both Orensanz *et al.* (1998) and Anderson and Piatt (1999) concluded that the large geographic scale of the changes across so many taxa is a strong argument that climate change is responsible.

Other studies have linked production, recruitment, or biomass changes in the BSAI with climatic factors. For example, a climate regime shift that might have occurred around 1990 has been implicated in a large increase in gelatinous zooplankton in the BSAI (Brodeur *et al.* 1999). Recruitment in both crabs and groundfish in the BSAI has been linked to climatic factors (Zheng and Kruse 1998, Rosenkranz *et al.* 1998, Hollowed *et al.* 1998, Hare and Mantua 2000).

There are indications from several studies that the BSAI ecosystem responds to decadal oscillations and atmospheric forcing, and that the 1976-1977 regime shift had pronounced effects. A peak in chlorophyll concentrations in the late 1970s was closely correlated with an increase in summer mixed-layer stability documented at that time (Sugimoto and Tadokoro 1997). Also, on a decadal time scale, chlorophyll concentrations in the summer were positively correlated with winter wind speeds, indicating a positive response of BSAI phytoplankton to stronger Aleutian lows (Sugimoto and Tadokoro 1997).

Evidence of biological responses to decadal-scale climate changes are also found in the coincidence of global fishery expansions or collapses of similar species complexes. Sudden climate shifts in 1923, 1947, and 1976 in the North Pacific Ocean substantially altered marine ecosystems off Japan, Hawaii, Alaska, California, and Peru. Sardine stocks off Japan, California, and Peru exhibited shifts in abundance that appear to be synchronized with shifts in climate (Kawasaki 1991). These historical 60-year cycles are seen in paleo-oceanographic records of scales of anchovies, sardines, and hake as well. Other examples are salmon stocks in the GOA and the California Current whose cycles are out of phase. When salmon stocks do well in the GOA, they do poorly in the California Current and vice-versa (Hare and Francis 1995, Mantua *et al.* 1997).

In addition to decadal-scale shifts, interannual events such as the ENSO can have significant impacts on fish distribution and survival, and can affect reproduction, recruitment, and other processes in ways that are not yet understood. This is particularly true for higher-latitude regions such as the northern California Current and GOA. As noted above, the 1997-1998 ENSO event significantly changed the distribution of fish stocks off California, Oregon, Washington, and Alaska. A change that has persisted to the present. Predicting the implications of this trend for future fishery management is problematic, in part because ENSO signals propagate from the tropics to high latitudes through the ocean as well as through the atmosphere, and it is difficult to separate these two modes of influence. Information on the dynamics of North Pacific Ocean climate and how this is linked to equatorial ENSO events is not adequate to adjust fisheries predictions for such abrupt, far-reaching, and persistent changes. Warm ocean conditions observed in the California Current during the present regime may be due, in large part, to the increased frequency of ENSO-like conditions.

In conclusion, evidence from past and present observations and modeling studies at the community and ecosystem levels for the BSAI and GOA suggest that climate-driven processes are responsible for a large proportion of the multi-species and ecosystem-level changes that have been documented. Modeling studies have been a valuable tool for elucidating the possible long-term implications of various fishing strategies. As with all computer-based models, these have been sensitive to unproven assumptions about recruitment and its relationship to climate. As the preceding discussion suggests, the models could be improved by incorporating components that include climatic effects on species, particularly with respect to recruitment. However, this approach has not been widely applied yet to species in the BSAI and GOA ecosystems.

3.10.2 Interactions Among Climate, Commercial Fishing, and Ecosystem Characteristics in the North Pacific Ocean

As the preceding discussions show, groundfish fishery management in the BSAI and GOA is implemented in a dynamic environment where both commercial fishing and climate-driven physical oceanographic processes interact in complex ways to affect the marine ecosystem. To characterize these interactions, it is necessary to distinguish, where feasible, the separate effects of fishing and climate on biological populations. The following discussion reviews current knowledge regarding these effects and their relationship to ecosystem characteristics.

Three processes underlie the population structure of species in marine ecosystems: competition, predation, and environmental factors. Natural variations in the recruitment, survival, and growth of fish stocks are consequences of these processes. The first process, competition, is a basic concept underlying many ecological theories (e.g., Hairston *et al.* 1960, Welden and Slauson 1986, Yodzis 1978, 1994). It requires an assumption that species in an ecosystem are limited in their access to critical resources such as food, space, reproductive mates, and time for important activities. Predation is important, because it changes prey density, thereby directly or indirectly affecting populations throughout the ecosystem. Finally, environmental factors, particularly climatic processes, are thought to be major agents of change in North Pacific Ocean ecosystems. Climate has the potential to influence the important biological processes of reproduction, growth, consumption and predation, movement, and, ultimately, the survival of marine organisms.

Against this complex and dynamic natural background, human activities such as commercial fishing can influence the structure and function of marine ecosystems. Like competition, predation, and climate change, the effects of commercial fishing can extend over a range of temporal, spatial, and population scales. Large-scale commercial fishing has the potential to influence ecosystems in several ways. It may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways though the return of discards and fish processing offal back into the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. In addition, the selective removal of species has the potential to change predator-prey relationships and community structures. Fishing gear may alter bottom habitat and damage benthic organisms and communities.

Both climate and commercial fishing activity currently influence the structure and function of the North Pacific Ocean ecosystem (Francis *et al.* 1999). Since climate change and commercial fishing can co-vary, it may be difficult to distinguish the impacts of the two (e.g., Trites *et al.* 1999). The primary way in which complex scientific knowledge is integrated to further the understanding of the influence of natural and human-related processes on marine ecosystems is through the use of models. Models can be as simple as conceptual diagrams that show a picture of how we think a certain ecosystem process operates, or they can be very complicated, with quantitative descriptions of the relationships between various factors and species growth, recruitment, movement, or survival. Reviews of the status of models that have been developed to understand the effects of climate and fishing on ecosystems have been produced by Livingston (1997) and Hollowed *et al.* (2000a). These reviews outline the types of models presently being used and the state of our ability to understand and predict the effects of the two important factors of climate and fishing in marine ecosystems by using models.

Most models that consider more than one species link the species together through knowledge about their feeding (trophic) interactions. Once the trophic linkages among species are understood, questions about impacts of predators and prey on one another (Yodzis 1994), or how natural or human-induced habitat changes affect the food-web structure (Yodzis 1996), can be addressed with a variety of multi-species or ecosystem models. Another model type, called a technical interaction model, may consider the simultaneous capture of groups of species by a particular fishery or type of fishing gear.

With the exception of information on forage fish, which—unlike many marine species—are preyed on as adults and not just mainly as juveniles, most scientific advice from multi-species models is not presently being used in making short-term management decisions. These models are mainly useful for trying to understand the possible medium- (6 to 10 years) and longer-term implications of various management strategies on the ecosystem.

However, long-term predictions from single-species, multi-species, and ecosystem-level models remain uncertain, because the predictions rely heavily on assumptions about recruitment, particularly for predators (Gislason 1991 and 1993), which may be strongly influenced by environmental variation. Limitations still exist regarding the ability to predict both future changes in climate and recruitment rates resulting from a particular climate state.

Therefore, as noted by Parkes (2000) and Hall (1999a), predator-prey models are not considered reliable enough to provide directly applicable management advice at the present time. Hall (1999b) notes that ecosystem-based management advice should move toward setting single-species biological reference points for non-target species, developing single-species reference points for localized regions (i.e., spatially explicit management), and using measures of system-level properties (e.g., species diversity, trophic level of the catch, biomass-size distributions) to derive ecosystem-level reference points.

Food web models of the BSAI, specifically, the EBS shelf, ecosystem have been developed for the 1950s and 1980s (Trites *et al.* 1999). These models use the Ecopath strategy for evaluating mass-balance in marine ecosystems. Ecopath uses estimates of biomass, consumption, diet, and turnover rates of populations or groups of populations to evaluate energy flow and mass-balance in a particular ecosystem (Christensen 1990).

Ecopath creates static biomass flow models of ecosystems and represents a snapshot of the ecosystem for a given time period. Species in these models are linked, so that the biomass transfer resulting from processes such as fecundity, mortality, production, respiration, and predation are in equilibrium (balanced). These types of models provide a way to identify large-scale views of ecosystems and to highlight data gaps (Christensen 1990, 1992, 1994; Pauly and Christensen 1995).

An examination of energy flow within the ecosystem is instructive, although one must be careful in interpreting the inevitable differences among the flow estimates. For instance, although the magnitude of biomass flow from prey to tertiary consumers (e.g., juvenile pollock to seabird predators) is modest relative to that between primary producers and primary consumers (e.g., phytoplankton to crustaceans), it may nonetheless play a significant role in the dynamics of the food web (P. Yodzis, University of Guelph, Ontario, Canada, personal communication). Further, if a food web is composed of few, highly connected species in a trophic sense, removal of a predator may yield a larger ecosystem perturbation than a similar removal from an ecosystem with weaker trophic links among many predators and prey (e.g., Pimm 1982).

The Ecopath models for the Bering Sea were initially developed to see if impacts of intensive whale harvesting that occurred in the 1950s and 1960s were sufficient to explain the ecosystem structural changes that were observed in the 1980s, discussed in Section 3.10.1.3. The primary removal of energy in both decades was by harvesting whales and pelagic fishes in the 1950s, and pollock in the 1980s. The production estimate for the 1950s simulation showed baleen whales as the dominant ecosystem component. These whales were classed as a midlevel consumer with a trophic level slightly higher than pollock, due to their consumption of squid. The dominant component in the 1980s simulation was pollock, the dominant fishery. There was a slight drop in trophic level of the catch between the two periods, but this was acknowledged to be an artifact of the volume of squid assumed in the diet of the baleen whales. Without this assumption, there was little change in trophic level of harvest. Trophic level of the catch actually incr eased from the 1950s to the 1980s, if only fish harvests are considered. This would suggest that harvesting in the Bering Sea at present is at a level that has been sustained over long periods. A further result of this simulation was that whale harvests required an estimated 47 percent of net primary production in the Bering Sea in the 1950s. Fisheries of the 1980s, dominated by pollock, required only 6.1 percent of primary production.

Measures of ecosystem maturity show some differences between the two Bering Sea models. The ratio of primary production to respiration, net system production, and the ratio of biomass to throughput indicate a more mature ecosystem state in the 1950s compared with the 1980s. This is due to the assumption that benthic infauna biomass was lower in the 1980s. However, benthic infaunal surveys used to estimate biomass for the two models used different methods and may not be comparable.

Trophic pyramids are similar for the two time periods, and both indicate that biomass and energy flow were distributed fairly well throughout the system. The steep-sided shape of the pyramids indicates that there is a lot of energy flow at lower trophic levels. One system maturity index, the ratio of primary production to total biomass, actually indicates a more mature system in the 1980s relative to the 1950s. However, this was due to assumptions about the change in primary production between the two time periods, for which there is conflicting evidence. Conclusions about system maturity will be premature until trends in primary production and benthic infauna biomass are better understood.

The Bering Sea appears to be more mature than other modeled ecosystems, particularly with regard to total system throughput, which measures the sum of all energy flows in the system. It has ecosystem measures that indicate it has significant strength in reserve, which makes it more resilient or resistant to perturbations compared with other ecosystems.

Ecosim, a forward-looking simulation coupled to Ecopath, was used to project the results of various scenarios. The model was run in either an equilibrium or dynamic mode. The equilibrium mode assumed that the total biomass of the ecosystem remained stable, and as the biomass of one component declined, others were required to increase to balance it. Dynamic models do not have this requirement.

The equilibrium mode of Ecosim was used to examine the results of changes in a species' abundance on interacting groups. The results of the equilibrium model suggest that changes in baleen whale numbers could significantly affect pollock populations, and that increases in sperm whale numbers could yield decreases in the numbers of Steller sea lions through competition. Reducing pelagic fish numbers reduces the numbers of seabirds that feed on them, as well as numbers of Steller sea lions and large flatfish. Increasing fishing pressure on pollock would have little effect on their biomass, and increasing fishing pressure on large flatfish would result in increased Steller sea lion populations through the removal of a competitor.

In a different approach, the dynamic mode of Ecosim was used to look at possible mechanisms involved in the historical marine biomass changes seen between the 1950s and the 1980s. Scenarios used for the dynamic model were a regime shift that resulted in changes in primary production; a commercial fishery simulation to see if fishing whale could account for the observed changes; three pollock fishing scenarios that project into the future; and scenarios which varied the fishery mortalities on pollock and pelagic fishes.

These simulations suggested that commercial harvesting of fish and whales had little likelihood of producing the changes seen in actual pollock populations since the 1950s. The effect of increasing primary production provided a much more realistic change in the pollock population. While most groupings showed increases, Steller sea lions did not.

There are substantial uncertainties about the abundance of small pelagic fish in both time periods and the abundance of pollock in the 1950s model. Low abundance of pollock and higher abundance of small pelagic fish in the 1950s was assumed. However, although non-standardized surveys by the Soviets during the 1950s showed apparently lower pollock abundance, their research on diet composition of groundfish indicated that pollock was a primary prey item of many species. It is possible that pollock may have been more abundant in the 1950s than has been assumed. Further model testing with this change in assumptions should be done.

Another dynamic simulation showed that, contrary to what might be expected, stopping the commercial pollock harvest had a slight negative effect on Steller sea lions. This is because two of the Steller sea lion prey items, small pelagic fish and juvenile pollock, declined when adult pollock increased. Adult pollock are cannibalistic and compete with small pelagic fish for large zooplankton prey in this model. More recent versions of the model, which changed the assumptions regarding recruitment now show that juvenile pollock actually increase under this scenario, but that Steller sea lions still show a slight negative effect. This is presumably because of the assumption of the dominance of small pelagic fish as a prey item of Steller sea lions. Small pelagic fish still decline under the assumption of increasing pollock, because adult pollock compete with them for large zooplankton prey.

In conclusion, these model simulations indicate uncertainty about the biomass of lower trophic level species in the two time periods. It appears that climate-related shifts in lower trophic level production could partly explain the ecosystem changes that occurred between the 1950s and the 1980s. However, the model only captures predation-related recruitment variability and cannot show climate-related variability in recruitment, which is probably much larger. More detailed scenarios that examine the spatial availability of prey will have to be performed to improve our understanding of the complex interaction between fishery removals and predator-prey interactions.

3.10.3 Current North Pacific Ocean Ecosystem Status and Sustainability

In order to examine North Pacific Ocean ecosystem status and sustainability, we need to identify key ecosystem components and processes that characterize an ecosystem. We must identify features of these components and processes that may indicate whether Alaskan groundfish fisheries have had impacts on the BSAI and GOA ecosystems. The first step in this identification of key components and processes is to examine the definition of ecosystems.

A review of the literature shows that there are numerous definitions of what constitutes an ecosystem. One of the earliest definitions, by Tansley (1935), includes all of the organisms and all the physical factors, what he termed the habitat factors in the widest sense. These linked biological-physical systems are what he termed an ecosystem. It was clear from the definition that although most focus tended to be on the organisms in the system, those organisms could not be separated from their physical environment. Similarly, Botkin (1990) defined an ecosystem as a set of interacting species and their local, non-biological environment, functioning together to sustain life. Large marine ecosystems have been defined as regions characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations (Sherman and Alexander 1986). Odum's (1977) definition of an ecosystem also recognizes that the biological and physical aspects form a functional unit that has some characteristic trophic structure and material cycles (i.e., how energy or mass moves among the groups). Central to these definitions is the relationship of the organisms to the physical environment and the concept of trophically-dependent or interacting species or groups.

The main ecosystem components and processes that are important to evaluate in order to determine ecosystem impacts of human activities are still the subject of a great deal of research and debate. There are two fairly different scientific views of ecosystems. The functional view was expressed by Odum (1972) and the more hierarchical view was recognized by O'Neill *et al.* (1986). In Odum's functional view of ecosystems, the functional elements consist of:

- Energy flow circuits.
- Food chains (trophic relationships).
- Diversity patterns in space and time.
- Nutrient cycles.
- Development and evolution.
- Control (maintenance of a steady state at the system level by the use of feedback control mechanisms).

Functional components in this view are elements and molecules involved in material cycles (e.g., carbon, nitrogen, carbon dioxide, water); organic compounds that link living and non-living ecosystem components (proteins, carbohydrates, etc.); climate regime (temperature, rainfall, etc.); producers (mainly green plants), consumers (mainly animals that consume other animals or organic matter); and decomposers (mainly bacteria) that break down organic matter and release substances that can be used by producers. This view of ecosystems places energetics as the central focus. It deals with cyclic causal pathways and feedbacks that are often unobservable, but essential to ecosystem maintenance. In its extreme form, energy flow and nutrient cycling are more important than the living entities performing the function. This view tends to ignore the role of species in the system and makes it difficult to detect total ecosystem changes. Therefore, ecosystem study at this level of organization tends to be model-dominated.

Another dominant form of studying ecosystems is the population-community approach, in which ecosystems are considered as networks of interacting populations of different species. The abiotic environment is viewed as more of an external influence on the biological system and is not seen as an integral part of it. This level of study is observation-dominated, since most field research is focused at the population-community level. This view has limitations, in that it is difficult to infer ecosystem properties from species properties, although an exception might be the use of indicator or key species. The isolation of organisms from their biotic and abiotic environment in this approach can also make it difficult to understand ecosystem dynamics.

These two somewhat dichotomous views of ecosystems can be reconciled somewhat by recognizing that species serve important functional roles in ecosystems. An integrated view of the population-community level of study and the process-functional approach recognizes that ecosystems consist of sets of biological communities in which populations of organisms serve various functional roles (O'Neill *et al.* 1986). This view of ecosystems links the community-population studies that have been a dominant research focus with the process-functional approach that is typical of Odum's ecosystem definition, where the focus is more on flows of energy or matter.

Given these views of ecosystems, it seems an evaluation of North Pacific Ocean ecosystems should include key ecosystem processes or functions outlined by Odum, such as trophic relationships, diversity patterns, energy flow, and the role of the physical environment in influencing the dynamics, as well as information about species and communities. Because ecosystem features may be difficult to observe at the broad functional level that Odum describes, we should consider important observable processes at the species or community level that can provide an indication of changes that might be occurring at the ecosystem level.

Costanza (1992) prescribes three types of measures that might indicate overall ecosystem "health." These measures are vigor (a measure of system activity, metabolism, or primary productivity), organization (includes diversity and connectivity), and resilience (ability of a system to maintain structure and patterns of behavior in the face of disturbance). He suggests network analysis and simulation modeling to develop these measures. However, as was noted in Section 3.10.2, simulation models are not well developed in this regard, and we may need to rely more heavily on indicators that are direct measures of small pieces of the system in order to evaluate the present status of North Pacific Ocean ecosystems. Therefore, we will focus more on species- and community-level measures that indicate changes in trophic relationships, diversity patterns, energy flow, and the role of the physical environment in influencing these changes.

Because of the need for further validation of predator-prey and ecosystem models, there has been a large effort to develop indicators of ecosystem change based on more observable aspects of ecosystems and factors influencing them, such as fishing and climate. The Ecosystem Considerations Chapter of the Groundfish Stock Assessment and Fishery Evaluations Reports (NPFMC 2002) provides a compendium of status and trends of various ecosystem components and present status of knowledge with regard to human and climate-induced factors that might be influencing these components. Key indicators of ecosystem change with regard to trophic relationships, diversity patterns, and energy flow can be derived from these species- and community-level measures.

As noted above, commercial fishing can influence ecosystems by altering predator-prey relationships, not only by removing key species but also through the introduction of non-indigenous species; by adding or removing energy and redirecting pathways of energy flow through fish removals and the return of discarded biomass to the sea; and by altering biodiversity as measured in a variety of ways, including species-level diversity, functional diversity, and genetic diversity. Any fisheries management policy that allows commercial fishing will create the potential for such effects to a greater or lesser degree. Since passage of the MSA in 1976, fisheries management policy in the BSAI and GOA has been implemented against the background of a relatively mature and resilient ecosystem that has exhibited changes in species composition, guild and community structure, production, recruitment, geographic distribution, and biomass. As discussed in Sections 3.10.1.5 and 3.10.2, the factors driving these ecosystem changes remain speculative, but decadal-scale climate shifts and interannual climatic variations linked to the ENSO phenomenon have been suggested as forcing agents (McGowan *et al.* 1998). For example, increases in zooplankton biomass and in salmon landings documented in the GOA have been correlated with the intensity and location of the winter mean Aleutian low pressure system, which changes on an interdecadal time scale (Francis and Hare 1994, McGowan *et al.* 1998, Orensanz 1998, Anderson and Piatt 1999, Robards *et al.* 1999). Beyond such correlations with climatic indices, cause-and-effect relationships between climate and ecosystem changes have not been proven, but climate-related changes in physical oceanographic factors such as temperature, salinity, current patterns, upwellings, sediment composition, and nutrient supply have been implicated (e.g., Meuter 1999).

Changes in BSAI and specifically in EBS species composition within guilds and in total guild biomass have been examined to determine if they might be correlated with fishing pressure on predator-prey cycles. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected invertebrate, fish, bird, and marine mammal species did not show positive correlations with prey abundance, and that cyclic fluctuations in abundance occurred in both fished and unfished species. Furthermore, these workers found that changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure. The authors concluded that the EBS ecosystem shows two indicators of stability. First, the trophic level of the harvest, after rising slightly since the 1950s, appears to be stable as of 1994, suggesting that present harvest levels are sustainable. Second, the fish populations examined are stable, i.e., fluctuate normally without showing prolonged trends in a particular direction. This conclusion is supported by modeling results indicating that the Bering Sea ecosystem is more stable, i.e., more resilient or resistant to perturbations, than other modeled ecosystems. That the system is more mature, i.e., biomass and energy flow are distributed more evenly at various trophic levels than in other modeled ecosystems.

Commercial fishing can remove predators, prey, or competitors, thus altering predator-prey dynamics in the food web. Fishing can selectively remove fish-eating predators, then move down the food web and begin removing the next trophic level down, such as plankton-feeding fish. This process is known as fishing down the food web. Trophic level of the fish and invertebrate catch from the BSAI and GOA was estimated from the 1960s to the present (Queirolo *et al.* 1995, Livingston *et al.* 1999) to determine whether such fishing-down effects were occurring. Trophic level of the catch in both management areas has been relatively high and stable over the last 30 or more years. There is no evidence from the present fishery management regime that this fishing-down-the-food-web process has occurred.

Fisheries can have direct impacts on top predators such as sharks, seabirds, and marine mammals that are not part of the directed fishery but may be caught as bycatch. Sections 3.5.3, 3.7, and 3.8, respectively, describe the present-day baseline effects of the groundfish fishery bycatch on these top predator groups. Historical whaling has resulted in low present-day abundance of whale species in the North Pacific. Shark bycatch rates are variable by region, and present-day groundfish fishery impacts are unknown. There is no evidence that present levels of seabird and mammal bycatch in groundfish fisheries are an important source of mortality for most species.

Groundfish fisheries, through selective targeting or bycatch, can remove prey and thus negatively affect other ecosystem components that rely on those prey. Recent concerns have focused on the availability of pelagic prey in the North Pacific Ocean ecosystems in this regard. Thus, measures of the availability of pelagic prey such as walleye pollock, Atka mackerel, Pacific herring, and forage species are an indicator of possible groundfish fishery impacts on predator-prey relationships. See Sections 3.5.1, 3.5.2, and 3.5.4, respectively, for details about the present baseline for these species. Studies of pelagic forage availability show BSAI pollock and Atka mackerel above MSST, GOA pollock at low abundance levels, and BSAI herring as stable. Biomass estimates for forage species are not available, but bycatch estimates in the groundfish fisheries are above average, and relative abundance indices from bottom trawl surveys indicate possible increases in eulachon and capelin in the GOA (NPFMC 2002).

Also of concern with respect to predator-prey relationships is the effect that fisheries may have on prey availability at various spatial and temporal scales. Although prey availability might be high when viewed at the global or stock level, there is potential for localized prey depletion by groundfish fisheries. Previous analyses showed the potential of this effect for walleye pollock and Atka mackerel, and seasonal/spatial allocations of pollock and Atka mackerel catches have reduced the potential for this possible fishery impact in the present-day baseline. Seasonal and temporal catch allocations of pollock and Atka mackerel, along with SSL closures, have spread out fishing removals in space and time, although recent results show BSAI pollock fisheries increasing catch in northern fur seal foraging habitat.

Studies of predator-prey relationships in the BSAI and GOA regions, primarily in the EBS, suggest that there has not been clear evidence of fishing-related species fluctuations through food-web effects. Recent work done primarily in Port Valdez/Prince William Sound shows that biological introductions of non-indigenous species have occurred, although these introductions cannot be ascribed to a particular vessel type, such as oil tankers or fishing vessels (Hines *et al.* 2000). There have been 24 species of non-indigenous species of plants and animals documented in Alaskan waters, primarily in shallow-water marine and estuarine ecosystems, with 15 species recorded in Prince William Sound. One example of a likely introduction is the predatory seastar *Asterias amurensis*, which is found in other areas of Alaska but has not previously been found in Cook Inlet. Although these predators have the potential to produce a major impact on benthic communities, impacts from these introductions have not yet been observed in Alaskan waters. It is possible that most of these introductions were from tanker vessels or other large ships that have large volumes of ballast-water exchange. However, exchange via fishery vessels that take on ballast from areas where invasive species have already been established and that transit in inshore Alaskan waters has been identified as a threat in a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). Therefore, it is concluded to be a conditionally significant adverse effect of fishing in the ecosystem baseline.

High-volume fishing and fish processing may alter the amount and flow of energy in an ecosystem by removing energy (i.e., large numbers of fish) and by altering pathways of energy flow through the return of discards and offal to the sea. Results of mass-balance modeling by Trites *et al.* (1999) to investigate this question with respect to the EBS suggest that biomass and energy flow are evenly distributed throughout the system, and that the EBS is more mature, i.e., less disturbed (Odum 1985), than comparable shelf ecosystems. The annual total catch biomass in the EBS is estimated at about one percent of the total system biomass, excluding dead organic material. There is no indication that the annual removal of this small biomass percentage alters the amount and flow of energy sufficiently to affect ecosystem stability.

Annual surplus production is a real property of a population that can be measured or estimated.
Surplus production is defined as population growth plus recruitment minus natural mortality (Ricker 1978). It is "surplus" only in the narrow technical sense that it is production not required to maintain the population at current abundance. Annual surplus production can be either positive or negative. When the population is lower than its carrying capacity, expected surplus production is positive, i.e., the population tends to increase towards its carrying capacity. At some fraction of the carrying capacity between zero and 100 percent expected surplus production reaches a maximum. These relatively simple ecological concepts underpin MSY-based harvest policies. Whether maximum surplus production occurs at 50 percent of carrying capacity or some other level is a question best addressed with empirical studies of populations living in real ecosystems. Studies such as Myers et al. (1994) support the use of F40% as a risk-averse approach to MSY management, which would be expected to reduce the spawning population to 35-45 percent of carrying capacity. The percent reduction of juvenile fish not targeted by the fishery is likely to be much smaller (<20 percent reduction from carrying capacity) and may even increase under MSY-based harvest policies. Since juvenile fish are often targeted by other top predators such as seabirds and pinnipeds, predators that depend on the same prey populations as fisheries would not be impacted to the degree implied by a 60 percent reduction in the spawning population.

From the perspective of systems theory, all carbon sequestered in the living organisms of an ecosystem must end up somewhere, either by being recycled, exported to other ecosystems, or deposited in the sediments. In the Eastern Bering Sea, predation by top predators accounts for a relatively small fraction of the total natural mortality of populations targeted by fisheries (Aydin et al. 2002). Disease, parasitism, and all the other hazards of longevity apparently account for most mortality, though these sources of mortality are poorly understood. Fish that die without being consumed by predators are a small fraction of the total carbon recycled into the system by decomposers. The fact that ecosystems by definition do not produce a surplus of carbon (or biomass) does not invalidate the logic behind MSY management.

The foregoing discussion has treated ecosystems as equilibrium systems that return to a stable steady state in the absence of disturbance. This static view of ecosystems is no longer prevalent. Recent research has shown the ecosystems are highly dynamic in response to decadal-scale environmental forcing. There may be unknown biological thresholds that once crossed can move the ecosystem to a new state. While it is appropriate to use single-species steady-state models to approximate overall harvest rates, a fully developed harvest policy must be robust to potential ecosystem variation not anticipated by simple equilibrium models. Several such safeguards are built in to North Pacific harvest policies. The harvest control rules for Tier 3 can be used as an example. First, the F40% harvest rate, for which FABC can never exceed, is well below

F35%, which is used as an estimate of FMSY. Second, instead of a constant F40% harvest strategy, the maximum permissible harvest rate is reduced progressively if the stock declines below B40%. For important prey species of Steller sea lions (Atka mackerel, Pacific cod and walleye pollock), harvest rates in the directed fisheries are reduced to zero at 20 percent of unfished stock size.

When a fishery occurs on prey population that is important to a top predator, a potential exists for competition to occur. Predicting how populations of top predators will respond to a reduction in prey availability is extremely difficult. Linkages between species in an ecosystem are complex and non-linear. Top predators have the ability to adapt to changing conditions by changing their foraging strategies. They can allocate more time to foraging, switch to other prey, switch to more abundant smaller fish of the same species. In some cases, fisheries may make prey more available to top predators, for example, by discard of bycatch.

Based on simple mass-balance ecosystem models (i.e. Ecopath), a numerical response of top predators to reductions in prey abundance would be expected. When a predator is obligate on a single prey species, predator abundance would decline at the same rate as prey abundance. In this extreme case, a 60% reduction in the abundance of prey would produce a 60% reduction in the abundance of the predator. However, most top predators consume a variety of species, and can switch other forage species when one becomes scarce. Diet diversity and the ability to substitute one prey species with another would tend to result in predictions from mass-balance models of a smaller percent reduction in top predator abundance. If other prey species increase in abundance due to competitive release when a fishery reduces the abundance of a target species, some top predators may increase in abundance. These directional changes in the abundance of top predators are based on general properties of simple ecosystem models that lack spatial structure. Predators forage in space, and may require a density of prey above a threshold to forage successfully. Although aggregate biomass models do not show these kinds of spatial effects, they are an important consideration.

When fish are discarded and processed wastes are returned to the sea, energy is redirected to different parts of the marine ecosystem relative to the natural state. Queirolo *et al.* (1995), working before present stricter retention requirements for pollock and cod were mandated, estimated that the total production of discarded fish and processing wastes in the BSAI and GOA ecosystems was about one percent of the unused detritus already going to the bottom. With the new retention requirements now in effect, this estimate would be substantially smaller. These authors found no changes in scavenger populations relating to changes in discard or offal production, and found the annual consumptive capacity of scavenging birds, groundfish, and crabs in the EBS to be over 10 times larger than the total production of discards and offal in the BSAI and GOA. Pathways of energy flow within the BSAI and GOA ecosystems, therefore, are apparently not redirected in any significant way by discarded fish bycatch and processing wastes that are returned to the sea.

Fishing gear can inflict unobserved mortality on target and non-target organisms that can be another source of energy redirection in the ecosystem. In particular, bottom gear can inflict mortality or make benthic organisms more available to predators. Loss of biological and physical structural habitat can lead to increased mortality of marine fish and invertebrates that rely on those structures for refuge from predation. See Sections 3.6.4 and 3.6.5 for a more complete description of fishing gear effects on bottom habitat. Consequently, an indicator of the potential for bottom gear to redirect energy in this fashion is the amount of bottom gear effort in the North Pacific Ocean. Present-day trends in bottom gear effort show there has been a decline in this effort over the last ten or more years (NPFMC 2002).

Biological diversity, the third index of ecosystem health in addition to predator-prey relationships and energetics, is measured in several ways. Species diversity can change if fishing removes all individuals belonging to a single species from the system. Comparative abundance, another measure of biodiversity, can change if fishing alters the numbers of individual representatives of one or more species relative to a defined baseline condition. Functional or trophic diversity can change if a member of a trophic guild is removed; this automatically alters species diversity, changes the way biomass is distributed within the trophic guild, and can affect the functional contribution of the trophic guild to the total ecosystem. The selective removal of organisms that share a particular characteristic, e.g., rapid growth, can alter genetic diversity. Removal of spawning aggregations has the potential to alter genetic diversity if the particular aggregation of fish removed from the system is genetically different from other aggregations.

Assessments of species diversity are lacking for the BSAI and GOA. This is a data gap that must be corrected so that a baseline for species diversity can be established for each of these ecosystems. Without such a baseline, it will not be possible to reliably quantify potential changes in species diversity under any future management regime. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate species diversity could be affected by bottom trawling. Because comparatively little is known about the taxonomic structure of benthic communities of the BSAI and GOA, the potential cumulative effect of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Population levels of target and prohibited species show that virtually all of them are above MSST, with the exception of some Bering Sea crab populations (Section 3.5.2.4). Bottom trawl surveys provide an index of abundance for many non-target fish species, and although abundance changes have been observed (NPFMC 2002), there is no evidence in the baseline for fishing effects leading to species extinction. Trends in the number of ESA-listed species might also be an indicator of species diversity changes, but these numbers have been relatively constant, and fishery management actions have been taken to mitigate the effects of fishing on these species (Section 3.4). Area closures provide protection against species extinctions, and the amount of area closed to fishing is another measure of protection of species diversity. The amount of area closed to fishing has been increasing in the baseline and thus has provided an unknown, but presumably increasing, degree of protection against decline in species diversity (Section 3.6). The past/present effects of fishery management policies and of external actions and events on the BSAI and GOA ecosystems are summarized in Table 3.10-3.

With respect to trophic guild diversity, Livingston *et al.* (1999) investigated the variability and evenness of biomass levels in guilds of the EBS. They found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. Changes in guild biomass diversity were observed when a dominant guild component (e.g., pollock) changed in abundance, but these changes were related primarily to recruitment rather than to fishing, and there appeared to be no significant loss of functional (trophic) diversity. Bottom gear effort, which is an indicator of benthic community guild disturbance, has been decreasing (NPFMC 2002). HAPC biota (Section 3.6.2), a group of benthic organisms that might be considered a structural habitat guild, do not show fishing-related declines, and some groups (sponge, sea anemone, and sea pens) show increasing or relatively high abundance indices in recent bottom trawl surveys of the BSAI and GOA (NPFMC 2002), as discussed in more detail in Section 3.6. However, corals, which are a very long-lived component of the HAPC biota functional guild, are not well assessed in the baseline. Furthermore, present closed areas do not have much overlap with known coral distributions. Consequently, there is a potential for a conditionally significant adverse impact of fishing on structural diversity through effects of bottom gear on corals.

Genetic diversity has not been systematically studied under the current fisheries management regime, and this is another data gap that prevents establishment of a baseline against which future assessments might be gauged to determine if significant changes have occurred. If a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of a baseline. Even in heavily fished systems such as the North Sea, however, there is little evidence that selection for body length in cod has reduced genetic diversity after 40 years of intensive fishing. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have indicated genetic variations among different stocks. These studies, however, have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. There has been heavy exploitation of certain spawning aggregations historically (e.g., Bogoslof pollock), but present-day spatial-temporal management of the groundfish fishery has tended to reduce fishing pressure on spawning aggregations. It is unknown whether commercial fishing has altered the genetic diversity of stocks with distinct genetic components at finer spatial scales than the present groundfish fishery management regions.

In conclusion, the BSAI and GOA groundfish fishery management areas generally exhibit sustainable ecosystem-level characteristics with regard to overall productivity and the ability to maintain structural and functional patterns in the face of disturbance. Decadal-scale climate shifts and interannual climatic variations linked to the ENSO phenomenon have been suggested as forcing agents for ecosystem changes (McGowan *et al.* 1998). The evidence discussed here suggests that against the background of climatic variation, fishery-related effects on ecosystem parameters, while present to varying extents, have not been large, and that the contribution of the fishing side may be relatively small in comparison to the climatic drivers.

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Chapter 4

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Chapter 4 Environmental and Economic Consequences

This Programmatic Supplemental Environmental Impact Statement (SEIS) has so far presented the preliminary information necessary to analyze the potential impacts resulting from implementation of any of the five policy alternatives (Alternatives 1-4, plus the North Pacific Fishing Management Council's [NPFMC] Preferred Alternative). We have explained the purpose and need for federal action (Chapter 1) and reviewed both the legal context of federal fisheries management in Alaska and the tools managers use to satisfy those legal requirements (Chapter 2); also in Chapter 2, we defined the alternatives presented in this document and the Fishery Management Plan (FMP) bookends created to illustrate the range of management measures that might be used to implement a given policy alternative; and, in Chapter 3, we defined the environmental and economic baseline conditions against which the impacts of the alternatives can be measured.

We now turn to the work of analyzing the possible impacts of the alternatives. Chapter 4 presents our analysis of the FMP bookends and the environmental and economic impacts that might reasonably be expected to follow from implementation of the suite of management measures contained in each FMP bookend. The analyses contained in this chapter will thus allow readers to evaluate the relative effectiveness of the policy alternatives in meeting the legal, environmental, and economic demands of the federal groundfish fisheries off Alaska.

Analysis of the impacts of management policies requires knowledge of potential actions that could be taken to implement the policy. Policies are, by definition, a high-level, overall statement or plan embracing the general goals and procedures of a government body. In the United States (U.S.), policies usually reflect the values and wisdom of the citizens, as expressed by laws and agencies of the nation. Policy goals and objectives are often used to frame the policy and make the statement clearer and easier to understand. Still, determination of the effects of a policy on the human environment is difficult to comprehend and analyze without some indication of how the policy might be implemented.

This chapter evaluates a number of example FMPs intended to illustrate a particular policy as defined by the alternatives described in Section 2.6. In evaluating example FMPS, we will be able to better understand the current management policy governing federal management of the groundfish fisheries off Alaska, as well as the trade-offs of changing existing policy to reflect a new management approach. Since we had no proposed alternative management policies or alternative FMPs to consider at the outset of the Programmatic SEIS process, National Marine Fisheries Service (NMFS or national Oceanic and Atmospheric Administration [NOAA] Fisheries) has relied heavily on comments received during the public scoping process and on the 2001 Draft Alaska Groundfish Fisheries Programmatic SEIS in crafting the alternatives. Additionally, NOAA Fisheries consulted frequently with the NPFMC in developing the alternatives by relying on their expertise and judgement.

Significant changes to the structure and organization of this chapter have been made in response to public comments on the 2001 Draft Programmatic SEIS. As we explained in Chapter 2, we have restructured the policy alternatives to better reflect a multi-species, ecosystem management approach. Each of the policy alternatives (Alternatives 1 through 4) now represents a different management approach, ranging from a more aggressive harvest strategy (Alternative 2) to a very restricted harvest strategy where fishing is only authorized with proof that no adverse impacts will occur (Alternative 4). Two intermediate policy alternatives are presented: Alternative 1, which would continue the current risk-averse policy, and Alternative 3, which would adopt a more precautionary policy. Each policy alternative contains a suite of policy goals and objectives, each addressing to various degrees the important components of the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) marine ecosystems.

To help both the decision-maker and the public understand what a policy means and what environmental consequences may occur, we have defined example FMPs to illustrate each policy. These example FMPs contain a number of FMP components that were identified by the public as important features of any fishery management program. The best example of the current management policy are the current BSAI and GOA groundfish FMPs. For Alternatives 2 through 4, we define two example FMPs, each comprised of a different combination of management tools and tool applications. Each of these example FMPs contain concepts or specific suggestions obtained from NPFMC and the public. From an overall programmatic perspective, the actual characterization of the example FMPs and their effects is not as important as what is learned about the environmental trade-offs one can expect when considering alternative management policies governing the Alaska groundfish fisheries. Understanding these general environmental trade-offs will enable NPFMC, NOAA Fisheries, and the public to collectively shape future management policy and identify potential alterations to the existing management program.

The example FMPs also satisfy another purpose. NOAA Fisheries has determined that providing a management framework can help guide and communicate the direction of future actions. This is accomplished by including, as an element of the preferred alternative, two example FMPs that serve as "bookends" to a range of management actions, recognizing their inherent environmental consequences. Each example FMP will be analyzed separately and will proxy a range of future management actions. The bookend framework, comprised of two example FMPs, will indicate the range of environmental effects of that policy. The FMP bookends are not intended to be stand-alone alternatives. The FMP bookends are examples of management plans that are driven wholly by the policy statements. They illustrate different ways the groundfish fisheries can be managed and the range of environmental effects that can be expected from the implementation of a policy alternative. An FMP framework will be included in NPFMC's and NOAA Fisheries' final decision, and will be used to define a range of management actions that will be pursued following completion of the Programmatic SEIS. This alternative structure recognizes that the resource being managed, as well as the marine ecosystem, is quite dynamic in nature and only partially understood. Providing a range of management tools and their potential effects for each policy alternative is an attempt to take into account the dynamic nature of the fisheries as a whole and to provide enough management program flexibility in each alternative to allow decisions based on the best available science.

Analyzing such a complex set of alternatives is difficult. Presenting our analysis in a single chapter of the Programmatic SEIS also has its challenges. This is first provided in Section 4.1, which describes the methods used to evaluate the alternatives and their associated FMP bookends. This section defines the term significance; describes how data gaps and incomplete information are treated; defines what is meant by direct, indirect, and cumulative effects; and provides a technical description of the multi-species model and its assumptions. Section 4.2 describes the concept of the FMP bookends and provides a detailed summary of each of the example FMP components used as proxies for a policy alternative. Section 4.3 provides the public with a qualitative examination of each FMP component and discusses the range of management measures that could later serve as plan amendments. In this qualitative assessment section, the public is provided with a general review of the likely environmental effects that could be expected from each of the measures, across example FMPs (Figure 4.0-1; illustrating the "row look"). Section 4.3 is intended to provide the public with information on what could be expected from each management tool (in relative isolation from other plan components), across a range of environmental effects categories, as well as an indication on how well these management tools may meet a particular set of policy objectives.

The Programmatic SEIS continues in Section 4.4 by reviewing the statements defining the current environmental baseline to which all the alternatives and their associated example FMPs will be compared. These baseline statements, developed in Chapter 3, provide an important reference point for this Programmatic SEIS. Sections 4.5 through 4.8 analyze Alternatives 1 through 4 by examining their associated example FMPs as proxies. Each FMP is analyzed as a whole (Figure 4.0-2; illustrating the "column look") so as to represent the entire FMP and all of its components. This is a marked departure from the 2001 Draft Programmatic SEIS document and is included as a result of considerable public input. Another difference between this and the 2001 Draft Programmatic SEIS is that this chapter is organized around alternatives, rather than by resource categories. Many members of the public recommended this organization as an improvement over the earlier draft.

Section 4.9 presents a policy analysis of each of the alternatives using the potential impacts of the example FMPs as a guide. Evaluation of each alternative is provided in terms of satisfying the Magnuson-Stevens Fishery Conservation and Management Act (MSA), Marine Mammal Protection Act (MMPA), Endangered Species Act (ESA), and other applicable federal laws. Section 4.10 concludes this chapter by providing the public with an overall comparison of the alternatives at the policy level.

At this point, we feel obliged to beg the reader's continuing patience. The following analyses are unavoidably lengthy. We have tried to err on the side of inclusiveness, rather than run the risk of omitting any information or analysis that might aid decision-makers and the public in evaluating the relative merits of the alternatives. Also, the description of modeling methods in Section 4.1.5 contains highly technical information and mathematical equations that we have seen fit to include in the text rather than consign to an appendix. Although we do not expect that all readers will want to follow these equations variable by variable, we have placed the methods description prominently to allow public scrutiny of the scientific rigor with which the analyses have been conducted. Yet, however lengthy, detailed, and technical the analyses, we have tried our best where possible to keep the information accessible to the reader.

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4.1 Methodology

Alternatives are analyzed in the Programmatic SEIS to determine their environmental impacts. As previously described at the beginning of this chapter, each alternative is analyzed first at the FMP level, and later at the policy level. The FMP-level analysis examined both individual components as well as all of the components together, using the example FMPs, to determine the significance and intensity of impacts. A number of analytical models were used to conduct this analysis.

Section 4.1.1 discusses the significance thresholds used to analyze the impacts of the alternative, and Section 4.1.2 explains how data gaps and incomplete information were treated in this document. Section 4.1.3 describes the methodology for the direct and indirect effect analysis, and Section 4.1.4 describes methodology for the cumulative impact assessment. Section 4.1.5 describes the multi-species model, Section 4.1.6 describes the habitat model, and Section 4.1.7 describes the sector model used to estimate socioeconomic effects.

4.1.1 Determining Significance of Potential Consequences

The National Environmental Policy Act (NEPA) requires that an Environmental Impact Statement (EIS) include

> *... the environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented (40 Code of Federal Regulations [CFR] 1502.16).*

The EIS analysis must also identify whether or not an adverse environmental effect is significant. Significance is determined by considering the contexts (geographic, temporal, societal) in which the action will occur, and the intensity of the action. The evaluation of intensity should include consideration of the magnitude of the impact, the degree of certainty in the evaluation, the cumulative impact of the action as related to other actions, the degree of controversy over the action, and violations with other laws.

In this Programmatic SEIS, significance thresholds have been determined for each resource category (target species, socioeconomic effects, ecosystem, etc.). In some instances, although the significance threshold remains the same, the qualifier "conditional" is assigned. This indicates that a significant impact is assumed, based on credible scientific information and professional judgement, but that more complete information is needed for certainty. The following impact ratings may be used for each resource category:

Significantly adverse (S-): Significant adverse effect in relation to the reference point, based on ample information and data and the professional judgement of the analysts who addressed the topic.

Conditionally significant adverse (CS-): Conditionally significant adverse effect in relation to the reference point. This determination is lacking in quantitative data or information; however, the professional judgement of the analysts is that the alternative will cause a decline in the reference point condition.

Insignificant impact (I): Insignificant effect in relation to the reference point; this determination is based on information and data, along with the professional judgement of the analysts, that suggest that the effects will not cause a significant change to the reference point condition.

Conditionally significant beneficial (CS+): Conditionally significant beneficial effect in relation to the reference point. This determination is lacking in quantitative data and information; however, the professional judgement of the analysts is that the alternative will cause an improvement in the reference point condition.

Significantly beneficial (S+): Significant beneficial effect in relation to the reference point, based on ample information and data and the professional judgement of the analysts who addressed the topic.

Unknown (U): Unknown effect in relation to the reference point; this determination is characterized by the absence of information or data sufficient to adequately assess the significance of the impacts, either because the impact is impossible to predict, or because insufficient information is available to determine a reference point for the resource, species, or issue.

These ratings are applied to resource-specific impact indicators in the following resource categories: target species, prohibited species, other species, forage fish species, non-specified species, habitat, seabirds, marine mammals, socioeconomic effects, and ecosystem effects. The specific application for each is described below.

4.1.1.1 Target Species, Prohibited Species, Other Species, Forage Fish Species, Non-Specified Species

The significance of the impacts on target species, prohibited species, forage fish species, other species, and non-specified species was evaluated with respect to five effects: 1) fishing mortality, 2) change in biomass level, 3) spatial/temporal concentration of the catch, 4) prey availability, and 5) habitat suitability. The significance of these effects was evaluated as to whether the impacts, within the current fishery management regime, may be reasonably expected to jeopardize the sustainability of each target species or species group.

Target species are unique in that thresholds for overfishing and stock size have been developed (Amendment 56/56 to the BSAI and GOA FMPs) that relate to sustainability of the stock. As such, these thresholds are used to evaluate the significance of the effects of the example FMPs relative to their impacts on the sustainability of the target species. Fishing mortality rates that exceed the overfishing mortality rate are considered to jeopardize the capacity of the stock to produce maximum sustainable yield (MSY) on a continuing basis and adversely impact the sustainability of the stock. A related measure of this potential is indicated by change in biomass levels. The significance of effects of the current spatial/temporal concentration of the catch, and the level of prey availability and habitat suitability for target species is evaluated with respect to each stock's current size relative to its maximum stock size threshold (MSST). An action that jeopardizes the stock's ability to sustain itself at or above its MSST is considered to adversely affect the sustainability of the stock.

The significance of the five selected effects is evaluated according to the specific criteria for the impact ratings (Tables 4.1-1, 4.1-2, and 4.1-3). Species or species complexes that fall within Tiers 1 though 5 have estimates of the current fishing mortality rates and are evaluated with respect to exceeding the overfishing mortality rate (fishing mortality effect). Species or species complexes that fall within Tiers 1, 2, or 3 have reliable estimates of MSST and are evaluated for the effects of spatial/temporal concentration of the catch, prey availability, and habitat suitability. Species or species complexes that fall within Tiers 4, 5, or 6 do not have reliable estimates of MSST and therefore cannot be evaluated for the significance of these effects. This inability to evaluate the significance of the effects also occurs for the forage, prohibited, and non-specified species. Since several species or species complexes do not have estimates of abundances-at-age, in this version of the model their abundance levels simply reflect the most recent estimate. For these groups, analysis of the effects of the example FMPs was limited to catch projections and likely consequences given patterns in related fauna.

4.1.1.2 Habitat

The potential effects of the groundfish fisheries on habitat that were used to compare the alternatives include mortality of, and damage to, living habitat, changes to benthic community diversity, and changes to the geographic diversity of impacts and protection. Specific impacts of groundfish fisheries on habitat are very difficult to predict. Evaluation of effects requires detailed information on the distribution and abundance of habitat types, the life history of living habitat, habitat recovery rates, and the natural disturbance regime. This information is generally incomplete.

Qualitative judgments as to the significance of effects were made after considering information on 1) bycatch of living habitat derived from the multi-species projection model; 2) the results of a habitat impacts model for estimates of the equilibrium levels of living habitat in fishable and currently fished areas; 3) estimates of the amount of area by habitat type and geographic zone closed year round to bottom trawling for all species; and 4) evaluation of the spatial distribution of bottom trawl closures relative to fishing intensity and habitat types. The evaluation criteria are described in Table 4.1-4. Significance determination in this analysis differs from the more commonly used approach in scientific research. Typically, the null hypothesis of no effect is tested rigorously and only rejected if there is a very low probability of it being true (Type I error). Scientists are trained to minimize the chance of a Type I error. In this Programmatic SEIS analysis, however, rigorous tests of available data to reject the hypothesis of no fishing effects were not relied upon to determine significance. This was done for two reasons. First, there was little information available to detect fishing effects, so rigorous statistical testing for a Type I error could not be performed. Second, it was believed that a more appropriate approach for this Programmatic SEIS was to decrease making a Type II error (accepting a hypothesis of no effect to habitat when an effect to habitat does actually exist. Reducing the probability of making a Type II error is more precautionary and is more responsive to both essential fish habitat (EFH) mandates and public comments received on the 2001 Draft Programmatic SEIS.

During the course of preparing the revised draft Alaska Groundfish Fisheries Programmatic SEIS, comments and questions were raised about the purpose and scope of the Programmatic SEIS and the agency's EFH EIS that is currently being prepared on a separate schedule. In response to these questions and to clarify the purpose and need, the following summary compares the two analyses.

<u>The Alaska Groundfish Programmatic SEIS and its Relationship to the Ongoing EFH EIS</u>

The EFH EIS and Groundfish Programmatic SEIS have different scopes and areas of focus.

EFH EIS. The analyses within the EFH EIS consider adverse effects of fishing on benthic marine habitat from the perspective of managed fish species that are dependent on certain qualities and features of that habitat. As such, the scope of this work is more narrow than a consideration of these changes at the scale of entire marine ecosystems (as pursued in the Programmatic SEIS.)

Programmatic SEIS. The analyses within the Programmatic SEIS consider adverse effects of fishing on benthic marine habitat from the perspective of ecosystem structure and function, as well as managed fish species. As such, the scope of this work is broader than a consideration of these changes on commercially important and functionally dependent fish species.

These differences are reflected in the issues, criteria, and assessments made in each EIS. To a lesser extent, the information available for analysis in each EIS is different because the Draft Programmatic SEIS was written and released prior to the EFH EIS. The principal differences between the scope, alternatives, and purpose and need of the two documents are summarized in Table 4.1-1.

Table 4.1-1 Major differences between the Alaska Groundfish Fisheries Programmatic Supplemental Environmental Impact Statement and the Essential Fish Habitat Environmental Impact Statement.

	Programmatic Supplemental Environmental Impact Statement (SEIS)	Essential Fish Habitat (EFH) Environmental Impact Statement (EIS)
Purpose and need	Programmatic review of Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) groundfish Fishery Management Plans (FMPs) and their effects on the marine ecosystem.	Review of alternatives for identifying EFH, identifying habitat areas of particular concern (HAPCs), and minimizing adverse effects of fishing on EFH for groundfish, crabs, salmon, and scallops.
Action	Broad scope: Reauthorization of all groundfish fisheries under Magnuson-Stevens Act (MSA), Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and other applicable law; set policy.	Narrower scope: Consider revising EFH designations and adopting mitigation measures to reduce the effects of fishing on EFH.
Alternatives	Broad multi-objective policies.	Alternative EFH designations, approaches to identifying HAPCs and mitigation measures.
Source of closed areas used in analysis	Based on public comments on 2001 draft Programmatic SEIS, EFH Committee (Fall 2002) concepts, internal analysis.	EFH Committee (finalized by North Pacific Fisheries Management Council in April 2003).
Legal authority	Under MSA, agency can take action to protect habitat even if not specified as EFH.	Under MSA, agency must minimize to the extent practicable adverse effects of fishing on EFH.

The different analyses used to assess the effects of fishing on habitat in the Programmatic SEIS and the EFH EIS are outlined in Table 4.1-2. While the Programmatic SEIS looks only at bottom trawl impact, the EFH EIS examines trawl, dredge, pot, and longline gear. Another difference is that the Programmatic SEIS usually cited results using the upper recovery value for soft bottom habitats (15 years, higher effects), while the EFH analysis uses a central value (5.5 years). However, both EISs acknowledge that impacts to benthic habitat occur in areas of high fishing intensity regardless of the recovery rate assumed in the analysis. The same quantitative model relating fishing effort to habitat impact is used in both EISs and the results are highly comparable with only subtle differences, which have little effect on the ratings or discussion in the two EISs.

Table 4.1-2 Differences in data and methods for habitat effect analysis and evaluation issues.

	Programmatic supplemental Environmental Impact statement (SEIS)	Essential Fish Habitat (EFH) Environmental Impact Statement (EIS)
Input data source	Bottom trawl only.	Trawl, dredge, pot, longline.
Years	1997-2001.	1998-2002.
Fishery class	Trawl.	By target species and gear.
Living substrate recovery time (soft bottom)	2 and 15 years, 200 years for coral.	3.8, 5.5, and 10 years.
Habitat issues	Living habitat mortality/damage, including coral benthic community and geographic impact diversity.	Prey availability, epibenthic structure, coral.
Managed fish habitat issues	Habitat suitability.	Spawning/breeding, feeding, growth to maturity.

The Programmatic SEIS baseline evaluation identifies areas of high impact on living substrates and noted the estimated high potential impact level to living benthic structure and the size of affected areas. The analysis also considers the likelihood that those areas represent a unique habitat for managed fish species as determined by geography and oceanography, and is not equivalent to all other habitat in the same classification. The analysis concludes that, coupled with historical impacts, impacts to long-lived, slow-growing species (i.e., coral) could cause long-term damage and possibly irreversible loss of living habitat, especially in the Aleutian Islands. The baseline condition of benthic habitat is, therefore, rated as conditionally significant adverse. For purposes of making policy decisions, it is important that any potential significant adverse effects, even if conditional, be presented to decision-makers and the public so that consideration can be given to these effects when developing management measures in the future.

The EFH EIS describes the same areas of high impact to habitat features identified in the Programmatic SEIS, but goes on to evaluate the expected effects of such reductions in habitat quality on the welfare of each managed species. Those evaluations include areas occupied by each species, available information on their use of the habitat, and the stock history of each species. The Programmatic SEIS analysis evaluates impacts to the habitat itself, focusing on habitat features that might provide functions to managed species and speculating that linkages to productivity exist. Considering the paucity of information on habitat function for species life history stages and the broader scope of the Programmatic SEIS, the Programmatic SEIS does not depend on finding proof of such linkages. The EFH EIS examines the likelihood of significant linkages between habitat effects and the welfare of each managed species to determine whether the effects of fishing on EFH of managed species are more than minimal and not temporary. The purposes and methods of analysis used in the EFH EIS are discussed in more detail in Appendix B of the EFH EIS.

While the Programmatic SEIS baseline evaluation identifies areas of concern regarding of the current state of habitat effects from fishing, the EFH EIS was designed to specifically address criteria set forth in the EFH final rule. While identifying areas of concern was one step in the EFH EIS, the ultimate purpose of the EFH EIS is to evaluate whether the effects of fishing has had negative effects on the EFH of managed species that was more than minimal and not temporary. Specific meaning of these terms are discussed in Appendix B of the EFH EIS.

The approach and methodology employed to assess the impacts on target groundfish species in the Programmatic SEIS and EFH EIS are similar. For each species in each EIS, a knowledgeable scientist was designated to perform an evaluation of whether the alternatives affected the welfare of each species in question relative to a number of key issues. In the Programmatic SEIS, the key issues are 1) fishing mortality; 2) change in biomass level; 3) spatial/temporal concentration of the catch; 4) prey availability; and 5) habitat suitability. The key issues analyzed in the EFH EIS are 1) stock biomass; 2) spatial/temporal concentration of the catch; 3) spawning/breeding; 4) feeding; and 5) growth to maturity. These issues are evaluated relative to the status quo fishery, or baseline condition, as well as to the alternatives developed under each EIS. Criteria are established for each issue to assist the analysts in making conclusions. The primary consideration in these evaluations revolve around the ability of the stock to maintain its health and support a sustainable fishery.

In the National Standard Guidelines to the MSA, sustainability is defined relative to a MSST, where stocks below the MSST are considered sufficiently small as to require an appropriate rate of rebuilding. This concept of sustainability is used in the Programmatic SEIS and EFH EIS to maintain consistency with the National Standard Guidelines. For Tier 3 fish stocks, estimated recruitments from the late 1970s to the present are used in defining MSST proxies. These estimated recruitments thus cover a range of recent history when impacts to the stock from fishing practices would be expected. Additionally, 10 year projections are made to assess whether the stock would be likely to fall below their MSST level under the status quo harvesting policy. In the EFH EIS, these projections are not available for the remaining mitigation alternatives. However, because each of the mitigation alternatives represents a more conservative harvest policy than the status quo alternative, a finding of stock status above the MSST under the status quo alternative could reasonably be expected to hold under the remaining alternatives.

It should be noted that the MSST criterion is not the only metric used for the evaluation. For some stocks, information is known about habitat associations and how these may be impacted under various harvesting regimes, from both previous studies and from the results of the Fujioka-Rose model. This information is presented in the narrative of the EFH EIS as part of the more focused look at the linkages between habitat impacts and sustainability. Additionally, for stocks in Tiers 4 through 6, MSST is not available, and an evaluation is based on professional judgment using the best available scientific information and evidence.

4.1.1.3 Seabirds

Significance criteria for seabirds are based on whether the proposed action would be likely to result in population level effects, defined as changes in the population trend outside the range of natural fluctuations. The projection model was used for predictions of fishing effort under the different FMP bookends, especially with respect to different gear types. The analysis also includes other factors such as spatial/temporal restrictions and potential gear modifications for seabird avoidance. However, because there are a large number of unpredictable variables and gaps in our knowledge about particular species and ecosystem effects, it is impossible to ascertain significance on a strictly quantitative basis. Conclusions are based on professional judgement of pertinent data and literature review.

Except for the supplemental food provided by the fisheries in the form of offal, the effects of the fisheries are all considered adverse to individual birds. Low levels of incidental take of seabirds are better for conservation purposes than high levels of take, but no amount of incidental take can be considered beneficial to a seabird population. The significance ratings for incidental take are, therefore, either insignificant or adverse. Although the number of seabirds that would be expected to be taken under the alternative FMPs varies considerably, this difference is not discernible by looking at a shared insignificant rating. The same type of situation applies to fishery-induced changes in benthic habitat important to benthic-feeding seabirds, so there is no beneficial rating for this effect. Effects of the fishery on food availability could be adverse, insignificant, or beneficial. If there is a plausible mechanism and a reasonable set of conditions under which an effect may occur under a given FMP, the significance rating may be labeled conditional. If there is a plausible mechanism for an effect, but not enough data to assess whether it occurs or whether the FMP would create the conditions under which it would occur, the significance rating may be unknown. The evaluation criteria are described in Table 4.1-5.

Species were grouped according to the similarity of their response to the groundfish fishery and/or similarity in their management status. Two species were analyzed on their own and the rest were discussed in five groups. The species categories and the main reason for their distinctions are listed below:

- Short-tailed albatross (listed as "endangered" under the ESA and have played a central role in the development of seabird protection measures).
- Laysan and black-footed albatross (do not breed in Alaska, conservation concerns regarding incidental take in fisheries).
- Shearwaters (do not breed in Alaska, most abundant seabird in Alaska in summer).
- Northern fulmars (the most frequently taken species in every groundfish gear type).
- Species of Management Concern (a U.S. Fish and Wildlife Service [USFWS] designation for species that may be susceptible to listing under the ESA, including red-legged kittiwakes, marbled murrelets, and Kittlitz's murrelets).
- Other piscivorous (fish-eating) species (most alcids, gulls, and cormorants).
- Other planktivorous species (storm-petrels and auklets).
- Spectacled and Steller's eiders (benthic feeding sea ducks listed as threatened under the ESA).

4.1.1.4 Marine Mammals

The standard for determining significance for effects on marine mammals is whether the impact would be expected to be detectable at the population level. Individual effects categories do not have to cause a measurable population decline or increase to be labeled significant, but data and/or plausible arguments must exist to determine that the action would have more than a negligible impact on the reproduction and/or survival of a species group in a way that could affect the population.

For each category of effects, it was determined wether the alternative fishing regime would result in significant adverse, insignificant, significant beneficial, or unknown effects on marine mammals. In addition, effects may be classified as conditionally significant, if significant effects could be expected under a plausible set of conditions. The intent of the conditional label is to imply uncertainty about whether an alternative FMP would actually result in conditions that led to a significant impact. When the conditional label is applied, a plausible mechanism for the impact and the conditions under which a significant impact would be realized is stated. In cases where data are lacking to rank an effect according to the significance criteria, the effect was determined to be unknown.

The expected effects of each alternative were compared to the baseline conditions to determine the relative significance of the impacts of the alternatives on marine mammals. The significant criteria are described in Table 4.1-6.

4.1.1.5 Socioeconomic Effects

In the socioeconomic impact analysis, the term significant for an expected change in a quantitative indicator means a 20 percent or more change (either plus or minus) relative to the comparative baseline. If the expected change is less than 20 percent, the change is not considered to be significant. The same threshold is roughly used to roughly assess changes in qualitative indicators (e.g., fishing vessel safety). However, whereas changes in quantitative indicators are based on model projections, predicted changes in qualitative indicators are based on the judgement of the socioeconomic analysts.

4.1.1.6 Ecosystem

Significance thresholds for determining the ecosystem-level impacts of fishing would involve both population-level thresholds that have already been established for species in the system (MSST for target species, fishing-induced population impacts sufficient to lead to listing under the ESA, and fishing-induced impacts that prevent recovery of a species already listed under ESA, for nontarget species) and community- or ecosystem-level attributes that are outside of the range of natural variability for the system (Table 4.1-7). These community or ecosystem-level attributes are more difficult to measure directly, and the range of natural variability of those attributes is not well known. We may also lack sufficient data on population status of target or non-target species to determine whether they are above or below MSST or ESA-related thresholds. Thus, indicators of the strength of fishing impacts on the system will also be used to evaluate the degree to which any of the alternatives may be having a significant ecosystem impact.

For each of the alternatives, the possible impacts on 1) predator/prey relationships, including introduction of non-native species; 2) energy flow and redirection (through fishing removals and return of discards to the sea); and 3) diversity will be addressed.

4.1.2 Data Gaps and Incomplete Information

The Council on Environmental Quality (CEQ) guidelines require that

> *When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or*

unavailable information, the agency shall always make clear that such information is lacking (40 CFR 1502.22).

The regulations instruct that where the information is relevant, but "the overall costs of obtaining it are exorbitant or the means to obtain it are not known" (40 CFR 1502.22), the following should be included in the EIS:

- A statement that such information is unavailable.
- A statement of the relevance of the information to evaluate reasonably foreseeable significant adverse impacts.
- A summary of existing information that is relevant to evaluating the adverse impacts.
- The agency's evaluation of adverse impacts based on generally-accepted scientific methods.

In the analysis, this Programmatic SEIS identifies those areas where information is unavailable to support a thorough evaluation of the environmental consequences of the alternatives. Efforts have been made to obtain all relevant information; however, some data gaps still exist at this time due to several reasons, such as the costs of obtaining the missing data are exorbitant, the data will take several years to obtain, or the means to obtain the data are unknown. Limited resources to collect and analyze baseline information due to limited funding is problematic. NOAA Fisheries receives a certain level of funding, of which a certain amount is set aside for research on Alaska fisheries issues. The amount set aside for research (including data collection) is fully committed, and NOAA Fisheries cannot expend funds it does not have. Therefore, the cost of research needed to fill in current data gaps in addition to currently funded research is exorbitant. Examples of existing data gaps include the uncertainty of survey biomass estimates for many species, which in some cases would require the initiation of species-specific surveys to improve estimates; research needed to assess the use of existing and proposed refugia to improve reproductive success; and life history studies needed to elevate groundfish species in Tiers 4 through 6 into Tiers 1 through 3. NOAA Fisheries' Stock Assessment Improvement Initiative explicitly addresses these needs, and expanded stock assessment funds have been requested in NMFS proposed budgets. Where data gaps still exist, the Programmatic SEIS provided the information listed above, according to the CEQ guidelines.

As outlined in Section 4.1.1, the impact ratings used in this analysis include three categories that indicate a lack of complete data: unknown, conditionally significant adverse, and conditionally significant beneficial. In cases where these ratings are used, a discussion is included about the nature of the unavailable information and its relevance to this analysis. In cases where a conditional qualifier is used, the analysts, using credible scientific methods, have based their assessment on existing information and specific assumptions based on professional judgement in order to evaluate the reasonably foreseeable adverse or beneficial impacts. Where an unknown significance rating is used, not enough baseline information exists to evaluate the impact of the alternatives.

Section 5.1 catalogs the information that is unknown or unavailable for all resource categories. The section discusses ongoing and proposed research relating to the North Pacific groundfish fisheries, and lists the known data gaps for each resource category. Additionally, the specific research initiatives recommended in the various alternative policies are also identified.

4.1.3 Direct and Indirect Analysis

4.1.3.1 Target Species, Prohibited Species, Other Species, Forage Fish Species, Non-Specified Species

The impacts on target species, prohibited species, other species, forage fish species, and non-specified species were evaluated with respect to five effects: 1) fishing mortality; 2) change in biomass level; 3) spatial/temporal concentration of the catch; 4) prey availability; and 5) habitat suitability. Fishing mortality, biomass changes, and spatial/temporal concentration of the catch are considered direct effects, and prey availability and habitat suitability are considered indirect effects. The significance of these effects was evaluated according to whether they might be reasonably expected to jeopardize the sustainability of each species group within the current fishery management regime. Under FMP 1, all target species are managed within the definitions of Amendments 56/56 to the BSAI and GOA FMPs, which set the overfishing levels and the maximum permissible acceptable biological catch for six tier designations as described in Appendix B. Under FMP 1, only one stock is designated as falling within Tier 1 (eastern Bering Sea [EBS] pollock), and no stocks fall within Tier 2. Of the 21 BSAI target groundfish categories, 11 species are managed under Tier 3, no species are under Tier 4, eight species or species complexes are under Tier 5, and one species group (squid) is under Tier 6. Of the 16 GOA target groundfish categories, eight species are managed under Tier 3, seven species or species complexes are under either Tiers 4 or 5, and one species (Atka mackerel) is under Tier 6. The significance of the effects of the current fishing mortality levels is evaluated with respect to the overfishing mortality rates as set forth in Amendments 56/56.

As a means of evaluating the intensity (significance) of the effects on target species prohibited species, other species, forage fish species, and non-specified species under the alternatives, a system was developed whereby the significance of the five selected effects was evaluated. Additional details for each species or species complex are given in the specific section for that species or species complex. The system consists of four rankings of significance, including significant negative, unknown, insignificant, and significant positive. Recognizing that such general terminology is inherently subjective, we applied criteria where possible to define the terms and rankings. Where metrics were not available, descriptions of the impacts within the text are relied upon to justify the significance evaluation.

For the target species, the multi-species, multi-fisheries simulation projection model provided fundamental dynamics to the model behavior. That is, as the biomass of an FMP species changed in the future, the constraint (via acceptable biological catch/total allowable catch [ABC/TAC] control) also changed. The outputs from the model were primarily intended to reflect these dynamics and the interactions with the species composition of the different fisheries.

4.1.3.2 Habitat

This analysis focuses on the following question: do the alternative management policies result in conditions that offer protection to and minimization of adverse impacts to habitat? For Alaska groundfish, this includes the habitat for all target groundfish species, non-target species, prohibited species, other species, and their prey. When viewed in aggregate, across all species, habitat includes all pelagic and benthic habitat in the Alaska Exclusive Economic Zone (EEZ). However, the focus of this analysis is benthic habitat, which is generally believed to be at greater risk to the impacts of fishing than non-benthic habitat in the water column. In addition, much of the analysis focuses on the impacts of bottom trawling. It is recognized that fixed gear (longlines, pots, and jigs) or pelagic trawl gear that comes in contact with the sea floor can disturb benthic habitat. In some types of habitat, fixed gear may cause an impact due to its ability to be more easily fished on rougher substrates (e.g., boulders with coral) than bottom trawl gear. However, most scientific studies of gear impacts have dealt with bottom trawls and dredging because this gear is the most controversial (Auster and Langton 1999, Jennings and Kaiser 1998, Hall 1999b, NRC 2002).

The impacts of bottom trawling on benthic habitat are described in Section 3.6.4. In general, relative to unfished habitat, areas fished with bottom trawls are expected to have reduced habitat complexity, reduced species diversity, and changes in species composition. The level of habitat complexity depends on the structural components of the living and non-living benthic environment. Habitat complexity is reduced when epifauna that form structures are removed or damaged, Sedimentary bedforms are smoothed, and infauna that form burrows and pits are removed. Worldwide studies of the effects of bottom trawling have generally found that trawling reduces habitat complexity (Auster and Langton 1999). These findings have been confirmed by studies conducted in Alaska (Freese *et al.* 1999, McConnaughey *et al.* 2000). The extent of the impacts depends on many factors, such as habitat type, natural disturbance, recovery rates, and the intensity and spatial distribution of bottom trawling.

Evaluating habitat impacts in marine fisheries is not a well developed field. There are few, if any, known applicable analytical methods for evaluating habitat. During the preparation of the Programmatic SEIS, we developed methods to evaluate impacts of fisheries on benthic habitat. Specific impacts on habitat, as noted above in Section 4.1.1.2, are difficult to predict, however, because the information needed to do so is generally incomplete for Alaskan waters. It may never be possible to fully and quantitatively account for all factors involved in determining how an ecosystem will respond to fishing activities. We have analyzed the direct and indirect effects identified in Table 4.1-4 by using, to varying degrees, four primary sources of information:

1. Estimates of the bycatch of living habitat derived from the multi-species projection model described in Section 4.1.5.

2. The results of a habitat impacts model (Fujioka 2002, Rose 2002) for estimates of the equilibrium levels of biostructure.

3. Estimates of the amount of area by habitat type and geographic zone closed year round to bottom trawling for all species.

4. Evaluation of the spatial distribution of bottom trawl closures relative to fishing intensity and habitat types.

We want to emphasize that while the multi-species model, habitat impacts model, and estimates of the amount of area by habitat type closed year round were used initially, these information sources later became peripheral to the habitat impacts analysis. The multi-species projection model was used by Programmatic SEIS analysts as a tool to determine impacts of the alternatives in future years. These data were obtained from the NMFS Observer Program. For the most part, we found that future projections of living habitat bycatch using these data and multi-species model results did not prove useful in analyzing habitat impacts as compared to target species and other fish species impacts. For example, the NMFS Observer Program aggregates all coral species into a single category. While these data are useful in documenting that these benthic organisms are taken as bycatch in various groundfish fisheries, problems arise due to the wide variety of coral species and the vulnerability of hard versus soft corals to different gear types. Differences in recovery rates among species make assessing fishing impacts on these species difficult. All corals likely provide an important biostructure component to habitat for some of the managed species.

In order to run the habitat impact model described by Fujioka (2002; see Section 4.1.6) for the various alternatives, reliable catch and effort projections are needed. For example, for FMPs where the illustrated closure scheme differs substantially from the baseline in the location and amount of areal closures and/or fishing effort (example FMP 2.1, FMP 3.2 and FMP 4.1), the resolution of the data needed to run the model was not available.

Estimates of the amount of area by habitat type and geographic zone closed year round to bottom trawling for all species refers to some simple calculations of the amount of area closed to bottom trawling. While we present these data in the Programmatic SEIS for information purposes, this information was used sparingly to rate the alternatives in terms of habitat impacts.

As a result of these data limitations, our analysis relied most heavily on a comparison of maps of fishing intensity (presented by C. Rose [2002] at the Effects of Fishing Symposium) and closure area illustrations developed by the project team. This qualitative approach was an important part of the Programmatic SEIS analysis. Analysts would have liked to have conducted a more quantitative analysis of the spatial distribution of proposed closures relative to fishing intensity; however, there was only sufficient time to apply the data quantitatively to the status quo FMPs (e.g., FMP 1), and we used our best professional judgment in evaluating the other alternatives.

This analysis does not include impacts of trawling on non-living habitat, such as boulders, cobbles and sandwaves, which can be disturbed by bottom trawls (Auster and Langton 1999). In most cases, the structural integrity, and hence the complexity of the habitat, would not be greatly reduced, but when nonliving substrates are disturbed, the organisms living on them may die or be damaged.

Living Habitat – Direct Mortality of Benthic Organisms

Living habitat includes organisms that provide high microhabitat complexity and serves as cover for fish and their prey. Living habitats include: corals, sponges, anemones, sea whips, sea pens, and tunicates. Criteria to determine acceptable levels of mortality to living habitat have not been established. Such criteria would need to consider fishing induced mortality relative to such characteristics as natural mortality, fecundity, abundance, growth rates, and recruitment. Many deep water areas are characterized as stable environments dominated by long-lived species. In such areas, the impacts of fishing can be substantial and long-term (Auster and Langton 1999). Species such as red tree coral (Primnoa) are very long lived (more than 100 years old) and slow growing, and the habitat they provide does not easily recover if damaged by fishing (Risk *et al.*1998, Andrews *et al.* 1999, Krieger and Wing 2000). Recent studies indicate long recovery rates for deep water sponges that have been damaged or removed by trawling (Freese 2003). A potential quantifiable measure of the expected impact to such habitat are estimates of their living habitat bycatch derived from the multi-species projection model described in Section 4.1.5. Observer data from 1999 to 2001 provides information to estimate baseline levels of this bycatch (Tables 4.1-8 and 4.1-9). For the most part, we found that projections of bycatch of living habitat from the multi-species projection did not provide realistic data to rate the alternatives. Thus, we relied more heavily on application of the habitat impacts model (see Section 4.1.6) as the tool to assess changes to direct mortality of benthic organisms.

There is also unobserved mortality and damage to living habitat that would not be reflected as bycatch (Freese *et al.* 1999, Krieger and Wing 2000, Freese 2003). Assuming that most living habitat caught as bycatch dies, then observed bycatch is a minimum estimate of fishing-induced mortality. We caution about comparing bycatch across gear types and fisheries. For example, if a particular fishery tends to catch more living habitat, this could indicate more impact for that fishery. However, there is little or no information to compare impacts between different gear types. Additionally, one gear type may be particularly efficient at catching and retaining an organism relative to the impact it has on living habitat, while another gear type may not retain the organism while causing a different level of impact. Such variability makes assessing fishing impacts very challenging and, as a result, this has been prioritized for research.

Benthic Community Diversity and Geographic Diversity of Impacts

Areas that are closed to fishing can protect living habitats from damage by fishing activities. In addition, closed areas can allow recovery of habitats already impacted by fishing. Ideally, placement of the closed areas would occur across a range of vulnerable, representative habitat types (National Research Council [NRC] 2002). Areas only seasonally closed to particular fisheries provide little protection to benthic habitat. For example, in the current BSAI and GOA FMPs, seasonal closures to Pacific cod, Atka mackerel, and pollock fishing exist in areas of sea lion foraging. These closures, however, provide little protection to benthic habitat because they are either fished seasonally and/or allow fisheries for other species. Thus, they address sea lion concerns, but fail to address the need to fully protect benthic habitat. Only year-round closures for all species are considered to provide protection to benthic habitat.

Simple calculations of the amount of area by habitat type and geographic zone closed to bottom trawling may provide some data to rate the alternatives. However these data do not provide information on the spatial distribution of closures relative to fishing intensity. Area calculations are mostly provided for information purposes.

Consideration must also be given to the geographic distribution of fishing intensity relative to closures. For instance, if closures are placed primarily in areas where there is little or no fishing then there will be little benefit to habitat over baseline levels. In contrast, if closures are placed primarily in fished areas that have high fish density and the displaced fishing effort moves to areas of low fish density, the result may be more habitat damage because greater effort may be required to catch the same amount of fish. Consideration of the geographic distribution of impact levels allows the habitat unit's distance and direction from other habitat, geographic, and oceanographic features to be accounted for.

We were able to apply the habitat impacts models to the status quo FMP (FMP 1) to quantitatively assess these direct effects. However, for the other alternatives we had to rely on a more qualitative approach. Thus, we used maps of baseline fishing intensity (Rose and Jorgenson 2002), and mapped alternative-specific closure areas to assess changes to benthic community diversity and geographic diversity of impacts.

Given that little is known about the habitat requirements of target, prey, or predator species in the BSAI and GOA and the location of specific habitats in these regions, managers must ask what is the best strategy for distributing fishing impacts over the potential fishing grounds? Should effort be distributed uniformly over the fishing grounds, or should effort be concentrated in certain areas while leaving other areas unfished? If so, how large and in what orientation should the fished or unfished areas be? One may theorize that vast expanses of contiguous fishing effort or impact levels should be avoided. The evaluation of fishing impacts of example FMPs in this Programmatic SEIS operates under the following assertions and assumptions:

1. Knowledge about habitat value and its distribution is of low resolution based on gross bathymetric information, such as shelf, slope, gullies, or large scale geographic or oceanographic features, and we assume that such features capture benthic habitat.

2. Relative to habitat distribution, spatially diverse or patchy fishing impacts are preferable to uniformly distributed impacts (Duplisea *et al.* 2002). Thus, one of the criteria used to evaluate the alternatives will be the spatial and geographic diversity of fishing impacts. The patchiness of fishing effort may be enhanced by having some areas not fished dispersed within historically fished areas. This patchiness promotes habitat diversity.

3. Geographic diversity of impacts and protection is obtained by having a consistent pattern of varying levels of impact within a habitat type. This would be achieved most simply by establishing long-term closure areas over a portion of each habitat type within fished areas. Totally encompassing the habitat type or the cluster of historical fishing intensity within a closure, would not achieve a diverse impact.

4. Bathymetric features such as gullies, banks, shelf, slope, and slope/gully intersections represent individual general habitat types. In addition, clusters of fishing intensity represent an area of unique habitat, perhaps defined only in part by benthic habitat. In the GOA, the spatial resolution of these habitat types is on a much finer scale than the fairly uniform bathymetry of the Bering Sea. Habitat types in the Aleutian Islands are not as easily classified or distinguished, and are on an even finer spatial resolution.

4.1.3.3 Seabirds

Because of differences in foraging behavior, abundance, and distribution, some seabird species are more likely to be directly or indirectly affected by the groundfish fishery than others. Direct effects are those that take place at the same time and place as the fishing activity. Indirect effects are removed in time and/or space from the initial action. The mechanisms and history of direct and indirect effects of fisheries on seabirds are described in Section 3.7.1, along with other natural and human-caused influences on these effects. Details on the extent of each type of effect for each species, to the extent that they are known, are presented in the species accounts of Section 3.7.

For purposes of this chapter, some types of potential effects offer clearer comparisons of the alternatives than others. For seabirds, one direct effect (mortality) and two indirect effects (prey availability and benthic habitat) were analyzed to make the distinction between alternatives. Data on incidental seabird take come from the North Pacific Groundfish Observer Program and include birds that are killed or seriously injured in fishing gear or by striking the vessel or its rigging. Both indirect effects involve changes in the food supply of birds, but the mechanisms are different. Prey availability involves the removal of prey and competitors for that prey from the water column. Benthic habitat describes changes in the physical and biotic structure of the ocean bottom that potentially affect the capacity of that habitat to support the food web important to seabirds. Consumption of fishery wastes has implications for both incidental take (attracting birds and resulting in increased vessel interactions) and food availability. Since incidental take is addressed in different ways by the different alternatives, and the production of fishery wastes is closely linked to overall TAC, consumption of fishery wastes will be incorporated into the analysis of effects on prey availability, which is related to fishing effort. The effects on benthic habitat are analyzed separately because they are more defined in space, and the alternatives vary considerably and specifically with fishing area closures.

Other potential effects, such as oil spills, plastic pollution, and introduction of nest predators, are the result of vessel traffic rather than fishing effort. An oil spill from a shipwrecked fishing vessel or the accidental release of rats from a ship to a seabird colony could have very substantial repercussions for one or more seabird species. However, the magnitude of the effect will depend on a host of variables that cannot be predicted. In addition, the risks of these types of events occurring are not necessarily proportional to fishing effort. Even the closure of the fishery would not eliminate these risks because the fishing and processing vessels would likely be used in other fisheries or brought to port where they may actually increase the risk of an effect (i.e., introduction of nest predators). Because these types of effects do not lend themselves to distinguishing between the alternatives, they will not be analyzed in the direct/indirect effects of each FMP. However, they are important to the overall effects of the fishery and are included as part of the baseline condition and as contributions to the cumulative effects.

Significance criteria were based on whether the proposed action would be likely to result in population-level effects, which are defined as changes in the population trend outside the range of natural fluctuations (see Section 4.1.1 for further details). The projection model was used for predictions of fishing effort under the different FMP bookends, especially with respect to different gear types. The analysis includes other factors such as spatial/temporal restrictions and potential gear modifications for seabird avoidance. However, because there are a large number of unpredictable variables and gaps in our knowledge about the natural history and populations of particular species, as well as many kinds of ecosystem effects, it was not possible to ascertain significance on a strictly quantitative basis. Conclusions are based on professional judgements of pertinent data, literature review, and the likelihood of certain conditions occurring.

4.1.3.4 Marine Mammals

Effects of the groundfish fishery management alternatives on marine mammals will be examined by focusing analyses around four core questions, which were modified from Lowry (1982):

- Is the alternative management regime consistent with efforts to avoid direct interactions with marine mammals (incidental take and entanglement in marine debris)?
- Does the alternative management regime result in harvests of fish species that are of particular importance to marine mammals as prey, at levels that could compromise foraging success (harvest of prey species)?
- Does the alternative management regime result in temporal or spatial concentration of fishing effort in areas used for foraging by marine mammals (spatial/temporal concentration of removals with some likelihood of localized depletion)?

- Does the alternative management regime modify marine mammal or forage behavior to the extent that population-level impacts could occur (disturbance)?

The existing environmental conditions under and independent of the 2002 fishery management measures were used as the baseline for comparing the alternatives with respect to effects on marine mammals, using the above questions to determine impacts. The expected effects of each alternative were compared to the effects as they exist under the baseline conditions to determine the relative significance of the impacts on marine mammals.

Direct Effect – Incidental Take/Entanglement in Marine Debris (Question 1)

Groundfish fisheries directly affect marine mammals when animals are incidentally caught or become entangled in fishing gear. When animals are incidentally taken or entangled, serious injury or mortality may or may not result. Some species are more susceptible than others to interactions with fishing gear, depending on the extent of spatial overlap with the fisheries and on the animals ability to detect and avoid gear. Fishery/marine mammal encounters that result in high levels of mortality and serious injury may have the potential to cause population-level effects. The level of incidental take and entanglement that results in population-level effects will vary according to the status and trajectory of each stock.

The MMPA requires that take of ESA- or MMPA-listed marine mammals incidental to commercial fisheries be authorized under a 101 (5)(E) permit upon determination that the incidental mortality and serious injury from these fisheries will have a negligible impact on the species or stock. For most activities, a negligible impact is defined as having a duration and intensity which results in an insignificant effect on the population. For fishing activities, the intensity of the effect is a more important consideration than the duration of the effect. If an impact is expected to cause no more than a ten percent delay in recovery of an ESA- or MMPA-listed species, then the impact is deemed negligible and will thus be insignificant. If incidental take and entanglement in fishing gear is expected to occur at a level which would delay recovery of a stock by more than ten percent than would be expected under baseline conditions, the impact will be significant. This approach allows for the incorporation of parameters specific to each population and thus accounts for the variable effects of incidental take according to the status and trajectory of each stock.

To calculate the delay in recovery imposed by additive mortality and injury incidental to fishing operations, definitions of the following are needed: the point at which the population is considered to be recovered, the current population size, and the intrinsic rate at which the population is increasing. For species with increasing population trajectories, it is possible to estimate the time until the population will be recovered. For species with negative population trajectories (declining stocks), the time period over which the population would be expected to go extinct can be estimated. If the additional mortality and serious injury resulting from incidental takes in commercial fisheries does not accelerate the estimated time to extinction by more than ten percent, the impact will be determined to be negligible at the population level, thus rendering it insignificant for purposes of this analysis.

Under the best-case scenario, incidental take and entanglement of marine mammals in fishing gear would be zero animal. Yet even under this scenario, the population effect on the species would be insignificant; therefore, effects ratings of (conditionally) significant beneficial are not applicable to this analysis.

Direct/Indirect Effect – Harvest of Key Prey Species (Question 2)

Direct and indirect interactions between marine mammals and groundfish fisheries occur due to overlap in the size and species of groundfish harvested in fisheries that are also important prey for marine mammals, and due to the spatial/temporal overlap in marine mammal foraging and commercial fishing activities. By design, fishing significantly reduces the spawning biomass of harvested species. The relevant question is whether fishing under these global (e.g., large-scale, such as BSAI- or GOA-wide) exploitation strategies reduces the environmental carrying capacity of marine mammals by affecting the prey on which they depend for survival.

Fishery removals of marine mammal prey may cause food availability to become the limiting factor regulating the size of the marine mammal population. If fisheries remove more of a prey species' standing biomass than is required to maintain a marine mammal population at the current size, the fishery would be deemed to have a significant adverse effect at the population level. Alternately, if a fishery management regime is expected to increase the available standing biomass of a prey species to a level such that the size and/or health of the marine mammal population is expected to increase, the fishery would be deemed to have a significant beneficial effect at the population level.

To make a determination of the point at which the alternate fishery regimes affect the availability of key prey species relative to the baseline to the extent that marine mammals experience population-level effects, it is necessary to know the following: the marine mammal's energy requirements; the relative contribution of each prey species to those energy requirements; the adequacy of the existing standing biomass of prey; the standing biomass of the prey species before and after the fishery; and how the change in the standing biomass equates to changes in the marine mammal population's vital rates or carrying capacity. With the best available scientific and commercial data, our current understanding of marine mammal bioenergetic requirements does not allow such a determination.

Due to the limited state of knowledge regarding the effects of the harvest of marine mammal prey species, we relaxed the requirement that varying levels of fishery removals be directly linked to effects which would be detectable at the population level. The significance criteria for this category of effects was selected to allow for informative comparisons of each fishery management alternative relative to the baseline. A 20 percent change in the fishing mortality rate relative to the baseline was selected as the significance threshold, as it was judged to result in large enough changes to the prey field such that significant impacts on marine mammal populations would reasonably be expected due to changes in the standing biomass of their key prey. Predicted fisheries harvest rates were modeled for each FMP scenario and FMP bookend using the Multi-species Analytical Model. Scenarios in which the fishing mortality rate (*F*) of key prey species is projected to increase by at least 20 percent were determined to have significant adverse effects on marine mammals, whereas a decrease in F of at least 20 percent was determined to have a significant beneficial effect. The effect of harvest of prey species was determined to be unknown when there was insufficient diet information for a given marine mammal species to determine if there would be overlap with the fisheries. After assessing the predicted change in fishing mortality rate of individual key prey species, a judgement was reached on the aggregate change in available standing biomass of marine mammal prey based on the factor discussed above, and whether this aggregate change from the baseline would have population-level effects on a species. This method of assessing the availability of prey is similar to the analysis used int the Steller Sea Lion Protective Measures EIS and the Steller Sea Lion BiOp. (NMFS 2001b and 2001c). In some cases the baseline availability of prey is considered adverse for an individual marine mammal species; therefore lack of a change from the baseline would continue to be adverse.

Indirect Effect – Spatial/Temporal Concentration of the Fishery (Question 3)

Overall effects of fisheries on marine mammal populations vary according to the spatial/temporal concentration of the fishery. Although global fishery removals are designed to be precautionary, such that the productivity of target stocks and their ability to support natural predators are not compromised. In the times and locations where fisheries and marine mammals overlap, fisheries compete with marine mammals such that the resource can become limited. The intensity of the effects on marine mammals will vary according to the extent of competition (amount of overlap and degree of resource limitation) and the importance of the resource to marine mammals in a particular season or area. Because it is not possible to quantify the amount of competition between fisheries and marine mammals, nor to state the level of competition that results in changes at the population level, the effects of spatial/temporal fishing concentrations under the various alternatives were assessed qualitatively according to the spatial and seasonal foraging requirements of marine mammals. Alternatives were categorized as having significant adverse effects on marine mammal populations if there was much more spatial/temporal concentration in important foraging habitat and/or critical periods over baseline conditions (fishery conditions under 2002 rules and regulations). Significant beneficial effects were assigned if there was a much lower concentration of the fishery in key areas and seasons compared to baseline conditions. Unknown effects were assigned when there was insufficient information to determine what constitutes the key areas and seasons for a given marine mammal species.

Direct Effect – Disturbance (Question 4)

Activities related to groundfish fisheries in the BSAI and GOA have the potential to affect marine mammal behavior. Disturbance to marine mammals may result from vessel traffic, fishing operations, or underwater noise, such that otherwise normal behavior or movement patterns are altered. As defined here, these disturbances have significant adverse effects on marine mammal populations when marine mammal or forage behavior is modified to the extent that population level impacts could occur. Because it is not possible to quantify disturbance resulting from fisheries, nor to state the level of disturbance that results in changes at the population level, the level of disturbance expected to occur under the various alternatives was compared qualitatively to the baseline level of disturbance to evaluate the significance of the alternatives. The effects analysis for this category incorporated projections from the multi-species management model to determine changes in fishery patterns and information on marine mammal distributions and behavior to infer potential disturbance levels. The significance criterion was similar to that for evaluating fishery concentrations in time and space with substantially more disturbance from baseline conditions leading to a significant adverse finding. Insignificant effects were assigned for those species that do not appear to be disturbed by fishing vessels, and in cases where the level of disturbance was not expected to fluctuate to a large degree relative to the baseline. Under the best-case scenario, disturbance of marine mammals resulting from groundfish fishing activities would be zero. Even under this scenario, the population effect on the species would be insignificant; therefore, effects ratings of conditionally significant beneficial are not applicable to this analysis. Unknown effects were assigned when there was insufficient information to determine what constitutes disturbance for the species.

Marine Mammal Species and Species Groups

The effects of the alternative FMPs were analyzed on either individual species/stocks of marine mammals or on aggregate groupings of marine mammals according to the level and intensity of the expected effects or according to the status of the marine mammal stock. Species or stocks analyzed individually includes the western stock of Steller sea lions, the eastern stock of Steller sea lions, northern fur seals, harbor seals, transient killer whales, and sea otters. Marine mammals analyzed in aggregate include other pinnipeds, toothed whales (including resident killer whales), and baleen whales occurring in the BSAI and GOA groundfish fisheries. Western and eastern Steller sea lion stocks were split in the analysis due to the differences in their population trajectories, ESA listing status, and degree of overlap with groundfish fisheries. Northern fur seals and harbor seals were broken out from the other pinnipeds because they are expected to be more affected, directly or indirectly, by groundfish fisheries than the other pinniped species in the affected area. Transient killer whales were split out from the other toothed whales because their diets differ substantially from the other species in this category.

4.1.3.5 Socioeconomic Effects

Assessment of socioeconomic impacts considers the following important factors:

- Impacts on harvesting and processing sectors, including: catcher vessels, catcher processors, and inshore processors and motherships. Catches of all groundfish species, groundfish ex-vessel value and product value, groundfish employment and payments to labor, excess capacity, product quality, product utilization rates, average costs, and fishing vessel safety were used as variables.

- Regional impacts, on six regions (Alaska Peninsula and Aleutian Islands, Kodiak Island, Alaska southcentral, southeast Alaska, Oregon coast, and Washington inland waters), using processing, harvesting, payments to labor, and employment variables.

- Community Development Quota (CDQ)-related impacts, including changes to the CDQ program and changes to the CDQ species TACs.

- Impacts related to subsistence use of groundfish, Steller sea lions, and salmon, as well as opportunities for practicing subsistence.

- Environmental justice impacts resulting from changes in fishing activity, or impacts to the CDQ program or subsistence.

- Impacts on consumer benefits (U.S. consumers of groundfish products).

- Impacts on benefits from marine ecosystems (other than those benefits related to commercial groundfish fisheries), including non-market (existence value and option value, etc.), and other uses of the ecosystem, such as recreational fishing or tourism.

The socioeconomic impacts of the alternatives have been assessed using the Sector Model to estimate catch and processing amounts and revenues for the fishing and processing sectors and regions described in Section 3.9.2. The Sector Model uses output from the multi-species management model, combined with the historical harvest and processing proportions, to estimate the distribution of catch and processing among the various sectors and regions that rely on the groundfish fishery.

The Sector Model is a three-step process that:

- Estimates total catch and deliveries to processors.

- Proportions out deliveries to specific catcher vessel sectors.

- Distributes catches and processing amounts among the various regions where processors are located or vessels are owned.

In each step of the Sector Model, the catch of each species by gear and subarea is distributed to successive sectors based on the historical distribution from 2001 (the baseline condition for socioeconomic effects). The model and analytical framework used in the analysis for the harvesting and processing sectors are described in Section 4.1.7.

4.1.3.6 Ecosystem

Ecosystems consist of populations and communities of interacting organisms and their physical environment that form a functional unit with a characteristic trophic structure and material cycle (i.e., how energy or mass moves within the unit). Fishing has the potential to influence ecosystems in several ways. Fishing may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal back into the sea and through mortality of organisms not retained in the gear. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. Selective removal of species and/or sizes of organisms that are important in marine food web dynamics such as nodal prey species or top predators has the potential to change predator/prey relationships and community structure. Removals concentrated in space and time may impair the foraging success of animals tied to land such as pinnipeds or nesting seabirds; these animals may have restricted foraging areas or critical foraging times that are key to survival or reproductive success. Introduction of non-native species may occur through emptying of ballast water or introduction of hull-fouling organisms from ships from other regions (Carlton 1996). Introductions of such species have the potential to cause large changes in community dynamics. Fishing can alter different measures of diversity. Species-level diversity, or the number of species, can be altered if fishing essentially removes a target or nontarget species from the system. Fishing can alter functional diversity if it selectively removes a trophic or other ecosystem member and changes the biomass distribution among a trophic groups. Fishing gear may alter bottom habitat and damage benthic organisms and communities that serve important functional roles as structural habitat or within the food web. Fishing can alter genetic-level diversity by selectively removing faster growing fish or removing spawning aggregations that might have different genetic characteristics than other spawning aggregations.

A great deal of literature addresses possible indicators of ecosystem status in response to perturbations (e.g., Odum 1985, Pauly *et al.* 1998, Rice and Gislason 1996, Murawski 2000). These indices can show changes in energy cycling and community structure that might occur due to some external stress such as climate or fishing. For example, fisheries might selectively remove older, more predatory individuals. Therefore, we would expect to see changes in the size spectrum (the proportion of animals of various size groups in the system), mean age, or proportion of r-strategists (faster growing, more fecund species, such as pollock) in the system. These changes can increase nutrient turnover rates because of the shift towards younger, smaller organisms with higher turnover rates. Total fishing removals and discards also provide a measure of the loss and re-direction of energy in the system due to human influences. Total fishing removals relative to total ecosystem energy could indicate the importance of fishing removals as a source of energy removal in an ecosystem. Changes in scavenger populations that show the same direction of change as discards could be an indicator of the degree of influence discards have on the system. Discards as a proportion of total natural detritus would also be a measure that could indicate how large discards are relative to other natural fluxes of dead organic material. Levels of total fishing removal or fishing effort could indicate the potential for introduction of non-native species through ballast water in fishing vessels. Fishing practices can selectively remove predators or prey; tracking the change in trophic level of the catch may provide information about the extent to which this is occurring (e.g., Pauly *et al.* 1998). Thus, in this analysis, we use measures of total catch, total discard, and information about the changing mean size of organisms to indicate the potential of each of the alternatives to impact ecosystem energy flow and turnover.

Total catch and trophic level of the catch will provide information about the potential to disrupt predator/prey relationships through introduction of non-native species or altering the food web through selective removal of predators, respectively. Pelagic forage availability will be measured quantitatively by looking at population trends of pollock and Atka mackerel, target species that are key forage for many other fish and marine mammal species in the BSAI and GOA. Bycatch trends of nontarget species, such as the managed forage species group and herring, will be used as indicators of possible fishery impacts on those pelagic forage groups. Angermeier and Karr (1994) recognized that an important factor affecting the trophic base is spatial distribution of the food. The potential for fishing to disrupt this spatial distribution of food, which may be particularly important to predators tied to land, will be evaluated qualitatively to determine the degree of spatial/temporal concentration of fishery removals of forage. We will evaluate these factors to determine the potential of each of the alternatives to disrupt predator/prey relationships.

The scientific literature on diversity is somewhat mixed about what changes might be expected due to a stressor. Odum (1985) thought that species diversity (number of species) would decrease and dominance (the degree to which a particular species dominates the system in terms of numbers or biomass) would increase, if original diversity was high. The reverse might occur, if original diversity was low. Significance thresholds for species-level diversity due to fishing are catch removals high enough to cause the population of one or more target or non-target species to fall below minimum biologically acceptable limits. The MSST for target species, would either trigger ESA listing or would prevent recovery of an ESA-listed species. Genetic diversity can be altered by humans through selective fishing (removal of faster growing individuals or certain spawning aggregations). Accidental releases of cultured fish and ocean ranching tends to reduce genetic diversity (Boehlert 1996). Significance thresholds for genetic diversity impacts due to fishing would be catch removals high enough to cause a change in one or more genetic components of a target or non-target stock that would cause it to fall below minimum biologically acceptable limits (e.g., MSST for target species, ESA listing or non-recovery of ESA-listed species). More recently, there is growing agreement that functional (trophic or structural habitat) diversity might be the key attribute for ecosystem stability (Hanski 1997). This type of diversity ensures there are a sufficient number of species that perform the same function. If one species declines for any reason (human or climate-induced), then alternate species can maintain that particular ecosystem function, and there we would be less variability in ecosystem processes. However, measures of diversity are subject to bias, and we do not know how much change in diversity is acceptable (Murawski 2000). Furthermore, diversity may not be a sensitive indicator of fishing effects (Livingston *et* *al.* 1999, Jennings and Reynolds 2000). Nonetheless, we will evaluate the possible impacts that the alternatives may have on various diversity measures.

Quantitative measures of some of the indicators mentioned above have been identified for each of the alternatives. These include total catch, trophic level of the catch, total discards, total groundfish biomass, trophic level of groundfish biomass, bycatch amount of forage, top predator species, and habitat area of particular concern (HAPC) biota for the BSAI and GOA. We will address for each of the alternatives the possible impacts on predator/prey relationships, including introduction of non-native species; energy flow and redirection (through fishing removals and return of discards to the sea); and diversity.

4.1.4 Cumulative Effects Methodology

4.1.4.1 Introduction

Analysis of the potential cumulative effects of a proposed action and its alternatives is a requirement of NEPA. An EIS must consider cumulative effects when determining whether an action significantly affects environmental quality. The CEQ guidelines for evaluating cumulative effects state that "…the most devastating environmental effects may result not from the direct effects of a particular action but from the combination of individually minor effects of multiple actions over time" (CEQ 1997).

The CEQ regulations for implementing NEPA define cumulative effects as

> *the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).*

Cumulative effects are linked to incremental actions or policy changes that individually may have small outcomes, but that in the aggregate and in combination with other factors can result in greater effects in the BSAI and GOA. At the same time, the CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action on the universe, but to focus on those effects that are truly meaningful.

The cumulative effects analysis assesses the potential direct and indirect effects of groundfish FMP policy alternatives in combination with other factors that affect physical, biological, and socioeconomic resource components of the BSAI and GOA environment. Peer reviewed literature and quantitative research on the cumulative effects of fishing activities in the Bering Sea and GOA are limited. The cumulative effects analysis presented for each of the FMP policy alternatives addresses the potential magnitude of effects and is somewhat qualitative in nature.

The intent of the cumulative effects analysis is to capture the total effects of many actions over time that would be missed by evaluating each action individually. A cumulative effects assessment describes the additive and synergistic result of the actions proposed in this Programmatic SEIS as they interact with factors external to those proposed actions. To avoid the piecemeal assessment of environmental impacts, analysis of cumulative effects were included in the 1978 CEQ regulations, which led to the development of the CEQs cumulative effects handbook (CEQ 1997) and federal agency guidelines based on that handbook (e.g., USEPA 1999). Although predictions of direct effects of individual proposed actions tend to be more certain, cumulative effects may have more important consequences over the long-term. The possibility of these hidden consequences presents a risk to decision-makers, because the ultimate ramifications of an individual decision might not be obvious. The goal of identifying potential cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of alternative management actions. This section characterizes the incremental cumulative effects that potentially arise from external factors in combination with the direct and indirect effects.

4.1.4.2 Methodology

The methodology for cumulative effects analysis in this Programmatic SEIS consists of the following steps:

- *Identify characteristics and trends within the affected environment that are relevant to assessing cumulative effects of the FMP policy alternatives, including lingering effects and how they have contributed to the comparative baseline.* This information is presented in Chapter 3 of this Programmatic SEIS and summarized in the cumulative effects sections for each of the alternatives.

- *Describe the potential direct and indirect effects of each of the four FMP policy alternatives.* This information is presented in detail in Sections 4.5 through 4.9 of this Programmatic SEIS, and is summarized in the cumulative effects ranking tables. The cumulative effects analysis uses the specific direct and indirect effects that have been evaluated for comparison with external factors.

- *Identify past, present, and reasonably foreseeable external factors such as other fisheries, other types of human activities, and natural phenomena that could have additive or synergistic effects.* Past actions must be evaluated to determine whether there are lingering effects that may still result in synergistic or incremental impacts when combined with the proposed action alternatives. The CEQ guidelines require that cumulative effects analysis assess reasonably foreseeable future actions. Because analysis of relevant past, present, and future effects depends on the resource or characteristic being evaluated, the time period for looking at past and reasonably future effects will vary. Both past BSAI and GOA FMP amendments and pertinent external factors used to evaluate potential effects are described further in this introduction.

- *Use cumulative effects tables to screen all of the direct/indirect effects with external factors to capture those synergistic and incremental effects that are potentially cumulative in nature.* Both adverse and beneficial effects of external factors on the criteria used for direct and indirect effects are assessed, and then evaluated in combination with the direct and indirect effects to determine if there are cumulative effects.

- *Evaluate the significance of the potential cumulative effects using criteria established for direct and indirect effects and the relative contribution of the action alternatives to cumulative effects.* Of particular concern are situations where insignificant direct and indirect effects lead to significant cumulative effects or where significant external effects accentuate significant direct and indirect effects.

- *Discuss the reasoning that led to the evaluation of significance, citing evidence from the peer-reviewed literature and quantitative information where available.* As with direct and indirect effects, the term conditional significance has been used where conclusions of significance have been based on reasoned assumptions, and the term unknown is used where there is not enough information to reach a conclusion of significance.

The advantages of this approach are that it closely follows CEQ guidance, employs an orderly and explicit procedure, and provides the reader with the information necessary to make an informed and independent judgment concerning the validity of the conclusions.

The CEQ (1997) has established step-by-step guidelines for conducting a cumulative effects analysis. The guidelines set forth 11 steps that can be classified into four basic stages: scoping, organizing, screening, and evaluating. Table 4.1-10 shows how the cumulative effects assessment for groundfish fisheries management was adapted to closely follow the CEQ guidelines.

4.1.4.3 Scoping

A historical review of the BSAI and GOA FMP amendments was conducted, looking at the intent and consequences of FMP amendments since 1980. This information was used to prepare the comparative baseline that is presented in Chapter 3 and summarized in Section 4.4. In addition to issues that were derived from the historical FMP amendment review, both the scoping process and public review of the first draft of the Programmatic SEIS identified issues to be addressed in the cumulative effects analysis. The scoping comments identified two major issues associated with analysis of potential cumulative effects: the consideration of the additive effects of management actions over time and the cumulative effects of the management regime as a whole, and the consideration of impacts of natural events versus fisheries management on the ecosystem, including the human component (socioeconomic and subsistence) of fishing communities.

Public comments on the first draft of the Programmatic SEIS identified 15 themes associated with the scope and conclusions of the analysis of potential cumulative effects. Among the suggestions was that the cumulative effects analysis use a different baseline to compare the alternatives than the status quo management system. A summary of these issues can be found in the Scoping Summary Report (NMFS 2000a) and Comment Analysis Report (Appendix G).

4.1.4.4 Additive and Cumulative Effects of Past FMP Amendments

The potential effects of the original BSAI and GOA FMPs and their amendments are difficult to substantiate quantitatively. Given the inherently large fluctuations that occur naturally in fish populations and the complexity of the North Pacific fishery, it is not feasible to identify biological responses to managerial decisions designed to fine tune fishery harvests under the mandate of both preserving stocks and maximizing commercial exploitation. Intended and unintended socioeconomic effects on the fishing industries and regions and communities that participate in the groundfish fishery are easier to assess. The analysis of FMP amendments was used to develop the comparative baseline presented in Chapter 3 and summarized in Section 4.4, and to identify lingering effects to carry forward into the cumulative effects analyses in Sections 4.5 through 4.9.

4.1.4.5 Identification of External Factors and Effects

A cumulative effects analysis takes into account the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7). External factors play an important role in developing the comparative baseline used to evaluate the effects of the proposed action and its alternatives, and to identify present and reasonably foreseeable future actions that are relevant to the cumulative effects analysis. For the purposes of this Programmatic SEIS, the definition of external actions includes both human controlled events such as other fisheries, pollution, and industrial development, and natural events such as disease, winter mortality, and short-and long-term climate change.

In order to ascertain the importance of the external impacts in the cumulative effects analysis, a comprehensive checklist was produced for each resource category (marine mammals, seabirds, target species, non-target species, prohibited catch species, habitat, socioeconomic characteristics, and ecosystem). Information presented in the checklists was obtained from reviewing EISs, reports and resource studies, and peer-reviewed literature. The identified external factors were discussed in meetings with staff of the NOAA Fisheries Alaska Fisheries Science Center (AFSC) to confirm accuracy, identify any effects that might have been missed, and explore pathways through which the external influences might act in an additive or interactive fashion with the alternatives to produce cumulative effects.

Within each resource checklist the effects were divided into the two main categories: human controlled events, and natural events. Due to inherent differences between socioeconomic resources and biological resources and systems, external effects impacting the socioeconomic category were developed to consider different events and topics, or different aspects of the same event. For example, potential biological factors of other fisheries include disturbance and habitat damage, whereas potential socioeconomic factors include the contribution of participation in other fisheries to the overall viability of fishing industry harvesters and processors. Table 4.1-11 summarizes the external effects that have been incorporated into the cumulative effects analysis.

4.1.4.6 Organizing the Cumulative Effects Analysis

Potential cumulative effects of each of the policy alternative FMPs are presented in Sections 4.5 through 4.9. For each of the alternatives, the analysis of cumulative effects follows the analysis of direct and indirect effects within the discussion of each of the major resource topics (e.g., Target Fish, Marine Mammals, Socioeconomic Characteristics). The structure of the cumulative effects analysis also parallels the direct and indirect effect analysis in the organization of the impact screening tables. The categories of effects evaluated for each of the direct/indirect analyses are used to organize the cumulative effects screening tables.

The categories of effects to be evaluated were developed jointly by analysts preparing the direct/indirect and cumulative effects analyses. These effects appear in the far left hand column of both the direct/indirect and cumulative effects matrices. This approach facilitates evaluating the additive and synergistic effects of the FMP policy alternatives with past FMP amendments and external effects. It also provides transparent logic for those reviewing the Programmatic SEIS.

4.1.4.7 Screening Potential Cumulative Effects

The screening process for the cumulative effects analyses consists of the following steps:

- Identify the cause and effect relationships and incorporate them into the categories of effects to be evaluated for the direct/indirect and cumulative effects analyses.

- Identify whether potential effects on a given resource from past external actions remain, and whether they have a lingering effect on the resource that contributes to the significance of potential cumulative effects.

- Identify potential effects on a given resource from both direct and indirect effects of the policy alternative FMPs and from present and reasonably foreseeable external actions.

- Develop and utilize matrices as the organizational structure to incorporate past effects, direct/indirect effects, and the potential effects of present and reasonably foreseeable events in evaluating the potential for and significance of cumulative effects.

As indicated above, parallel impact assessment tables or matrices have been constructed to screen and evaluate direct, indirect, and cumulative effects, and to ensure that the evaluation is orderly and systematic. Each direct and indirect matrix scores the alternatives with respect to the impacts they could produce on the subject resource component. The range of scores includes insignificant, significant, conditionally significant, and unknown. A plus (+) or minus (-) is added to the significant or conditionally significant score to indicate a beneficial or adverse effect, respectively.

A second series of matrices was prepared for each resource component under each alternative. The cumulative effects matrices tabulate the external factors identified in the scoping process (columns) against the direct and indirect effects that have been identified. Under a single resource category (e.g., marine mammals), a separate cumulative effects matrix was prepared for each resource component (e.g., Steller sea lion, northern fur seal, harbor seal, etc.). The matrices include both beneficial and adverse environmental effects associated with past, present, and potential future management decisions related to the four policy alternatives. External effects that could function additively or interactively with the direct and indirect effects of the alternatives are organized into two major categories of human controlled and natural events.

4.1.4.8 Evaluating the Significance of Potential Cumulative Effects

The potential for cumulative effects and their significance was evaluated for the resources and characteristics of the human environment described in Chapters and 3 and 4. For biological, habitat, and ecosystem resources and characteristics, significance criteria and thresholds take into account the geographic scope, population level implications, and regulatory aspects of potential effects. Significance criteria and thresholds for socioeconomic characteristics take into account the relative magnitude of change, the geographic distribution of effects, and the regulatory aspects of potential effects.

Table 4.1-12 is an example matrix illustrating the approach taken to evaluate cumulative effects. Starting in the far left-hand column, the category of effect used in both the direct, indirect, and cumulative effects analysis is presented, along with a significance rating for the direct and indirect effect. Any persistent past effects to be carried forward in the cumulative effects analysis are identified. Next, reasonably foreseeable future human controlled and natural effects are identified and briefly described, along with the nature of contribution to cumulative effects. Categories include potential adverse or beneficial contribution, not a contributing factor, and unknown. The direct and indirect, persistent past, and external effects are then integrated to determine whether there is a cumulative effect and its significance. The far right hand column summarizes the cumulative effect and whether it is significant, conditional significant, insignificant, or unknown. Several rules of logic are applied to the process. If the direct/indirect effect is unknown, it is not possible to determine the cumulative effect, which is also unknown. If there are no persistent past effects and there are no reasonably foreseeable future effects (not a contributing factor), then there are no cumulative effects for a specific effects category. The logic for applying ratings of conditional significance and unknown is the same for direct and indirect effects (see Sections 4.1.2 and 4.1.3). The cumulative matrix tables are supported by text that describes in more detail the persistent past effects, relevant external factors, and the logic in determining the significance of cumulative effects.

4.1.5 Description of the Multi-Species Analytical Model and its Assumptions

4.1.5.1 Background

In the Draft 2001 Programmatic SEIS, simulation models were developed that evaluated individual stocks independently, as if each species could be caught separately from other species. The simulation model thus failed to reflect the multi-species character of nearly all Alaska groundfish fisheries, which catch a wide variety of species even when targeting a single species. This meant that in many cases, single-species simulations did a poor job of representing the likely consequences of alternative management scenarios. For this revised Programmatic SEIS, simulation models have been developed that reflect the multi-species nature of the fisheries and their management.

Current groundfish management in federal waters of Alaska consists of strict quota management for FMP-managed species. These quotas are closely monitored, and as quotas are approached in a given year, with reserves set aside for bycatch in other fisheries, directed fisheries become closed. Prohibited species catch (PSCs) limits are also closely monitored and affect fishing season length and area openings. These quotas and PSCs effectively become constraints for all groundfish fisheries operating in the GOA and BSAI regions. These constraints are established based on area-specific TACs. The TACs are derived from the NPFMC's annual recommendations for ABC levels. As a matter of policy, the NPFMC's TAC for a given species or species group has always been less than or equal to the ABC for that species. The resulting management system is one that strives to meet the objective of providing fishing opportunities subject to a large number of constraints. Analysis of this type of fisheries regime has been modeled using Linear Programming (e.g., Brown *et a*l. 1979, Siegel *et al.* 1979, and Murawski and Finn 1986). In this Programmatic SEIS, we attempt to mimic management of complex interacting fisheries and their impact on GOA and BSAI living marine resources using a similar approach.

Simulating current groundfish management in the U.S. North Pacific economic zone involves considering interactions between a large number of species, areas, and gear types. These fisheries are managed subject to a large number of constraints (e.g., ABCs and PSCs). Management decisions are based on expectations about the array of species likely to be captured by different gear types and the cumulative effect that each individual fishery has on the allowable catch of each individual species or species group. The expectations of capture by different fisheries are based on historical catch data of each species within area and gear strata. The ABC constraints come from probabilistic projections of future stock dynamics for each individual species. Given these constraints, the predicted catch for each example FMP is then computed from an inseason management model. This management model accounts for the technical multi-species interactions of the groundfish fisheries (see Ackley 1995 for an example application of within-year patterns for the EBS fishery). Finally, the predicted catches are fed back into the age-structured information for each species to compute the correct fishing mortality level and are then projected through each year. This provides a reasonable representation of the current fisheries management practice for dealing with the multi-species nature of bycatch in target fisheries. Fisheries are defined by distinct target species, gear type, and area. The optimal decision-making process related to actual removals is simulated using historical information on catch composition of these fisheries. A schematic of the modeling approach is presented in Figure 4.1-1.

This section begins with a description on how individual stocks are treated and projected into the future, including details on how the constrained optimization is used to mimic management. A critique of the approach and assumptions follow. The subsequent section describes how catch estimates were derived, followed by how specific alternatives were modeled (including the data that were used). This section then concludes with a brief description on how model results were applied in different resource categories (e.g., to assess the impact on marine mammals).

4.1.5.2 Methods

Treatment of Stocks

For the stocks with age-structure information, the model is very similar to those used for the stock assessments upon which ABC recommendations are currently based, and it contains features and assumptions common to many fishery population dynamics models. Parameters and other inputs were obtained for each stock. They were taken directly or inferred from the most recent Stock Assessment and Fishery Evaluation (SAFE) report or obtained from AFSC scientists. The simulations began with numbers of a given age in 2002, which were projected forward using a random recruitment simulator (Inverse Gaussian) and a fishing mortality rate defined by the FMP under consideration. Recruitments were drawn from a statistical distribution that is described below. The parameters consisted of maximum likelihood estimates obtained from the recruitments listed in the 2002 SAFE report. Recruitment estimates after 1978 were used to estimate distribution parameters. No serial correlation was assumed. The age of recruitment varied between stocks, corresponding to the minimum age used in the respective assessment models. For stocks where age-structure information is not available, but ABCs are set, the model used the most recent estimates of ABC as the upper limit on total catch. The list of species considered for the BSAI and GOA is presented in Table 4.1-13. The actual age-structure data used for the analyses are available online at www.fakr.noaa.gov/sustainablefisheries/seis/data.

Projection Model

The following presents details on the steps of the projection simulations. A glossary of notation is provided at the end of this section for reference.

Step 1: Select the Catch Composition Array Appropriate for the Alternative

As presented below, separate hypothetical catch-composition arrays were developed for each alternative. A catch-composition array can be simply thought of as a table where the rows represent a specific fishery defined by target species, area, and gear type, and the columns represent the catch by species group or stock (See www.fakr.noaa.gov/sustainablefisheries/seis/data).

Step 2: Project Recruitments for all Years and Simulations

Recruitment estimates for the years 1978 through 2001, or the largest available subset thereof, were obtained from each of the respective 2002 stock assessments. For each stock, these recruitments were used to find maximum likelihood estimates for the inverse Gaussian distribution parameters. The distribution was parameterized such that one of the parameters represented the distribution mean. A recruitment time series was obtained for each simulation by drawing randomly from this parametric distribution.

Step 3: Estimate Actual Fishing Mortality Rates for the Initial Year

The steps in this part of the model are described below. Because the example FMPs were assumed not to take effect until after 2002, these steps were conducted only once, rather than separately for all eight FMPs. Compute the fishing mortality rate that would set catch equal to C_t by solving the following implicit equation:

$$C_{2002} = F_{2002} \sum_{a=1}^{n_{age}} \left[N_{a,2002} \left(\frac{1 - \exp\left(-M_a - F_t \sum_{k=1}^{n_{gear}} s_{a,k} d_k \right)}{M_a + F_t \sum_{k=1}^{n_{gear}} s_{a,k} d_k} \right) \sum_{k=1}^{n_{gear}} w_{a,k} s_{a,k} d_k \right]$$

Step 4: Project Numbers at Age for all Ages, Years, and Simulations

For each example FMP, 200 projection simulations were conducted. The projected numbers at age in each year were based on an annual feedback of actual catch obtained from the linear programming constrained optimization algorithm, hereafter referred to as the LP. The steps for these projections for a given species were as follows:

1. Initialize the simulation index:

   $u = 0$

2. Increment the simulation index:

   $u = u + 1$

3. Initialize the time index:

   $t = 1$

4. Compute numbers at age for initial year of simulation u:

   $$N_{a,t,u} = R_{t,u} \quad \text{for } a = 1, t = 1$$
   $$N_{a,t,u} = n_a \quad \text{for } a > 1$$

5. Set fishing mortality rate for initial year of simulation u:

   $F_{t,u} = F_{2002}$

6. Increment time index:

$$t = t + 1$$

7. Compute numbers at age in year t of simulation *u*:

$$N_{a,t,u} = R_{t,u}, \quad R_{t,u} \sim \text{InvGaussian}(\beta, \gamma) \qquad \text{for } a=1$$

$$N_{a,t,u} = N_{a,t-1,u} \exp\left(-M_a - F_{t-1,u} \sum_{k=1}^{n_{gear}} s_{a,k} d_k \right) \qquad \text{for } 1 < a < n_{age}$$

$$N_{a,t,u} = N_{a,t-1,u} \exp\left(-M_a - F_{t-1,u} \sum_{k=1}^{n_{gear}} s_{a,k} d_k \right) + N_{a-1,t-1,u} \exp\left(-M_{a-1} - F_{t-1,u} \sum_{k=1}^{n_{gear}} s_{a-1,k} d_k \right) \qquad \text{for } a = n_{age},$$

8. Compute the ABC fishing mortality rate that establishes the TAC for year *t* of simulation *u*.

The appropriate fishing mortality rate was determined by the projection year and the relative spawning biomass of the stock as shown in the table below (B_{ref} corresponds to $B_{40\ percent}$ in all cases unless otherwise specified). F_{ref} corresponds to the fishing mortality specified as the F_{ABC} value.

Relative spawning biomass	**Fishing mortality rate**
$B_{t,u} < \alpha B_{ref}$	$F_{t,u}^{ABC} = 0$
$\alpha B_{ref} \le B_{t,u} < B_{ref}$	$F_{t,u}^{ABC} = F_{ref} \left(\frac{B_{t,u}}{B_{ref}} - \alpha \right) / (1 - \alpha)$
$B_{ref} \le B_{t,u}$	$F_{t,u}^{ABC} = F_{ref}$

where $B_{t,u} = \sum_{a=1}^{n_{ages}} N_{a,t,u} m_a w_a \phi_{a,t,u}$ and $\phi_{a,t,u}$ is the total mortality rate between the beginning of the year and the time of spawning. The value of $B_{t,u}$ was computed iteratively (since it can be a function of fishing mortality). Note also that for some FMPs described below these rules change for some species. For a given FMP *I,* the fishing mortality is treated as a function of the F_{ABC} value.

$F_t^{Alt} = f\left(F_{t,u}^{ABC}\right)$ as specified by the FMP.

9. Compute the TAC value as annually varying limit on catch. For a given species and value of (for $F_t^{Alt_l}$ alternative *l*) the projection model computes the TAC used in the constraint as

$$TAC_t^{Alt_l} = \sum_{k=1}^{n_{gear}} \sum_{a=1}^{n_{age}} N_{a,t} w_{a,k} \frac{F_t^{Alt_l} s_{a,k} d_k}{F_t^{Alt_l} s_{a,k} d_k + M_a^p} \left[1 - e^{-F_t^{Alt_l} s_{a,k} d_k - M_a^p} \right]$$

10. Compute the actual catch, $C_{t,u}$, given the suite of constraints from the LP optimization described below.

11. Solve for the fishing mortality rate $X_{t,u}$ that would set catch equal to $C_{t,u}$ in year *t* of simulation *u* as estimated from the multi-species management constrained optimization problem described below and varies by FMP by solving the following implicit equation:

$$C_{t,u} = X_{t,u} \sum_{a=1}^{n_{age}} \left[N_{a,t} \left(\frac{1 - \exp\left(-M_a - X_{t,u} \sum_{k=1}^{n_{gear}} s_{a,k} d_k \right)}{M_a + X_{t,u} \sum_{k=1}^{n_{gear}} s_{a,k} d_k} \right) \sum_{k=1}^{n_{gear}} w_{a,k} s_{a,k} d_k \right]$$

12. Check to see if all years of simulation *u* have been completed, then continue as necessary:

If $t<n_{pro}+1$, return to (6)
If $t=n_{pro}+1$, end simulation *u*.

13. Return to (2) until all simulations are complete.

Step 5: Store Stock Performance Statistics from the Above Projections

A series of individual stock performance indicators for species with specified age-structure results were computed separately for each FMP as follows:

Total biomass in each year and simulation:

$$T_{t,u} = \sum_{a=1}^{n_{age}} N_{a,t,u} w_a$$

Spawning biomass and catch, as specified above, were stored for each species, year, and simulation. Approximate confidence bounds were computed from the simulation output by simply ranking results from the simulations and computing the percentile values corresponding to the desired intervals (here taken as the 10^{th} and 90^{th} percentile). Also computed was the implied spawning biomass per recruit (SPR) rate, given the level of catch in a single year and simulation. (For example, the theoretical percentage of unfished spawning output expected from a single recruit if fishing mortality were equal to the estimated fishing mortality over the life of the species.)

Average age for each stock in the final projection year across all simulations was computed as:

$$A = n_{sims}^{-1} \sum_{u=1}^{n_{sims}} \frac{\sum_{a=1}^{n_{age}} a\, N_{a,2002+n_{pro},u}}{\sum_{a=1}^{n_{age}} N_{a,2002+n_{pro},u}} + a_{\min} - 1$$

The Linear Programming Algorithm

LP is an active research branch of operation research that has proved to be useful in resource management. In this context, an optimization problem is considered linear if all objective function and constraint coefficients can be arranged in a linear way. The linear optimization problem, in this case, consists of finding the optimal catch allocation in order to maximize the overall catch or total revenue across all fisheries and subject to a certain number of linear constraints. We used a revised Simplex algorithm (Press *et al.* 1992) to find the optimal vertex in this multidimensional space.

The objective function and constraint coefficients were computed primarily from the NOAA Fisheries, Alaska Region blend dataset. The data were averaged over the period 1997 to 2001, so all the coefficients represent averages from this time period. FMP-specific constraints were developed for both the BSAI and GOA. Namely TAC constraints for each FMP area complex, special gear sconstraint for some species, lower and upper bound constraints on the variation of catch relative to average levels for each fishery, and constraints of the maximum allowable biological removals of each system.

Objective Function Coefficients

The target function consisted of coefficients derived from the blend data set for FMP-managed species across different fisheries. The ex-vessel value ($V_{j,g}$) for each species and proportion retained by each fishery were used to compute the coefficients of the linear objective function:

$$A_g = \sum_{j=1}^{n_{species}} \sum_{k=1}^{n_{area}} V_{j,g} C_{j,k,g}^{N} R_{j,g}$$

with the overall objective function to be maximized in year *t* is given as:

$$\Theta_t = \sum_{g=1}^{n_{fish}} A_g Y_{t,g}$$

where

A_g	Objective function coefficients applied to each fishery
$C_{j,k,g}^{N}$	Catch data from the blend dataset by species, sub-area and fishery
$R_{j,g}$	Retained fraction of catch
$Y_{t,g}$	Relative total catch between fisheries within each year (main result returned from the constrained optimization)

$V_{j,g}$ Estimated ex-vessel value of each species within different fisheries

t Year

j Species

k Sub-area

g Fishery

h Gear-type

Linear Constraints

In our optimization problem there are two types of constraints: values that are maxima or upper bounds, and values that are minima or lower bounds. There were five types of upper-bound constraints and one type of lower-bound constraint, these are presented below in consecutive order. The coefficients were computed only once for a specific FMP since the catch-composition data is constant for this model version over time and assumed known without error.

The bounding information or constraints were based on a number of sources detailed below. Note that some constraints change over time (e.g., the ABC/TAC constraints).

Acceptable Biological Catch (ABC/TAC) Constraints

These constraints determined an upper bound equivalent to the TAC for each species in each sub-area. Each constraint has one coefficient and represents the average annual catch by FMP species and area as:

$$\sum_{g=1}^{n_{FA}} Y_g a_{j,k,g}^{ABC} \leq b_{j,k}^{ABC_t}$$

$$a_{j,k,g}^{ABC} = C_{j,k,g}^{N}$$

$$b_{j,k}^{ABC_t} = TAC_{t,j,k}\ f_k$$

where $TAC_{i,j,k}$ = Total allowable catch for species *j*, in sub-area *k* in year *I* and f_k is the split by area for a particular species, and the bounds of the constraints are calculated as a function of a fixed allocation fraction of the TAC across sub-areas and the estimates for TAC by year.

Gear Type (G) Constraints

Gear allocations for a specific annual TAC were included to reflect the current practice. In the model, these constraints were specified as

$$\sum_{g=1}^{n_G} Y_{t,g} a_g^G \leq b^G$$

$$a_g^G = \sum_{g=1}^{n_{area}} C_{k,g}^N$$

$$b^G = TAC_e f_k^G$$

where e = Index for species with gear restrictions

f_k^G = Proportion of TAC allocated to each gear type, G, of each species in sub-area k.

For example, sablefish TAC's are allocated between longline fixed gear and trawl gear. The model accounts for these allocations as added constraints.

Fishery Expansion Constraints

Upper-bound constraints on relative catch are placed by FMP species upper limit (UL) so that relative catch does not grow unreasonably beyond the baseline data or 1997 to 2001 average.

$$Y_{t,g} a_g^{UL} \leq b_g^{UL}$$

b_g^{UL} values typically ranged from 1.3 to 3. However, some alternatives specified different values as detailed in Section 4.1.5.5 Description of the Alternatives.

Fishery Contraction Constraints

Based on extensive initial runs of this model, the optimal solution often eliminated a number of fisheries. To prevent this, and to ensure that the catch remains positive, the following set of lower-limit (LL) constraints were applied.

$$Y_g a_g^{LL} \geq b_g^{LL}$$

where $a_g^{LL,}$ is a scalar for fishery g.

Overall Optimum Yield (OY) Constraint

The specification that the OY cap could not be exceeded was given as:

$$\sum_{g=1}^{N_{fish}} Y_{t,g} a_g^{OY} \leq b^{OY}$$

$$a_g^{OY} = \sum_{e=1}^{N_{sp}} \sum_{k=1}^{N_{Area}} C_{e,k,g}^N$$

$$b^{OY} = OY$$

where OY = optimum yield summed for the geographical area (e.g., BSAI) for all target FMP species

e = index of target species used for optimum yield.

Note that this was generally two million metric tons (mt) for the BSAI and 800,000 mt for the GOA. However, some alternatives specified different values as detailed below in the FMP descriptions section.

Optimizing the Objective Function Subject to the Constraints

To find the optimum solution in standard tableau notation (Press *et al.* 1992), we can reduce the system of equations to the following array with columns 2 to *g+1* corresponding to each fishery:

where

m_{ABC} Number of ABC type of constraints (number of species that have TAC)

m_G Number of gear type of constraints

m_{UL} Number of upper limit constraints on relative catch of FMP species

m_{LL} Number of lower limit constraints on relative catch of FMP species

m_{OY} Number of optimum yield constraints (only one)

Some of the coefficients (A_i , a_i^j) are zero but they are presented here in a general notation.

$$
\begin{array}{cccccc}
0 & A_1 & \cdots & A_i & \cdots & A_g \\
b_{i,j,k}^{ABC_1} & -a_{j,k,1}^{ABC_1} & \cdots & -a_{j,k,i}^{ABC_1} & \cdots & -a_{j,k,g}^{ABC_1} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
b_{i,j,k}^{ABC_{m_{ABC}}} & -a_{j,k,1}^{ABC_{m_{ABC}}} & \cdots & -a_{j,k,i}^{ABC_{m_{ABC}}} & \cdots & -a_{j,k,g}^{ABC_{m_{ABC}}} \\
b^{MG_1} & -a_1^{MG_1} & \cdots & -a_i^{MG_1} & \cdots & -a_g^{MG_1} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
 & & & & & \\
b^{G_1} & -a_1^{G_1} & \cdots & -a_i^{G_1} & \cdots & -a_g^{G_1} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
b^{G_{m_G}} & -a_1^{G_{m_G}} & \cdots & -a_i^{G_{m_G}} & \cdots & -a_g^{G_{m_G}} \\
b^{UL_1} & -a_1^{UL_1} & 0 & 0 & 0 & 0 \\
\vdots & 0 & 0 & -a_i^{UL_n} & 0 & 0 \\
b^{UL_{m_{UL}}} & 0 & 0 & 0 & 0 & -a_g^{UL_{m_{UL}}} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
b^{OY} & -a_1^{OY} & \cdots & -a_i^{OY} & \cdots & -a_g^{OY} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
b^{LL_1} & -a_1^{LL_1} & 0 & 0 & 0 & 0 \\
\vdots & 0 & 0 & -a_i^{LL_{m_{LL}}} & 0 & 0 \\
b^{LL_{m_{LL}}} & 0 & 0 & 0 & 0 & -a_g^{LL_{m_{LL}}}
\end{array}
$$

4.1.5.3 Data

Estimation of the 1997 to 2001 Catch by Species and Fisheries

We used the NOAA Fisheries, Alaska Region blend estimates of catch by area, species, gear, and target species combined with observer fish ticket data. The fish tickets are landing receipts recorded by Alaska Department of Fish and Game (ADF&G) statistical areas.

The North Pacific Groundfish Observer Program currently provides all of the information we have on fishery interactions with non-target species. Observers estimate total catch and species composition of the catch in a random sample of hauls. All animals are counted, weighed, and identified to the lowest practical taxonomic level, regardless of their status as a target species, or whether they will later be discarded by the vessel. The Observer Program is extensive, covering the majority of fishing effort in the BSAI and up to 30 percent of fishing effort in the GOA.

Despite the large size and extent of the Observer Program, not all fishing is observed at all times. Only fishing vessels over 124 feet (ft) in length must carry an observer for all days fishing. Smaller vessels (60-124 ft) are only required to carry an observer for 30 percent of days fishing, and vessels under 60 ft are never required to carry an observer. Therefore, we had to extrapolate the data collected by observers to the reported catch from all observed and unobserved fishing in order to estimate the total catches of non-target species groups from all fishing for this analysis. This assumes that observed fishing and unobserved fishing have the same catch composition. Although this assumption is unverified, observer data is the best and only source of information on non-target species catch.

Catches were estimated by species group for the recent domestic fishery, 1997 to 2001, using the following method: within each year, each vessel's observed catch of a given species group was summed within statistical area, gear type, and week. A target fishery was then assigned to each vessel's weekly catch, generally by assuming that the species with the highest retained catch for that week was the target species. The Programmatic SEIS describes target fishery designations and the specific algorithm for assigning targets. This is consistent with target assignments done as part of the inseason management system at the regional office. Catch by target species and non-target species, where available, was then summed for each year over all observed vessels within each area, gear, and target fishery. The ratio of observed non-target species catch to observed target species catch within each area, gear, and target fishery was multiplied by the total reported (regional office blend-estimated) target species catch within that area, gear, and target fishery. Data from years prior to 1997 could not be assigned to target fisheries in a way that is consistent with total catch targets assigned by the NOAA Fisheries Alaska regional office due to changes in the structure of the observer database. We do not consider this a problem because the most recent years of catch information are most valuable for the purposes of this analysis. Catches of other species, forage fish, and grenadiers were estimated for 1990 through 2001 as part of the annual stock assessment process and are reported in annual SAFE documents for the BSAI and the GOA.

The catch-composition data were processed to reflect area and time closures specific to each alternative. Since the catch-composition estimates were assigned to spatial/temporal strata, then the effect of changes in management measures could be reflected by modifying the catch-composition arrays accordingly. For example, if an alternative had specific closed areas, then the catch-composition data that fell within those categories were deleted. The notion here was simply to try to reflect how catch-composition might change under alternative area-time constraints.

Methods Used to Apportion the Estimates of Total Catch, Retained Catch, and Ex-Vessel Value by Processor Group and Vessel Class and to Estimate Product Value by Processor Group

We used blend estimates of total catch and retained catch and fish ticket estimates of retained catch for 1999 to 2001 to apportion the catch and ex-vessel value projections discussed above by processor group and vessel class. The resulting estimates of retained catch by processor group were used with 2001 estimates of product value per mt of retained catch to generate the estimates of product value. The methods used are discussed below.

Step 1: Define Processor Groups and Identify the Processors in Each Group

We defined the following six groups of inshore processors and six groups of at-sea processors to assist in analyzing the economic and social effects of the GOA and BSAI groundfish fisheries both historically and for the alternatives being considered in this Programmatic SEIS.

1. Large BSAI pollock processors (the American Fisheries Act [AFA] inshore sector processors that operate in or near Unalaska and Akutan.

2. Other Alaska Peninsula and Aleutian Island processors.

3. Floating processors (non-AFA floating processors).

4. Kodiak processors.

5. Southcentral processors.

6. Southeast processors.

7. Surimi factory trawlers.

8. Fillet factory trawlers.

9. Head and gut factory trawlers.

10. Longline catcher processors.

11. Pot catcher processors.

12. Motherships.

We then identified the processors in each of these mutually exclusive groups.

Step 2: Distribute Catch and Ex-vessel Value Projections by Processor Group

We used blend estimates of total catch and retained catch by fishery, species (for the TAC species), and processor group from 1999 to 2001 to estimate the shares of total catch and retained catch by fishery and species associated with each processor group. The fisheries were defined by target species, gear, and area. We then applied the total catch shares to the alternative-specific total catch projections to estimate alternative-specific total catch by fishery, species, and processor group. The retained catch shares were used in a similar way with the alternative-specific retained catch and ex-vessel projections to generate comparable estimates of retained catch and ex-vessel value. Data for 1999 to 2001 were used because the AFA was implemented in 1999, significantly changing the shares of catch among processor groups.

Step 3: Estimate Product Value by Processor Group

For each inshore processor group, we used 2001 Alaska Commercial Operator's Annual Report (COAR) estimates of groundfish purchases and product value by species to estimate product value per mt of retained catch. For each at-sea processor group, we used 2001 COAR product price data for at-sea processors, supplemented by 2001 product price data provided by representatives of the Head and Gut Factory Trawlers, together with Weekly Production Report production and retained catch data to estimate product value per mt of retained catch.

Step 4: Define Catcher Vessel Classes and Identify the Catcher Vessels in Each Group

We defined the following nine classes of groundfish catcher vessels to assist in analyzing the economic and social effects of the GOA and BSAI groundfish fisheries both historically and for the alternatives being considered in this Programmatic SEIS.

Bering Sea pollock trawl catcher vessels greater than or equal to 125 ft in length

- Bering Sea pollock trawl catcher vessels 60 to 124 ft in length.
- Diversified AFA-eligible trawl catcher vessels greater than or equal to 60 ft in length.
- Non-AFA trawl catcher vessels greater than or equal to 60 ft in length.
- Trawl catcher vessels less than 60 ft in length.
- Pot catcher vessels less than or equal to 60 ft in length.
- Longline catcher vessels less than or equal to 60 ft in length.
- Fixed gear catcher vessels 33 to 59 ft in length.
- Fixed gear catcher vessels less than or equal to 32 ft in length.

We then identified the catcher vessels in each of these mutually exclusive vessel classes.

Step 5: Estimate Retained Catch and Ex-vessel Value by Catcher Vessel Class

We used State of Alaska fish ticket estimates of retained catch by species, area, processor group, and vessel class from 1999 to 2001 to estimate the share of retained catch by species and area associated with each catcher vessel class. We then applied the retained catch shares to the alternative-specific retained catch and ex-vessel value projections by processor group to generate alternative-specific estimates of retained catch and ex-vessel value by species, area, and catcher vessel class.

Assumptions

The resulting estimates of total catch, retained catch, ex-vessel value, and product value are based on the assumptions that the following will not vary, either by alternative or from what has been observed recently for the BSAI and GOA groundfish fisheries:

- Species composition (i.e., bycatch rates) of TAC species in any individual fishery, where a fishery is defined by area, gear, and target species.
- Distribution of catch among processor groups in any individual fishery.
- Retention rates for a fishery, species, and processor group.
- Product mix for a species and processor group.
- Distribution of retained catch among catcher vessel classes for each processor group.
- Ex-vessel prices.
- Product prices.

We do not believe these assumptions are either equally valid for all the alternatives or valid for most of the alternatives. Unfortunately, the information necessary to estimate alternative-specific differences in bycatch rates, the distribution of catch among processor groups and vessel classes, retention rates, product mix, ex-vessel prices, or product prices is not available. This problem is addressed qualitatively in the sections that present the projections of ex-vessel value and product value for the various alternatives.

Estimates of Ex-Vessel Value Per Metric Ton of Retained Catch

We used 2001 Alaska COAR groundfish purchase data to estimate ex-vessel value per mt of catch by species, gear, and area for the species that are not almost exclusively processed at sea. For the other species, such as BSAI Atka mackerel, flatfish, and rockfish, we estimated that the ex-vessel value per mt of retained catch was 40 percent of the product value per mt of retained catch.

Description of the Fishery Definitions Used in the Model

In the GOA, 32 different fisheries were defined as having gear-area-target significance. These are listed in Table 4.1-14. Table 4.1-15 lists the 35 fisheries defined for the eastern BSAI regions (Figures 4.1-2 and 4.1-3).

To summarize characteristics of each ,fishery we devised a method to show the diversity of species mix observed in the catch. We used Simpson's (1949) index of diversity (κ) commonly used in population biology. For each fishery the index is computed as

$$\kappa = \frac{1}{\sum_{i=1}^{nspp} p_i^2}$$

where p_i is the proportion of catch in biomass over all species or species groups (55 different categories in the GOA and 56 in the BSAI). This index can be interpreted as roughly the effective number of species. For example, Figure 4.1-4 illustrates a hypothetical catch composition of five species caught in four different fisheries at different proportions. The effective number of species for Fishery A is very close to 1.0 (1.02) due to the fact that 99 percent of the catch is attributed to Spp_1. At the other extreme, Fishery D caught all five species in equal proportions leading to an index value exactly equal to 5. In Fishery B, only two species are caught in equal proportion, hence the effective number of species is exactly 2. In Fishery C, all five species occur, but in diminishing proportions; therefore, the effective number of species is slightly lower than 3.

Presenting the species mix for fisheries in this way provides a simple way of examining the differences between fisheries. More importantly, it can be used to show the effect of how sampling variability and time trends may affect the estimated catch composition of each fishery. For example, computing the effective number of species using five-years of NOAA Fisheries blend data in aggregate average catch by species and fisheries showed that for both the GOA and BSAI regions, flatfish and rockfish fisheries tend to have higher catch diversity, since these are fundamentally mixed-species fisheries. Pollock fisheries and fisheries using pot gear tended to have the lowest diversity (Figures 4.1-5 and 4.1-6). However, these figures show that the catch diversity in some fisheries can be quite different between years. This is presumably largely due to sampling error and partly due to real changes in catch composition. Another contribution to this variability could be how target fisheries are defined. (i.e., a target fishery is defined based on the dominant species catch reported by week). If a vessel actually targets multiple species within a week, then the diversity of the reported catch may be unrealistically high. These factors highlight important caveats regarding the ability to accurately predict how catch diversity levels may change from one year to the next. These problems would be exacerbated by using subsets of catch composition data within years that have closed areas. For this reason, we chose to assume that the best available estimates of fisheries catch composition were based on data aggregated from 1997 to 2001. Since many of these fisheries defined may reflect relatively small levels of catch, we evaluated this index for the major fisheries and examined the trend over time. For the GOA, 11 of the 32 fisheries represented 80 percent of the catch. These fisheries still had considerable inter-annual variability in catch diversity (Figure 4.1-7), but no apparent trend. In the BSAI, 8 fisheries represented 91 percent of the catch and had less inter-annual variability (Figure 4.1-8). The flatfish fisheries appeared to have a slightly increasing trend in diversity from 1997 to 2001. This suggests that the assumption of constant species compositions may be inappropriate. Further research on what has caused this apparent trend in catch diversity is warranted.

4.1.5.4 Critique of Assumptions and Approach

Forecasting fisheries behavior is an endeavor fraught with uncertainty. Even under a relatively constant management system, changes in socioeconomic and environmental conditions can result in substantial future uncertainty. Add in a complex set of alternative management measures, such as those presented in this document, and the uncertainty is magnified. The following describes an attempt to model key aspects of the current fisheries management system and, to the extent possible, modifications according to the specific management measures for the four alternatives and their range. The model's predictive power given the system complexity is poor. However, this multi-species technical interaction model does provide a more objective approach to evaluate alternative management actions compared to single species examinations.

The NPFMC Scientific and Statistical Committee (SSC) provided feedback on the modeling approach. In particular, they raised a number of concerns about using this type of approach (i.e., using LP to mimic fisheries management). For example, using ex-vessel value estimates as part of the objective function fails to reflect the costs. Unfortunately, extensive cost data are unavailable. The SSC noted that ex-vessel prices are likely to change over time. While modeling how these may change over time would be valuable, the degree of difficulty and added complexity prohibited development along these lines. This aspect seems unlikely to have a large-scale effect over the five-year simulation projection.

Within alternatives, the catch-composition array is assumed to be constant. That is, there is no random variability, nor are there trends in the underlying catch composition within a fishery. In reality, catch-composition values are likely to vary from year to year. Observation error and other sources of variability and potential biases mask this variability. The model was developed so that catch-composition variability can be implemented in the simulation. However, since available data are limited to five years, the magnitude of this uncertainty could not be assessed in time for this analysis. Explicitly modeling the catch composition of each fishery is an area of research that needs to be pursued, particularly as dynamic species interactions are introduced.

The fact that the catch-composition array is constant over time may not be unreasonable given the short time frame of the main projections (2003 to 2007). However, the long-term projections assess conditions to 2023; these results should be viewed much more cautiously. These long-term projections were done to provide some indication of general trends between stocks. For the five-year time frame used for estimating the catch composition by fisheries and species matrix (1997-2001), there appeared to be little or no trend in the diversity of the catch for the main fisheries (e.g., Figure 4.1-8). The annual variability in the diversity of the catch highlights the importance of including details on the effect of area closures on catch by species and fisheries matrices. Clearly, sampling error plays a large role, and, as finer geographic resolution is included, the effect of sampling error will increase. This will likely compromise real changes in bycatch patterns due to area closures.

The uncertainty in current abundance levels is not modeled. The point estimates for parameter values (e.g., the numbers-at-age) in the assessments published in the 2002 SAFE are used. This clearly underestimates the variability in the current abundance levels for all species of groundfish. Under FMP 3.2, estimation uncertainty is accounted for and is applied as a risk-averse adjustment. It is possible to add this type of estimation uncertainty explicitly within the projection model. However, time limitations and the additional complexity in the presentation of the results would detract from the analysis.

Another factor that tends to underestimate variability to some extent is the omission of stock-recruitment relationships from the projection model. The reason for this omission is that, with the exception of EBS walleye pollock, reliable estimates of the stock-recruitment relationship do not exist for any BSAI or GOA groundfish stock. When making projections over the long-term, omission of the stock-recruitment relationship will tend to understate the impacts on biomass and recruitment resulting from a sustained change in the harvest rate. However, when projections are restricted to the near future, as they are for the most part in this document, it is less likely that omission of the stock-recruitment relationship will bias results significantly unless one or more of the following conditions holds: 1) the stock-recruitment relationship for a stock is extremely strong, 2) the average lifespan of individuals in a stock is extremely short, or 3) the average harvest rate for a stock is extremely different from that which generated the initial conditions. Examination of existing stock-recruitment data for BSAI and GOA target groundfish stocks indicates that none of them appear to exhibit extremely strong stock-recruitment relationships, which is one of the reasons why it has proven so difficult to estimate such relationships in the past. Furthermore, none of the BSAI or GOA target groundfish species is extremely short-lived. Finally, while the average harvest rates for Alternatives 2 through 4 typically differ to some extent from the average harvest rates in Alternative 1, the only cases in which the differences are truly extreme occur under Alternative 4. Therefore, it is unlikely that omission of the stock-recruitment relationship will lead to significant biases in the results, with the possible exception of results pertaining to stocks whose average harvest rates under Alternative 4 diverge sharply from the corresponding average harvest rates under Alternative 1.

The SSC also recommended that alternative objective functions be considered. They noted that the purpose of the model is to project likely management actions under the alternatives. Hence, it might be useful to express the objective as a minimization of the weighted sum-of-squared deviations between actual and target levels of catch, where the weights reflect management preferences for meeting TACs. This would provide a non-linear, quadratic objective function with linear constraints, and would add a seemingly desirable feature to the model, at least for the status quo (FMP 1) specification. Time limitations precluded implementation of a Quadratic Programming approach. Furthermore, this approach would require subjective specification of the weights for the different alternatives. For the Linear Programming approach used here, the imperfect objective function requires fewer assumptions about how weights may change by alternative.

For this implementation, the results were largely insensitive to the objective function specification. Some of the assumptions that constrained the solution space most severely were limits placed on the ability of individual fisheries to expand and contract relative to the patterns observed during 1997 through 2001. Sensitivity analysis showed that as these bounds were relaxed, the overall catch and revenue based on ex-vessel value increased at the expense of greater departures from the status quo, and increased sensitivity to the objective function. For these sets of model specifications, bounds were selected based on discussions with economists in the iterative process of examining model results. There is clearly room for improvement in specifying these sets of constraints. One approach would be to poll a wider group of experts to arrive at more refined sets of limits. Such a setting would also provide needed feedback for model improvements and may provide insights to management on the relative benefits of different fisheries.

In summary, the complex interactions among changes in biomass levels, fisheries economic performance, and management effectiveness are just some of the reasons why any such forecast must be viewed cautiously.

4.1.5.5 Description of the Alternatives

The projection model was designed to approximate the general patterns of catch that might be expected given the multi-species nature of groundfish fisheries. The analyses rely on two main sources of information: observer and fish ticket data, the blend data and stock assessment estimates of population parameters, abundance-at-age in 2002, and recruitment variability. The first step in developing model configurations for each of the example FMPs was to process the observer catch-composition data to reflect, to the extent possible, the impact of each FMP. The baseline catch-composition data was derived from observer and fish ticket reports for the period 1997 through 2001. For certain fisheries where characteristics changed dramatically, such as the implementation of the AFA in 2000, the number of years included differed from this baseline. The details of estimating the catch-by-fisheries data used in the model is presented in a separate section below.

The second part of setting up alternative specifications involved limiting TACs either through different harvest control rules or specific ABC reductions. The following sections provide some descriptions about how the model is affected by the different alternatives.

For the main reported species, the PSC species and the other non-target species have been compiled for gear-area-target fisheries using 1997 to 2001 as the baseline average. For all FMPs, except FMP 2.2, the EBS pollock fishery and the Aleutian Islands Atka mackerel fisheries, the average of 2000 and 2001 data were used to better reflect the AFA and other recent management measures. Unless otherwise noted, the values for retention rates are shown in Tables 4.1-16 and 4.1-17, while the estimated average ex-vessel price by species and gear type is given in Tables 4.1-18 and 4.1-19. The catch by species and fisheries for the GOA and BSAI is available from the web (www.fakr.noaa.gov/sustainablefisheries/seis/data). An overview of the key differences between the alternatives as modeled is given in Table 4.1-20. It is important to note that yield and biomass results for any alternative cannot typically be attributed to any single aspect of alternative specification since all aspects are being implemented simultaneously.

FMP 1

This alternative is considered the baseline status quo relative to the 2001 fishing year. The ABC follows Amendment 56 for setting quotas. Furthermore, the ABC setting for FMP 1 is adjusted downward as appropriate and is typically based on recommendations from assessment authors and NPFMC.

For example, in the 2002 SAFE, the ABC fishing mortality for a number of species was set at $F_{t,u}^{Alt1} = \omega F_{t,u}^{ABC}$ where ω is 0.87 for Pacific cod in both the BSAI and GOA. For pollock ω is an added buffer added as a function of spawning biomass, as presented in the GOA pollock SAFE by Dorn *et al.* (2002). For non-Steller sea lion forage species α = 0.05, while for pollock, Pacific cod, and Atka mackerel, α =0.5. In the BSAI, an overall OY cap of 2 million mt of groundfish catch was an added constraint, while for the GOA the cap was set at 800,000 mt (FMP species only).

FMP 2.1

For this alternative, the catch-composition data are the same as FMP 1, with one exception: the pre-Individual Fishing Quota (IFQ), catch-composition rates for sablefish fisheries and earlier estimates of halibut mortality were used. The use of earlier data represents only a small difference when compared to the current estimates; and is available on the website (www.fakr.noaa.gov/ sustainablefisheries/seis/data). The F_{ABC} for this FMP is set equal to F_{OFL}, or the overfishing level (OFL), which, by NPFMC definitions, equals the point estimate of F_{msy}. This fishing mortality rate is held constant over all stock sizes, including as the stock drops below $B_{40\%}$ (i.e., $F^{ABC}_{t,u} = F_{msy}$ for $B_{t,u} > 0$). For all age-structured stocks, the F_{msy} was set equal to the SPR fishing mortality rate of $F_{35\%}$. For survey biomass stocks Tier 4 through 6 from Amendment 56, the ABC was set equal to the overfishing level (OFL). Additional measures for Steller sea lion prey species were omitted.

In FMP 2.1, the OY is set to the sum of ABC's in both the GOA and BSAI. Also, there are no constraints due to PSC limits. For example, bycatch of Pacific halibut will not constrain fishery development. The fishery-expansion constraint is set to 100 (i.e., fisheries can expand effort beyond the average level observed over 1997 through 2001).

FMP 2.2

Example FMP 2.2 is similar to FMP 1, except that the OY is set to the sum of ABCs in both the GOA and BSAI, instead of at a fixed cap. Also, the maximum permissible ABC value was used instead of the author's adjustment (see for FMP 1).

FMP 3.1

This FMP is similar to FMP 1, except that the constraint on Pacific halibut mortality is reduced by 10 percent and, therefore, more constraining. Also, the author's recommendation for ABCs (see for FMP 1) is omitted (e.g., the GOA pollock OFL buffer).

FMP 3.2

For example FMP 3.2, catch species by fishery data are modified to reflect improved rationalization. That is, the bycatch of discarded species is reduced by using existing total catch estimates and changing the fraction that is discarded. Specifically, for given species and fishery, the catch that has been estimated as being discarded in the data will be reduced by 20 percent. This means that under fisheries rationalization, the fishing behavior will change such that the actual incidental catch will be reduced. This change is implemented by modifying the input data on catch species by fishery and is sometimes referred to as the bycatch matrix. These data are available on the NOAA Fisheries website: http://www.fakr.noaa.gov/sustainablefisheries/seis/data.

Another aspect of improve rationalization specifies that the retention rates of what is caught in the future will increase; in other words, at which species are discarded the rate will be reduced 20 percent. This change is implemented by modifying the retention rate matrices for GOA and BSAI shown in Tables 4.1-21 and 4.1-22.

For example FMP 3.2, the OY is set to the sum of ABCs instead of the current 2 million mt capacity. Also, the halibut mortality limit is reduced by 30 percent relative to FMP 1.

One objective under FMP 3.2 was to incorporate formal estimates of uncertainty already estimated in many of the stock assessments. A large-scale research effort on developing methods to use fully Bayesian risk-averse methods is in progress, and a version of this development is used here.

Under the current system a common assumption is that the $F_{35\,\%}$ rate is a good proxy for F_{msy}, and thereby determines the F_{OFL}. Similarly, $B_{35\,\%}$ is commonly taken as a good proxy for B_{msy}. Given the parameter values from stock assessment results to determine these quantities, the NPFMC has implicitly accepted that the $F_{40\,\%}$ fishing mortality rate is suitably risk-averse regardless of uncertainty in future recruitment and current stock size. The risk-averse adjustment to the F_{msy}, here assumed to be $F_{35\,\%}$, formally accounts for the uncertainty in current stock size and future recruitment. In addition to the standard selectivity, average mass-at-age, natural mortality, current numbers-at-age, and maturity-at-age schedules, the method developed requires estimates of the covariance matrix of the current numbers-at-age and the time series of recruitment estimates. The advantages of the method developed include: 1) that the upper bound of the F_{ABC} is set to a constant level of risk-aversion; 2) simulations to determine the appropriate adjustment level can be avoided; 3) analytical solutions are available for all steps except one final maximization; and 4) the ability to assess the value of improving estimates and reducing variance of current stock size. A key feature of this analysis is the development of a method for calculating the stock-recruitment relationship given estimates of B_{msy} and F_{msy} and the other age-specific schedules listed above. The actual values for the adjustment are shown in Table 4.1-23 and a presentation of two scenarios where the risk-averse adjustment appears to be due to different sources is shown in Figure 4.1-9.

The application of the risk-averse adjustment was applied for all stocks:

$$F_{Har} = F_{msy} * \text{Adjustment}$$
$$F_{ABC} = \min(F_{Har}, F_{40\,\%}, F_{OFL\_Alt1})$$

While for rockfish species an added measure of precaution was applied where

$$F_{ABC\_RF} = \min(F_{60\,\%}, F_{Har})$$

FMP 4.1

In this example FMP, the OY constraint is set to the sum of ABCs. Note that this is effectively the same as omitting an OY constraint since the individual species" ABCs are constraints themselves. The species catch by fishery was modified so that fisheries with more than 33 percent bycatch of a species not listed as the target specie was eliminated. Pacific cod, pollock, and arrowtooth flounder were not included as a bycatch species to these fisheries.

Uncertainty corrections to the ABCs were based on survey catcher vessels Also, the F_{ABC} was set to $F_{75\%}$ for all Steller sea lion prey species and for all species of rockfish. Note that uncertainty corrections applied to the $F_{75\,\%}$ values, too.

Agency analysts discussed how to incorporate the formal estimates of uncertainty already estimated in some of the stock assessments (e.g., AD Model Builder applications or Bayesian analyses). This is an ongoing area of research; however, the example regime was deliberately designed to be applicable to all stock assessments regardless of the software used. Incorporating formal estimates of uncertainty available for some stocks would continue to impose the largest adjustments only on the best known stocks. For example, the current process for TAC setting does not reduce harvest levels when the reference biomass level ($B_{40\%}$) cannot be estimated for stocks in Tiers 4 to 6 of Amendment 56/56 ABC and OFL definitions. Stocks qualify for management under Tiers 4 to 6 only if reference stock levels cannot be estimated reliably.

The formal incorporation of uncertainty was accomplished by setting the fishing mortality rate associated with ABC (F_{ABC}) at specified fractions of the maximum allowable fishing mortality rate maximum F_{ABC}. This fraction varies directly with the uncertainty or variance of the survey biomass estimates. Specifically, this is accomplished by computing the average coefficient of variation for the survey biomass estimates in the time series and then computing the lower bound of the 90 percent confidence interval for a lognormal distribution with this coefficient of variation and a median of unity. This lower bound is the specified fraction by which to reduce maximum F_{ABC}. The specified fraction by which to reduce maximum F_{ABC} is provided as input to the model for FMP 4.1. All target species with biomass estimates were analyzed. Exceptions are made in the model projections for some species whose stock assessment F_{ABC} is below maximum F_{ABC}. These adjustment values, corresponding to the lower bound of the 90 percent confidence interval, are given in Table 4.1-24.

For FMP 4.1, the prohibited species cap for Pacific halibut mortality was reduced to 50 percent of the current level, causing a higher level of constraint.

FMP 4.2

No fishing was allowed for the 5 year-projection. We presume that under this example FMP, fisheries authorized following review would take the form of that regime being illustrated by FMP 4.1.

4.1.5.6 How Model Results Were Applied in Assessing Impacts of the Alternatives on Different Resources

Target, Forage, Prohibited, Other, and Non-Specified Species

For the target species, the multi-species, multi-fisheries simulation projection model provided fundamental dynamics to the model behavior. That is, as the biomass of an FMP species changed in the future, the constraint via ABC/TAC control also changed. The outputs from the model were primarily intended to reflect these dynamics and the interactions with the species composition of the different fisheries.

The significance of the impacts on target species were evaluated with respect to fishing mortality, change in biomass level, spatial/temporal concentration of the catch, prey availability, and habitat suitability.

The significance of the effects of the alternative fishing mortality levels are evaluated with respect to the overfishing mortality rates as set forth in Amendment 56/56. Fishing mortality rates that exceed the overfishing mortality rate are considered to jeopardize the capacity of the stock to produce MSY on a continuing basis and adversely impact the sustainability of the stock. A related measure of this potential is indicated by change in biomass levels. The significance of effects of the current spatial/temporal concentration of the catch and the level of prey availability and habitat suitability for target species are evaluated with respect to each stock's current size relative to its MSST. An action that jeopardizes the stock's ability to sustain itself at or above its MSST is considered to adversely affect the sustainability of the stock.

Species or species complexes that fall within Tiers 1 though 5 have estimates of the current fishing mortality rates, and are evaluated with respect to exceeding the overfishing mortality rate or fishing mortality effect. Species or species complexes that fall within Tiers 1, 2, or 3 have reliable estimates of MSST, and are evaluated for the effects of spatial/temporal concentration of the catch, prey availability, and habitat suitability. Species or species complexes that fall within Tiers 4, 5, or 6 do not have reliable estimates of MSST; therefore, we cannot evaluate the significance of these effects. This inability to evaluate the significance of the effects occurs for the forage, prohibited, and non-specified species. Since several species or species complexes do not have estimates of abundances-at-age, in this version of the model, their abundance levels simply reflect the most recent estimate. For these groups, analysis of the effects of the example FMPs were limited to catch projections and likely consequences given patterns in related fauna.

Habitat

A quantitative estimate of habitat impact under each example FMP requires an estimate of the fishing effort applied in areas remaining open under each scenario. The amount of effort should take into account the catch levels expected under the alternatives in each TAC management area and the amount of catch taken under the baseline that would have been taken inside and outside the area to be closed by the FMP. Because of the limitations in the multi-species bycatch model, not all species and their area-specific catches are easily explained by the stock dynamics. The impact of alternative-specific management practices on model outputs are also difficult to interpret on detailed area fishery and species scales. While stockwide projections of most major species are more easily understood, catch by TAC management area is required for the effort estimation. The time required to complete a rigorous analysis to validate, and in some cases correct, area-specific catch levels exceeds the time available to prepare this Programmatic SEIS. This necessitated a more qualitative evaluation in this Programmatic SEIS of the expected impacts on habitat based on known fishery characteristics.

Seabirds

The analysis of direct and indirect effects on seabirds relies on the projection model's estimates of fishing effort in mt by different gear types in the BSAI and GOA under the different FMP bookends. Hook-and-line or longline and trawl effort are particularly important for analysis of incidental take. For analysis of FMP 2.1, the projection model’s output essentially eliminates the BSAI longline cod fishery and triples the GOA longline cod fishery, and is based on small price differentials between gear types. This situation is considered an unrealistic artifact of the model's rules for allocating catch between gear types in lieu of specified allocations. For FMP 2.1, the BSAI longliners are assumed to take about the same volume of cod as they have under the baseline conditions, with the balance going to trawl and pot gear. For the GOA, longliners are assumed to take the same percentage of the cod TAC as they had under the baseline, which translated into a moderately higher catch because of the higher TAC. The implications of different spatial/temporal restrictions are also analyzed, especially as they relates to effects on prey availability for nearby seabird colonies and potential for trawling in critical habitat areas of eiders. Other factors that were not modeled, including implementation of seabird protection measures and the potential for a directed forage fish fishery, were also included in the analysis.

Marine Mammals

Results from the multi-species management model are used to analyze the effects of the example FMPs on marine mammal populations. Catch projections from the model are used to estimate incidental take of marine mammals and to evaluate harvest levels of marine mammal prey species. Total projected groundfish catch was averaged from 2003 to 2007 for each example FMP. This average projected catch is multiplied by the incidental take rate, calculated as marine mammal takes/mt of groundfish of each marine mammal species as derived from Angliss *et al.* (2001), to estimate changes in incidental take under each example FMP. The average annual fishing mortality rate (*F*) projected from 2003 to 2007 is compared to the baseline (2002) to determine the change in *F* expected under each alternative bookend for all key marine mammal prey species. Percent changes in *F* relative to the baseline were used to indicate changes in the prey field for affected marine mammal species. These analyses employ unmodified model results as they were reported and, therefore, incorporate all the assumptions that went into the model.

Socioeconomic

The output from the multi-species management model is used as the starting point for development of the socioeconomic impact model, referred to in the remainder of the document as the Sector Model. The Sector Model uses the multi-species management model output of catch of each species by gear in each area. The Sector Model distributes those catches and associated values, as well as income and employment, to the various fishing and processing sectors that depend on the groundfish resources, and to the geographic regions where the activities occur and where factor owners reside. A detailed description of the Sector Model is included in Section 4.1.7.

Ecosystem

The multi-species bycatch model is used to derive indicators for assessing the impacts of the alternatives on the ecosystem. The indicators chosen are ones that would characterize changes in predator/prey relationships, energy flow, and diversity. In predator/prey relationships, model outputs are used to obtain estimates of pelagic forage biomass of target species, such as the walleye pollock and Atka mackerel in the BSAI, and walleye pollock in the GOA. Total biomass of these species is used to derive this index. Bycatch estimates of squid, herring, and the managed forage species group from the model are used as another indicator of the magnitude of fishing impacts on these other forage species. Trophic level of the catch is an indicator of fishing down the food web, which is the sequential fishing down of species high in the food chain, such that over time the fisheries are left only with mid-trophic level species as targets. Model estimates of catch biomass for each target and nontarget species group are combined with estimates of trophic level of each species group, derived from food habits information to obtain estimates of the overall trophic level of the catch for each example FMP. Fishing effects on top predator species are evaluated through model estimates of bycatch of sharks and birds. Model estimates of total retained catch, and discards for target and nontarget species, are used as an indicator of the effects of the alternatives on energy cycling characteristics of the ecosystem through energy removal or total retained catch, and/or energy redirection discards. Finally, model estimates of bycatch of HAPC biota were used as an indicator of effects of fishing on functional structural habitat diversity.

Glossary of symbols used in description of the model

Dimensions

a_{max}	Maximum age used in the model (plus group)
a_{min}	Minimum age used in the model
n_{age}	Number of ages in the model
n_{gear}	Number of gear types for which separate selectivity schedules are used (as in the assessments)
n_{pro}	Number of years to project beyond the initial year in each simulation
n_{sims}	Number of simulations
n_G	Number of gears with allocation constraints
n_{Fsh}	Number of fisheries
n_{sp}	Number of species
n_{area}	Number of management areas defined for each species

Indices

a	Relative age index, $1 \leq a \leq n_{age}$
g	Fishery index, $1 \leq g \leq n_{Fsh}$
k	Sub-area
h	Fishing gear type
t	Projection year index, $1 \leq t \leq n_{pro}$
u	Simulation index, $1 \leq u \leq n_{sims}$
I	Alternative index
j	Species index

Life History and Fishery Parameters

d_h	Proportion of total instantaneous fishing mortality rate distributed to gear *h*
M_a	Natural mortality rate at age *a*
m_a	Proportion of age *a* fish that are mature
w_a	Weight-at-age *a* in the population
p	Proportion of females in the population
$s_{a,h}$	Selectivity of gear type *h* for fish of age *a* (scaled so that max(s)=1)
$w_{a,h}$	Weight of age *a* fish as sampled by gear *h*

Other Parameters and Expressions Used in Projections

SPR	Spawning biomass per recruit
ABC	Acceptable biological catch
TAC	Total allowable catch
OY	Optimum yield summed for the geographical area (e.g., BSAI) for all target (FMP) species
B_{ref}	A parameter of the control rules used to set the overfishing rate and to constrain F_{ABC}
$B_{t,u}$	Spawning biomass in projection year *t* of simulation *u*
C_{2002}	Actual catch observed in 2002 (or projected to be caught)

$C_{t,u}$	Catch in projection year *t* of simulation *u* for each population after the LP
$F_{t,u}$	Fishing mortality rate in projection year *t* of simulation *u* for each population
F_{lim}	A parameter of the control rule used to set the overfishing rate
F_{ref}	A parameter of the control rule used to constrain F_{ABC}
$X_{t,u}$	Fishing mortality rate in projection year *t* of simulation *u* for each population after the LP
$\phi_{a,t,u}$	Total mortality rate between the beginning of the year and the spawning period
$N_{a,t}$	Numbers at age *a* in projection year *t*
$N_{a,t,u}$	Numbers at age *a* in projection year *t* of simulation *u*
n_a	Numbers at age *a* in 2002
$O_{t,u}$	Rate of fishing mortality that constitutes overfishing in projection year *t* of simulation *u*
P	Probability of overfishing in at least one year of the projection period
R_{2003}	Recruitment for 2003 predicted in the 2002 stock assessment
$R_{t,u}$	Recruitment in projection year *t* of simulation *u*
$T_{t,u}$	Total biomass (between ages a_{min} and a_{max}) in projection year *t* of simulation *u*
TAC_{2002}	TAC actually specified for 2002
$X_{t,u}$	Fishing mortality rate that sets catch in projection year *t* of simulation *u* equal to C_{max}
A	Average age for each stock in the final projection year across all simulations
f_k	Proportion of the catch allocated to sub-area *k* for a particular species

Parameters and Expressions

Θ_t	Total objective function value
m_{ABC}	Number of ABC type of constraints (number of species that have TAC)
m_G	Number of gear type of constraints
m_{UL}	Number of upper limit constraints on relative catch of FMP species
m_{LL}	Number of lower limit constraints on relative catch of FMP species
m_{OY}	Number of optimum yield constraints (only one)
A_g	Objective function coefficients applied to each fishery
$C^{N}_{j,k,g}$	Catch data from the blend dataset by species, sub-area and fishery
$R_{j,g}$	Retained fraction of catch
$Y_{t,g}$	Relative total catch between fisheries within each year (main result returned from the constrained optimization)
$V_{j,g}$	Estimated ex-vessel value of each species within different fisheries

Computation of SPR values

SPR values are computed using species-specific demographic values (see www.fakr.noaa.gov/sustainablefisheries/seis/data), fishing mortality rates (e.g., $F^{y}_{40\%}$) that would reduce the female spawning stock (per recruit) to some fraction of the unfished level. The age-specific factors are selectivity, natural mortality, maturity, and weight or fecundity. For example, to compute $F^p_{40\%}$, an algorithm to solve the following set of implicit equations was used:

$$0.4B^p_{100\%} = \sum_{a=1}^{n^o_{ages}-1}\left[w^p_a m^p_a \prod_{j=2}^{a} e^{-\left(M^o_{j-1}+F^p_{40\%}s^o_{j-1}\right)}\right] +$$
$$w^p_{n^o_{ages}} m^p_{n^o_{ages}} \prod_{j=2}^{n^o_{ages}} e^{-\left(M^o_{j-1}+F^p_{40\%}s^o_{j-1}\right)}\left(1-e^{-M^o_{n^o_{ages}}-F^p_{40\%}s^o_{n^o_{ages}}}\right)^{-1}$$

where $B^p_{100\%}$ corresponds to the spawning stock per recruit of population *p* in an unfished equilibrium state. This information was used within the management rule that determines the quota. For some species and alternatives different F-spr rates were used.

4.1.6 Habitat Impacts Model

To evaluate the impacts of fishing on living habitat, the model developed by Fujioka (2002) is used. This model incorporates basic factors determining impacts of fishing on habitat. Given either estimated or assumed values of fishing intensity, where *f* equals the absolute effort in area swept per year divided by the area size, q_H equals sensitivity of habitat to fishing effort, ρ equals habitat recovery rate, the model predicts a value of equilibrium (i.e., long-term) habitat level, H_{eq}, as a proportion of the unfished level, H_0.

$H_{eq} = H_0 \cdot \rho\, S/(I + \rho\, S)$ where H_0 = unfished habitat level, $I = f\, q_H$, and $S = e^{-1}$.

Habitat impact or effect level, *E*, for the given effort, sensitivity, and recovery rates, would be 1- H_{eq}. Letting H_0 = 1.0, then

$E = I/(I + \rho\, S)$

Various habitat features could be impacted by fishing gear. Initially, this analysis focused on the impact to the biostructure habitat feature of living habitat composed of organisms such as soft corals, tunicates, and sponges with assumed recovery rates of 2 to 15 years. Where applicable, we attempted to address impacts to living habitat with slower recovery rates (i.e., 200 years), such as gorgonian corals (e.g., red tree coral, Primnoa). A widely accepted management policy has been to avoid impacting such long-lived organisms.

Habitat Sensitivity Rate (q_H)

The habitat sensitivity rate, q_h, is the proportion of habitat impacted by one pass of the fishing net. Organisms considered as indicators of habitat sensitivity range from relatively small and flexible (soft corals) to larger, more erect organisms (sea whips). Vulnerability of the organisms varies greatly depending on their physical characteristics and the characteristics of the trawl gear. The vulnerability may be difficult to determine. Certain features of the gear may make the gear more damaging to one type of organism than to another type. For biostructure sensitivity to bottom trawl gear, two values of q_H, 0.10 for less sensitive, and 0.25 for more sensitive, are proposed as plausible.

Habitat Recovery Rate (ρ)

Recovery rate, ρ , reflects the rate at which impacted habitat changes back into unimpacted habitat, H. In the absence of further impacts, impacted habitat would decrease exponentially with all habitat was in H the unimpacted condition. The recovery time, R, can be thought of as the average amount of time the impacted habitat stays in the impacted state, which would equal 1/ ρ in the absence of further impacts.

Little is known about the recovery rate of various benthic organisms that provide biostructure in waters off Alaska. The recovery rate as modeled includes any recruitment required to initiate recovery and the growth necessary to reach a size that can to provide habitat function. Recovery times as much as 15 (=1/ρ) years are within a plausible range. For this analysis, two biostructure recovery rates are used to cover a plausible range of impact. Scenario 1 is where ρ = 0.5 the 2-year or rapid recovery, and Scenario 2 is where ρ =.0667, the 15-year or long recovery. Table 4.1-25 shows the corresponding impact given levels of fishing intensities. For example, for f = 0.25, where the bottom area is swept once every four years, for ρ = 0.50, when habitat recovers in 2 years, and for a sensitivity rate q_H = 0.10, where one-tenth of the organisms are removed per sweep of the net, the long-term impact level, E, would be 0.049. That is, the habitat would be reduced slightly to 95.1 percent (H_{eq}) of its unfished level. If recovery rate ρ = 0.067, where habitat recovers in 15 years, and sensitivity q_H =0.25, where one-fourth of the organisms are removed per sweep of the net, the impact level would be 0.499, or 50.1 percent of its unfished level. This demonstrates that as f increases, impact level also increases, and the equilibrium level of habitat decreases.

Fishing Effort or Intensity (*f*)

Bottom trawl fishing effort has been estimated for each 5 kilometer (km) square block in the BSAI and GOA regions by Rose and Jorgenson (2002). Fishing intensity of a block is the fishing effort per year measured in area swept.High quality fishing effort data are available from the groundfish observer program. Individual sets were tallied for 5 x 5 km blocks for the years 1998 to 2002. This 5-year period was selected to represent the current level of fishing effects. Reported effort or duration for trawls was converted into swept areas. Trawl durations were multiplied by speed, trawl width, and proportion of effort on the bottom. Width and speed were estimated using a survey of trawlers on gear usage and from information collected by observers. The estimate for the proportion of pelagic trawl effort contacting the seafloor considered both the amount of time in which any part of the trawl contacted the seafloor and the width of trawl contact with the seafloor during different periods of the fishery (e.g., day/night, A and B seasons). Information for this estimate was provided by fishing organizations. As the vulnerability of pelagic trawls to damage precludes their operation on rough and hard substrates, bottom contact was set at zero for the hard bottom habitats of the GOA and Aleutians Islands.

Habitat Impact (*E*)

Impact is a function of sensitivity, recovery rate, and fishing intensity. For the given values of sensitivity q_h, recovery rate ρ, and bottom trawl fishing intensity *f* estimated for each 5 x 5 km block, habitat impact, $E_i = I_i/(I_i+\rho S_i)$, can be calculated for the 5 x 5 km block represented by the *I* parameter. Larger values of *E* equate with more impacts. Results for a region can be presented in a single value as a mean impact, as frequency distribution of impacts for each block, and as the geographic distribution of the impacts.

A draft report by Rose (2002) describes a proposed approach to quantifying impacts using the function = $(\sum E_i \cdot \text{Area}_i) / (\sum \text{Area}_i)$ summed over all area in waters less than 1,000 meters (m) deep (i.e, fishable EEZ waters). This is a single-valued metric which provides for simplified comparisons and evaluations. Ideally, any area summations would be weighted by habitat quantity and value as well, but such information is currently unknown and is set at 1.

In the analysis for this Programmatic SEIS, rather than summing the estimated impact block by block, the fishing intensity for each block is tabulated by intensity intervals, as shown in Table 4.1-26. For example, in the Bering Sea, 1,003 blocks were fished at an intensity level between 0.25 and 0.50, 822 blocks watershed at an intensity level between 0.50 and 1.00, and so forth. This information can be used to estimate the mean relative impact level for all the fished blocks, or for all fishable blocks (<1,000 m). This is approximated here by summing the frequency weighted midpoint impact levels and dividing by the number of fished blocks or number of fishable blocks. For example, for ρ=0.50 and q_H=0.10, the impact level for f=0.25 is 0.049, and for f = 0.50 is 0.095, with a midpoint of 0.072. The frequency weight of the interval 0.25 to 0.50 is 1,003. The interval midpoint impact levels are weighted and summed and divided for the Bering Sea by either 7,121 (number of fished blocks) or 31,995 (number of blocks <1,000 m in depth). For the more slow growing and more sensitive parameter scenario, the mean impact of fished areas is 0.419 and 0.093 for all fishable blocks.

This approximation should produce mean impact levels similar to the more exact computation method demonstrated in a report by Rose (2002). Ideally, any area summations would be weighted by habitat quantity and value as well, but such information is currently unknown and neither computation takes into account differences in the unfished level of biostructure habitat or habitat suitability that probably exist. This is a single-valued metric, which provides for simplified comparisons and evaluations. If all habitat over the fishable EEZ is of equal value to the productivity of the fisheries, then the simple mean impact estimates are indicative of the baseline fishing impacts. However, when summed over such broad categories of habitat, the mean impact value may not reflect effects if impacts are concentrated on specific habitat types, because not all habitat may be of equal value to stock productivity. Comparing impact expressed as a single value presumes that the value of different levels of impacts is additive. That is, two units of habitat each impacted to H_{eq} = 0.75 (E = 0.25) are equivalent to two units of habitat, one heavily impacted to H_{eq}=0.50 (E = 0.50) and one unimpacted at H_{eq} = 1.0 (E = 0.0). Thus, the average impacts are equal in both cases, but the actual effect on the ecosystem may not be equivalent. One could argue that all else being equal, the latter case provides a wider range of habitat type and greater diversity over the same amount of habitat and is preferred over a uniform distribution of impact. In contrast, if H_{eq} only needs to be greater than 0.5 to be effective EFH, the former case would be preferred. Whatever the case may be, comparison of the frequency distribution provides increased discernment of potential impact. Thus, the distribution of the impacts needs to be considered.

Mean impact levels were assessed in conjunction with the distribution information to further evaluate the baseline. While the mean impact values could be considered to indicate minor impacts, the distribution information shows that for the Bering Sea, for example, 552 + 277 = 829 blocks, or more than 8,000 sqare miles, are fished at an intensity of f = 1.00 or greater (Table 4.1-26). A map of the fishing distribution (Figure 4.1-10) shows that the heavily fished blocks are concentrated in a few large geographically extensive areas that are uninterrupted by any current fishing closures that might provide protection to or diversity in impact levels. The impact model estimates that those areas could have an impact level to bioshelter organisms of 18.1 percent or greater for the fast recovery rate parameter scenario, or as much as 82.8 percent for the slow recovery rate/more sensitive scenario. Concern for areas where such potential impact could be occurring is a major consideration in the evaluation of the baseline and comparison of the alternatives.

General results using the habitat model are used qualitatively to evaluate the closure strategies of the alternatives. The rates of relative change of catch and impact can be examined by combining the habitat impact model with standard fishery catch models. In general, closing large amounts of heavily fished areas may not result in significant reduction in net habitat impact, as large amounts of fishing effort are displaced. This results in increased impact levels in previously less heavily fished area. Such a large change in the system has high potential for unforeseen consequences. A strategy of closing only lightly fished habitat reduces further impact in those areas while displacing only moderate amounts of effort to heavier fished areas. An increase of effort in already heavily fished habitat increases habitat impact relatively less than an increase in lightly fished habitat. Such a strategy, however, does not address potential ongoing impacts in heavily fished areas. A strategy of closing only small proportions of heavily fished habitat and larger proportions of lightly fished areas can achieve similar or greater reductions in impact with only moderate increases in effort in the remaining open areas. With closures positioned appropriately, this strategy can protect a cross-section of habitat types and address the potential impacts of heavily fished habitat while minimizing economic effects and the chances of unforeseen consequences.

4.1.7 The Sector Model–An Adaptation of the Multi-Species Model To Estimate Socioeconomic Effects

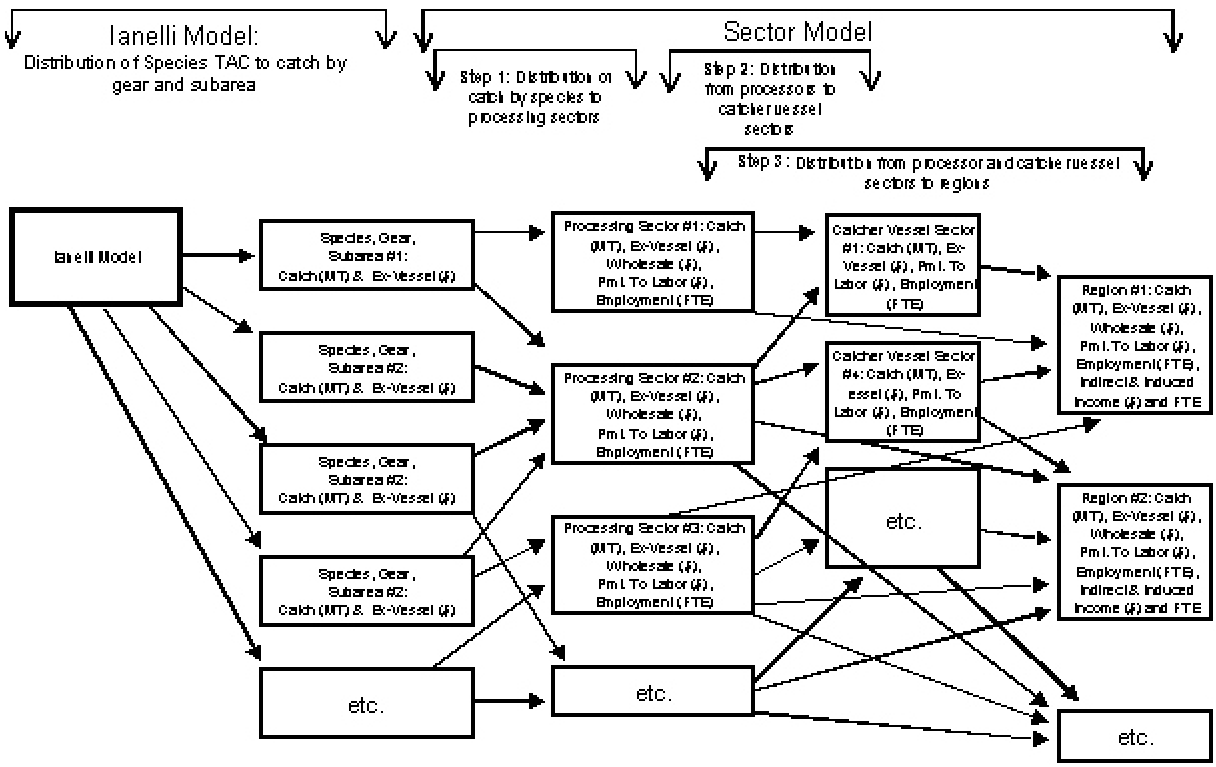
The socioeconomic impacts of the alternatives have been estimated using an extension of the multi-species model based on the harvesting and processing sectors and regions described in Sections 3.9 and 3.9.3. For the remainder of this discussion, the socioeconomic model extension is referred to as the sector model. The sector model applies 2001 harvest and processing proportions to the multi-species management (Ianelli) model output related to species catch by gear and subarea in order to estimate the distribution of catch and processing amounts among sectors and regions that rely on the groundfish fishery. A schematic representation of the linkages between the two models is shown below.

The sector model entails the following three-step process:

1. Estimate total catch and deliveries to processors.
2. Proportion out deliveries to specific catcher vessel sectors.
3. Distribute catches and processing amounts among the various regions where processors are located or vessel owners reside.

In each step of the sector model, the catch of each species by gear and subarea gets distributed to successive sectors based on the comparative baseline distribution in 2001.

The steps of the sector model can best be illustrated by providing a specific example. The multi-species management (Ianelli) model estimates that 1,472,600 mt of pollock will be harvested from the Bering Sea with trawl gear in 2003 under FMP 1. In step 1 of the sector model, this pollock is distributed to each processor sector according to the proportion of the total 2001 Bering Sea trawl pollock catch that the individual sector processed, including discards. In addition to total catch, the model uses 2001 information on each sector's retention percentage, wholesale value per round ton, payments to labor per dollar of wholesale product value, and full time equivalent (FTE) employment. These numbers are taken from the comparative baseline data presented in Section 3.9.9. Table 4.1-27 shows the 2001 conditions and how they are applied to generate the 2003 sector estimates for FMP 1. The results from Step 1of the sector model are used to estimate the direct economic impacts of the alternative FMP bookends on the various processing sectors.



As shown in the upper portion of the table, surimi trawl catcher processors caught 35.3 percent of the 2001 pollock trawl harvest from the Bering Sea and retained 99.8 percent of their catch. In the lower portion of the table, 35.3 percent of the 1,472,600 mt Bering Sea pollock trawl total under FMP 1 in 2003 is assigned to the surimi trawl catcher processor sector. The table also shows that 99.8 percent of the 519.3 mt of groundfish caught was retained. Assuming a wholesale product price of $604.4 per ton, the 2003 estimated wholesale product value for surimi trawl catcher processors is $313.8 million, with an estimated 35 percent ($109 million) of that be paid to labor. Employment generated by this sector is estimated to be 1342.8 FTEs, or 4.3 FTEs per million dollars of wholesale product value. A similar process is used to estimate the economic effects on other processing sectors.

Step 2 of the sector model distributes each processing sector's total retained catch amount back to the catcher vessels that delivered it, based on the proportion of each processing sector's deliveries from catcher vessel sectors in 2001. The analysis developed for each species, gear, and subarea, a processor sector/catcher vessel sector distribution matrix based on 2001 deliveries. The matrix for the Bering Sea trawl pollock sector is shown in Table 4.1-28. The table includes deliveries of catcher vessels to surimi and fillet catcher processors, inshore processors, and motherships. Although catcher vessels delivered only a relatively small amount of fish to surimi and fillet trawl catcher processors, they provided all the fish processed by other processing sectors. For example, the row for Bering Sea pollock shore plants indicates that 61.5 percent of their Bering Sea trawl pollock was delivered by Bering Sea pollock trawl catcher vessels greater than or equal to 125 ft, while Bering Sea pollock trawl catcher vessels 60 ft to 125 ft in length delivered 34.8 percent of the pollock catch. The remaining 3.6 percent was delivered by diversified AFA-eligible trawl catcher vessels greater than or equal to 60 ft and non-AFA trawl catcher vessels greater than or equal to 60 ft. The various catcher vessel sectors are defined and discussed in detail in Section 3.9.2.

The percentages, like those in Table 4.1-28, are multiplied by the total catch for the species gear and subarea for each processor to generate the total retained catch assigned to each catcher vessel sector for the FMP bookend and year. Ex-vessel prices and payments to labor and employment factors are applied to retained catches to generate the remaining catcher vessel sector indicators. Table 4.1-29 illustrates this process with numbers for the Bering Sea trawl pollock sector for FMP 1 in year 2003.

The third step of the sector model translates sector level activities to regional activities. This step is complex because the various sectors interact with regions in different ways, as described below:

- **Shore-Based Processors:** The sector model assumes that shore-based processors are closely related to the regions in which they are located. In fact, the shore-based processors are designated according to their associated region. Two exceptions are the Bering Sea Pollock Shore Plants, which are assigned to the Alaska Peninsula/Aleutian Islands region, and the Other States Shore Plants, which are assigned to the Washington inland waters region (most are located in Bellingham, Washington). The sector model assumes that ex-vessel values attributed to shore-based processors are directly linked to the region in which they are located through fish taxes. Further, the sector model assumes that all labor payments and employment generated by shore-based processors accrue within the region in which they are located.[1] This method of assigning employment to regions is similar to that used by state and federal agencies. Insufficient information exists to provide a more accurate account of regional employment patterns in the groundfish fisheries. Finally, the sector model assumes that the expenditures of shore-based processors for deliveries of raw fish and other supplies, as well as the expenditures of their employees, have indirect and induced impacts within the region in which they are located.[2]

[1] The method of assigning employment to regions used in this analysis does not attempt to account for the formal or legal residency of workers in shore-based processors. For example, the labor force of many of the shore plants in Alaska, especially those in the Alaska Peninsula and Aleutian Islands region (defined in Section 3.9.2.4), have been traditionally dominated by persons considered non-residents or relatively short-term residents of Alaska communities or the state. In part, residency is a matter of definition, as community population count varies by information source. U.S. Census methodology, for instance, counts every person present at the time of enumeration as part of the official population of the community, with very few exceptions. Additional information on workforce demographics and the role that transient processing workers play in the groundfish fishing industry and communities can be found in Section 3.9.6.

[2] Another shortcoming of the sector model is that it is unable to track expenditures of processors and catcher vessels in other regions. For example, many of the shore-based processing plants have headquarter offices in Seattle, and clearly some of their expenditures are made in the location of their headquarters. Further, because many of the employees of shore-based plants are seasonal, they are likely to spend most of their earnings in their hometowns.

- **At-Sea Processors (Catcher Processors, Motherships, and Floating Processors):** The sector model assumes that an at-sea processor generates most of its regional impacts in the region represented by the vessel owner's address as listed in Commercial Fisheries Entry Commission vessel registration files or NOAA Fisheries Federal permit data. Typically, the location of the corporation that coordinates the operations of the vessel is listed. Consequently, the model assumes that crewmembers on a catcher processor or other at-sea processor are hired from the same region in which the vessel's operations are coordinated.[3] Although this method of assigning employment to regions is similar to that used by state and federal agencies, it is recognized that this is a simplification, as vessels (and corporations) may have complex ownership structures that influence various operational parameters, including point-of-hire employment decisions.[4] As noted above, insufficient information exists to provide a more accurate account of regional employment patterns in the groundfish fisheries. Other economic impacts, such as those resulting from purchases of equipment and supplies, are also assumed to accrue to the vessel owner's region.

- **Catcher Vessels:** In order to be consistent with the way in which at-sea processing employment is assigned, catcher vessel employment is assigned to the region represented by the vessel owner's address as listed in Commercial Fisheries Entry Commission vessel registration files or NOAA Fisheries Federal permit data.[5] catcher vessels affect regions by making deliveries to processors and providing earnings for their returning owners and crew to spend in the region. When these vessels make deliveries to processors located outside of the region, they bring their outside earnings into their home region when they return. However, when catcher vessels make deliveries to local processors, their earnings are already counted as expenditures by the local processors. Therefore, it is important to track not only the catcher vessels' home regions, but also the locations where they delivered fish. The sector model assumes that all vessel owner and crew income contributes to the regional economy, but, to avoid double counting, only the income from landings made outside the region is used to calculate indirect and induced income and employment.

A matrix showing the home regions of vessels participating in the pollock trawl fishery in 2001 in shown in Table 4.1-30. Similar matrices were developed for each species, gear, and area combination.

Multiplying the numbers in the regional matrix in Table 4.1-30 by the catches by sector (Table 4.1-27 for at-sea processors and Table 4.1-29 for catcher vessels) yields the regional apportionment of Bering Sea trawl

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[3] The method of assigning employment to regions used in this analysis does not attempt to account for the formal or legal residency of workers in the at-sea processing sector.

[4] As one example of this complexity, the western Alaska CDQ program has created many seasonal job opportunities for residents of eligible Alaska communities aboard catcher processors as a result of CDQ investment in this sector, among other factors. Beyond employment considerations, additional information regarding the importance of CDQ program-related investments and industry partnerships in increasing the participation of Alaska residents in the groundfish fisheries, especially those in Alaska Native communities, is provided in Section 3.9.4.

[5] The method of assigning employment to regions used in this analysis does not attempt to account for the formal or legal residency of workers aboard catcher vessels. For example, some of the catcher vessels owned by residents of the Washington Inland Waters Region (WAIW) region (defined in Section 3.9.2.4) that frequently berth in Alaska ports may hire residents of those ports. Moreover, as in the case of the at-sea processing sector, complex corporate ownership structures may influence vessel operational patterns, including crew employment decisions.

pollock catches for 2003 from FMP 1 (as shown in Table 4.1-31). A similar process is used to assign catches of other species, gears, and areas to regions for other years and for other FMP bookends.

The next step in estimating regional effects of catcher vessels involves distinguishing in-region deliveries and extra-regional deliveries. In-region deliveries are defined as deliveries to processing facilities assigned to the same region to which the catcher vessel is affiliated. For example, when a vessel owned by a resident of Kodiak makes a delivery to a Kodiak shore plant, it is considered an in-region delivery. When that same boat makes a delivery to an Alaska Peninsula/Aleutian Islands shore plant, it is considered an extra-regional delivery. It should be noted that at-sea deliveries are considered in-region ,if the both the owner of the catcher vessel and owner of the at-sea processor are from the same region. As indicated earlier, the regional effect of catcher vessels making an in-region delivery are counted as part of the regional shore-based processor effects, while the regional effects of extra-regional deliveries are assigned to the catcher vessels. Table 4.1-32 shows the 2003 value of in-regional and extra-regional deliveries of Bering Sea trawl pollock by the catcher vessel sectors for FMP 1.

The sector model's final step calculates and assigns income and employment multipliers for each region. The multipliers relate total output in dollars from the fishing sector in a region to the additional indirect and induced income and employment that are generated. Part of this additional income and employment occurs in the businesses whose goods and services are used as inputs in the groundfish fisheries, such as fuel suppliers, chandlers, gear manufacturers, boatyards, and insurance brokers. These firms are commonly referred to collectively as the support service sector of the fisheries. Moreover, people earning incomes directly or indirectly from the fisheries make expenditures within the economy as well, generating additional jobs and income. These indirect and induced economic benefits can be substantial, especially for regions such as the WAIN region. The multipliers used in this analysis are estimated with IMPLAN Version 2.[6] The IMPLAN software was used to create an input-output model for each region considered in the analysis. The input-output model is a mathematical representation of the inter-industry/institution transactions that occur within a defined economic region. The model traces how many times a dollar is re-spent within the regional economy before leaving the region, and the economic impact of each round of spending. The economic base concept was used to determine the level of aggregation of the more than 200 economic sectors that have backward linkages to the fishing sector in the regions considered. The multipliers for these economic base sectors or aggregated sectors were generated from IMPLAN, and were used to determine the additional income and employment effects, or secondary effects, that the fishing sector contributes to each region. Table 4.1-33 shows the regional multipliers used in the analysis.

It is important to note that the sector model does not directly estimate inter-regional linkages. For example, the model does not specifically include income and employment resulting from expenditures of at-sea processors in regions outside of a vessel owner's region. While it is recognized that there are inter-regional effects, the data necessary to reasonably estimate those effects are not available. It is also important to note that the lack of inter-regional effects is offset to some extent by the assumption that all of the employment and income effects of a shore-based processor occur within the region in which the processor is located.

An example of the tables used in the regional effects assessment is provided in Table 4.1-34. The example shows the effects of the Bering Sea pollock trawl fishery on the Alaska Peninsula/Aleutian Islands region for FMP 1 and 2003.

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[6] 1999 IMPLAN baseline data, which are the most current available, were used to estimate the multipliers.

4.2 Introduction of Analytical Framework – Example Fishery Management Plans

Four policy alternatives and a preferred alternative are analyzed in this document. In order to provide sufficient detail to the analysis of the policies, each alternative is accompanied by, and associated with, a set of example FMPs. A description of the framework concept, followed by a summary of each alternative policy and their associated FMPs, is provided below.

4.2.1 Concept of the Analytical Framework

Each alternative is composed of three elements: a management approach statement that describes the goals, rationale, and assumptions behind the alternative; a set of management objectives that complement and further refine the goals set forth in the management approach; and, except for Alternative 1 (status quo), a pair of example FMP bookends that illustrate and frame the range of implementing management measures for that alternative. The management approach statement and objectives serve to define the direction the NPFMC and NOAA Fisheries wish to take in the managing the fisheries. The example FMP bookends serve two purposes: first, they provide an additional level of analytical detail that will facilitate the comparison of the physical, biological, and socioeconomic effects of the alternatives and the status quo; second, they provide the public with an illustration of the types of management measures the NPFMC and NOAA Fisheries envision using to achieve the goals of the alternative. The preferred alternative identified in this document includes a policy statement accompanied by a set of management objectives and a set of example FMP bookends that illustrates a range of management actions for that policy. This FMP framework structure communicates to the public how NPFMC and NOAA Fisheries intend to pursue their policy objectives in the future. By providing a range of potential management measures (as illustrated by the example FMP bookends as part of the preferred alternative), management flexibility is maintained under the MSA to adaptively manage the fishery through FMP amendments.

4.2.2 Description of the Example Fishery Management Plan Frameworks

Alternative 1 – Continue Under the Current Risk-Averse Management Policy

Under Alternative 1, the groundfish fisheries would continue to be managed based upon the present risk-averse policy. Alternative 1(a) represents the policy language currently stated in the FMPs, dating from 1979 and 1985 for the BSAI and GOA FMPs, respectively (see Section 2.6.1 for the full text of the alternative). These policies, based on the best scientific information available, avoid irreversible or long-term adverse effects on fishery resources and the marine environment, while at the same time providing for optimum yield.

Alternative 1(b) is a substitute for the written policy language in the current FMPs that would include objectives that specifically address the variety of concerns that are balanced in current management considerations (see Section 2.6.2 for the full text of the alternative). Alternative 1(b) encapsulates a risk-averse conservation and management program that is based on a conservative harvest strategy. This policy assumes that fishing does result in some adverse impacts to the environment, and as these impacts become known, mitigation measures will be developed and appropriate FMP amendments will be implemented.

FMP 1 (Current BSAI and GOA Groundfish FMPs)

Alternative 1(a) and 1(b) policies are both represented by FMP 1, which is the current fisheries management program for the BSAI and the GOA and incorporates management measures approved by the NPFMC through the June 2002 meeting. FMP 1 is described in full in Table 4.2-1.

In the current FMPs, the TAC is determined annually based on a conservative harvest strategy that calculates the OFL and the ABC for each managed stock or stock complex. The current FMPs specify the OFL and maximum ABC (max_{ABC}) by means of a six-tier system, wherein the amount and quality of information available for a given stock or stock complex determine the formula that is used to define F_{OFL} and max F_{ABC} (Tiers 1-5) or OFL and max_{ABC} directly (Tier 6). Most stocks are currently managed under Tier 3, where max F_{ABC} equals $F_{40\%}$ if biomass is above $F_{40\%}$. Precautionary adjustments are made, including decreasing F_{OFL} and F_{ABC} linearly with biomass whenever biomass falls below a tier-specific reference level, but only Tier 1 stocks include an uncertainty variation in max_{ABC}. The status of each stock in Tiers 1 through 3 is also examined annually with respect to the MSST, as defined in the National Standard Guidelines.

OY is specified in the current FMPs as a range that is aggregated across all stocks and does not vary with biomass. The current FMPs require the sum of the individual groundfish TACs to fall within the OY range. In the BSAI, the high end of the range, 2 million mt, acts as a cap on the TACs, as the aggregated ABCs regularly exceed this limit. In practice, although it is not required in the current FMPs, TACs are never set higher than the corresponding ABCs. Taking into account the ecosystem considerations of the food web, the current FMPs also prohibit directed fishing for forage species.

Through amendments over the last twenty years, the current FMPs have built up a network of spatial/temporal closed areas intended to protect resources of concern, as well as to minimize gear conflicts. In the BSAI, various areas around the Pribilof Islands and in Bristol Bay are closed year-round to trawling in order to protect red and blue king crab habitat, and there are chinook and chum salmon areas that are closed seasonally. Also in the BSAI, waters within 12 nautical miles (nm) of the Walrus Islands are closed to groundfish fishing to minimize disturbance near walrus haulouts. In the BSAI and the GOA, areas within 3 nm of Steller sea lion rookeries are permanently closed to fishing. Additionally, Steller sea lion protection measures impose trawl prohibitions within 10 to 20 nm of all rookeries and haulouts and prohibit fishing in Seguam Pass. In the GOA, trawling is prohibited in southeast Alaska west of 140°W longitude. Also, a 2.5 square nm (nm^2) area designated as the Sitka Pinnacles Marine Reserve in the GOA is closed to groundfish fishing to protect habitat for rockfish and lingcod (Figure 4.2-1).

The current BSAI FMP prohibits directed fishing for pollock with non-pelagic trawl gear. There is no similar restriction on pollock trawling in the current GOA FMP. Directed fishing for sailfish with longline pot gear is prohibited in the GOA. Non-pelagic trawling is prohibited in the Bristol Bay Red King Crab Savings Area in the BSAI and in the Cook Inlet in the GOA. Additionally, various areas around Kodiak Island are closed to non-pelagic trawling either year-round or seasonally to protect crab stocks (Figure 4.2-1; specific details on the FMP 1 map illustration are provided in Section 4.2.3).

Groundfish fisheries in the BSAI and GOA are required to discard any incidental catch of halibut, salmon, crab, herring, or Steelhead trout, known collectively as prohibited species. The FMPs currently set PSC limits on many of these species, with penalties ranging from closure of a particular zone or of the whole management area to closures of a directed fishery or fisheries for a specified season or for the remainder of the year. In the BSAI FMP, stairstep-based limits (i.e. the catch limit varies based on stock abundance) for trawl bycatch within specified zones are set for red king crab and C. bairdi crab. The BSAI FMP also specifies an absolute trawl catch limit for chinook salmon and "other salmon" within specified zones. Once the apportioned PSC limit for a trawl fishery is reached within a zone, the fishery is prohibited from fishing within that zone. The BSAI FMP specifies a trawl catch limit for herring in the BSAI at one percent of annual biomass. Catch limits on C. opilio crab and halibut bycatch in the BSAI are established in regulation. The C. opilio catch limit applies to a specified zone and is based on an adjusted percentage of biomass that must fall within a certain range. The halibut catch limit is a BSAI-wide limit measured in mt and is based on halibut mortality. In the GOA FMP, catch limits on halibut bycatch are authorized and set by the NPFMC as part of the annual procedure for setting groundfish harvest levels. There are no other PSC limits set in the GOA.

Other bycatch reduction measures are required under FMP 1. The Improved Retention/Improved Utilization (IR/IU) program requires that vessels fishing for groundfish fully retain all pollock and Pacific cod fit for human consumption, as well as fully utilizing the two species by inshore processors. A minimum utilization standard of 15 percent is set for all at-sea processors. The NPFMC is also adopting a policy to require full retention of demersal shelf rockfish by hook-and-line and jig vessels in the Southeast Outside District of the GOA. A Vessel Incentive Program (VIP) encourages bycatch reduction by setting bycatch reduction standards biannually. Vessels that fail to meet these standards can be penalized. Inseason bycatch management measures establish fishing seasons for bycatch management and give the NOAA Fisheries, Alaska Regional Administrator the authority to close areas with high bycatch.

The Reasonable and Prudent Alternative (RPA) measures adopted from the most recent USFWS biological opinion on the short-tailed albatross stipulate the use of certain seabird avoidance measures and require that the take of more than four short-tailed albatross within 2 years trigger consultation with the USFWS and the potential closure of fisheries. To further reduce the possibility of the fisheries' take of albatross, the NPFMC in 2001 required all longline vessels to adopt more stringent seabird avoidance methods.

A Licence Limitation Program (LLP) for groundfish vessels over 32 ft in length (with certain jig gear exceptions) and a moratorium on entry into the groundfish fisheries is in place for the BSAI and the GOA. An IFQ program is in place for sablefish in the BSAI and GOA, which includes provisions for community purchase of quota share. In the BSAI, the directed fishery for pollock is organized into cooperatives as authorized under the AFA. A multi-species CDQ program apportions 7.5 to 10 percent of all BSAI groundfish quota to 65 eligible western Alaska communities.

FMP 1 monitors the groundfish fishing effort through federal and state reporting requirements and through the use of the North Pacific Groundfish Observer Program. All vessels between 60 ft and 125 ft in length are required by regulation to have an observer on board 30 percent of the time; for vessels over 125 ft in length this increases to 100 percent. For AFA and CDQ catcher boats greater than 60 ft in length, one observer must be on board at all times, and for catcher processors and motherships, two observers must be on board at all times. The program also requires observers at inshore processing plants. An additional monitoring tool is the reporting requirements for BSAI and GOA vessels to submit daily or weekly logbooks that include information on the composition of catch and the locations of the hauls. The ADF&G also collects data from fish tickets at the point that catch is sold. Mandatory Vessel Monitoring Systems (VMS) verify vessel locations for all directed Atka mackerel, pollock, and Pacific cod fishing.

Alternative 2 – Adopt a More Aggressive Harvest Management Policy

Alternative 2 would maximize biological and economic yield from the resource while still preventing overfishing of the groundfish stocks. Such a management approach would be based on the best scientific information available, would take into account individual stock and ecosystem variability, and would continue to work with other agencies in protecting threatened and endangered species. A more aggressive harvest strategy would be implemented based upon the concept that the present policy is overly conservative and that larger harvests can be taken without overfishing the target groundfish stocks. This policy assumes that fishing at the recommended levels would have no adverse impact on the environment, except in specific cases that are known and mitigated. For the full text of the alternative, see Section 2.6.3.

Example FMP 2.1

Example FMP 2.1 illustrates a more aggressive harvest strategy than Alternative 1 by removing many of the existing constraints from the fisheries. Example FMP 2.1 is described in full in Table 4.2-1. As the policy is based on an assumption that the impacts of fishing on the environment are generally known and mitigated, the precautions currently built into the existing TAC-setting process would be alleviated. The buffer between the ABC level and the OFL would be removed, and the maximum OY for the groundfish stocks in the BSAI would be released from its 2 million mt cap and allowed to float as the sum of the OFLs for the BSAI groundfish stocks. Additionally, example FMP 2.1 removes the precautionary element included in the current FMPs that decreases F_{ABC} linearly with biomass when the biomass falls below a specific reference level.

Example FMP 2.1 would also remove physical constraints from the fisheries by repealing the various closure areas currently in place. The fishery would be returned to an open-access scenario, where time and area closures, gear restrictions, and prohibited species catch restrictions are repealed. The potential impact of the groundfish fisheries on Steller sea lions, however, means that the current mitigating suite of protection measures that constrain fishing around rookeries and haulouts and protect Steller sea lion prey species (pollock, Pacific cod and Atka mackerel) when at low biomass levels would remain in place (Figures 4.2-2 and 4.6-1; specific details on the example FMP 2.1 map are provided in Section 4.2.3). This is required by the ESA to avoid determinations of jeopardy and adverse modification to Steller sea lions. The same applies to the impact of groundfish fishing on short-tailed albatross, where the current take limits would remain in effect.

The federally-mandated effort limitation program for the directed BSAI pollock fishery, enacted under the AFA, would remain in place, with its accompanying CDQ allocation, but all other effort limitation programs (such as the sailfish IFQ program and the multi-species CDQ program) would be repealed. Reporting requirements would remain in place, but the observer program, except as federally mandated by the AFA, would be repealed, as would VMS requirements.

Example FMP 2.2

A more moderate illustration of Alternative 2, example FMP 2.2, also represents a more aggressive harvest strategy than Alternative 1. Example FMP 2.2 is described in full in Table 4.2-1. In this case, the mechanisms for setting ABC and TAC remain the same as in the current FMPs (see FMP 1 for further detail), but the existing regulatory capped maximum OY of 2 million mt in the BSAI would be removed in favor of a maximum OY equaling the sum of individual groundfish ABCs in the BSAI. Additionally, bycatch reduction incentives and bycatch restrictions would be repealed, other than those related to PSC limits or IR/IU. Under the assumption that fishing does not have an impact on the environment other than what is generally known and mitigated, the more stringent seabird avoidance measures enacted in 2001 would be repealed, leaving only the mitigation measures recommended by USFWS to avoid jeopardy or adverse modification for short-tailed albatross. Closure areas in example FMP 2.2 are the same as those in FMP 1 (Figure 4.2-3; specific details on the example FMP 2.2 map are provided in Section 4.2.3).

Alternative 3– Adopt a More Precautionary Management Policy

Alternative 3 would seek to increase the existing precautionary management measures through community or rights-based management, ecosystem-based management principles, and, where appropriate and practicable, increased habitat protection and additional bycatch constraints. Under this approach, additional conservation and management measures would be implemented as necessary to respond to social, economic or conservation needs, or if scientific evidence indicates that the fishery was negatively impacting the environment. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management. For the full text of the alternative, see Section 2.6.4.

Example FMP 3.1

Example FMP 3.1 illustrates a management approach that accelerates precautionary management measures by increasing conservation-oriented constraints on the fisheries where necessary, formalizing precautionary practices in the FMPs, and initiating scientific review of existing practices as a precursor to the decision of how to best incorporate adequate precautions. Example FMP 3.1 is described in full in Table 4.2 1.

Example FMP 3.1 implements changes to the TAC-setting process following a comprehensive review. Precautionary measures such as setting TAC less than or equal to the ABC and specifying MSSTs for Tiers 1 through 3 in accordance with National Standard Guidelines, would be formalized in the FMP. Sharks and skates would be removed from the Other Species management category and given their own TACs, and criteria to do the same for other target stocks would be developed. Efforts would be accelerated to develop ecosystem indicators for setting TAC limits, as per ecosystem management principles,.

In order to balance the needs of social and economic stability with habitat protection and resource conservation, a review would be conducted of the existing closure areas in the BSAI and the GOA (for closure areas under FMP 3.1, see Figure 4.2-4 and Section 4.2.3). The closure areas would be evaluated against a Marine Protected Area (MPA) methodology, which would be developed as part of this alternative. The NPFMC and NOAA Fisheries would also seek to initiate joint consultation and research with USFWS to develop fishing methods that reduce incidental take of threatened and endangered species. To mitigate any adverse impacts of fisheries management decisions on fishing communities, and to comply with other national directives, formal procedures would be implemented to encourage increased participation of Alaska Natives in fishery management.

Example FMP 3.1 recognizes that the anticipated community or rights-based management programs may ultimately address bycatch reduction objectives (a review of bycatch rates under current programs has been initiated) but, a moderate reduction of PSC limits will be initiated as an intermediary step. Additionally, PSC limits for crab, herring, and salmon would be authorized in the GOA, in addition to the halibut PSC limits authorized under the current GOA FMP. Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through improvements in the observer program and third party verification of economic data.

Example FMP 3.2

Example FMP 3.2 implements the increase of existing precautionary measures on a more rapid timeline than example FMP bookend 3.1. Example FMP 3.2 is described in full in Table 4.2-1. Rather than reviewing existing practices prior to incorporating increased precautions, this bookend implements changes to many aspects of the FMPs concurrently with the initiation of scientific research efforts necessary to bring management measures in line with a precautionary policy.

Example FMP 3.2 significantly accelerates precautionary management by incorporating an uncertainty correction into the estimation of ABC for all species. Additionally, OY would be specified separately for each stock or stock complex rather than for the groundfish complex as a whole (i.e., OY would be set as a formula rather than as a range, eliminating the BSAI 2 million mt OY cap), and would be set equal to the respective stock or stock complex's TAC. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. Example FMP 3.2 would also incorporate stock-specific biological reference points in the tier system where scientifically justifiable. This could result in Tier 3 rockfish stocks, for example, being capped at $F_{60\%}$ rather than $F_{40\%}$. In implementing this bookend, criteria would be developed for specifying MSSTs for Tiers 4 through 6, along with a list of priority candidate stocks; and the development of criteria for moving stocks from the Other Species and Nonspecified Species management categories would minimally result in sharks and skates being given their own TACs.

Example FMP 3.2 also reexamines the existing closure system in the BSAI and the GOA. The bookend sets a guideline of 0 to 20 percent of the EEZ (3 to 200 nm) to be closed as an MPA, of which no more than 5 percent should be completely closed to commercial fishing as a designated No-Take Marine Reserve. The remainder of the closed area would be designated as a no-bottom-contact MPA. The objective of these measures would be to provide greater protection to a full range of marine habitats within the 1,000 m bathymetric line (Figure 4.2 5; specific details on the example FMP 3.2 map are provided in Section 4.2.3). The guideline aims to provide greater protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species, while at the same time respecting traditional fishing grounds and maintaining open area access for coastal communities. Additionally, the bookend would extend the existing bottom-trawl ban on pollock to the GOA.

Additional conservation benefits would be realized in example FMP 3.2 through the comprehensive rationalization of all fisheries (except those already part of a cooperative or IFQ program.) In adopting rationalization programs such as cooperative-style programs with built-in community protections, habitat and bycatch concerns would also be addressed by reducing concentrated effort in the fisheries. To increase precautions regarding bycatch, PSC limits would be significantly reduced (and set for all prohibited species in the GOA), but would not be expected to act as a proportionate restraint on the fisheries due to the incentives for bycatch reduction under cooperatives, or other bycatch incentive programs implemented as necessary under this bookend.

In accordance with ecosystem principles, the NPFMC and NOAA Fisheries would seek to initiate joint consultation and research with USFWS to develop fishing methods that reduce incidental take of all seabird species. Formal procedures would also be implemented to increase consultation with and representation of Alaska Natives in fishery management.

Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through increase of observer coverage and improvements to the observer program, as well as an increase in the use of VMS and the range of economic data collected from industry.

Alternative 4 – Adopt a Highly Precautionary Management Policy

Alternative 4 represents an extremely precautionary approach to managing fisheries under scientific uncertainty. This type of management policy shifts the burden of proof to the users of the resource and the NPFMC/NOAA Fisheries to demonstrate that the intended use would not have a detrimental effect on the environment. It would involve a strict interpretation of the precautionary principle. Management discussions would involve and be responsive to the public, but would decrease emphasis on industry and community concerns in favor of ecosystem processes and principles. This policy assumes that fishing does produce adverse impacts on the environment, but we have little information regarding these impacts. The initial restrictive and precautionary conservation and management measures would be modified or relaxed when additional, reliable scientific information becomes available. For the full text of the alternative, see Section 2.6.5.

<u>Example FMP 4.1</u>

Example FMP 4.1 illustrates an FMP where current levels of fishing are reduced and other precautionary restrictions are implemented until scientific research shows that the fisheries have no adverse effect on the sustainability of the resource and the environment. Example FMP 4.1 is described in full in Table 4.2-1.

Example FMP 4.1 would substantially reduce the potential of the fisheries to have adverse environmental impacts on the environment. A modified TAC-setting process would create a more substantial buffer between ABC and the OFL by setting the fishing mortality rate at $F_{75\%}$ for all Steller sea lion prey species (pollock, Pacific cod, and Atka mackerel) and for rockfish (a long-lived, slow-growing species). Also, the max F_{ABC} for each stock or stock complex in Tiers 1 through 5 would be adjusted downward based on the lower bound of a confidence interval surrounding the survey biomass estimate. OY would be specified separately for each stock or stock complex rather than for the groundfish complex as a whole (i.e., OY would be set as a formula rather than as a range, eliminating the BSAI 2 million mt OY cap), and would be set equal to the respective stock or stock complex TAC. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. For species managed as members of a stock complex, rather than setting TAC as the aggregate of the individual members' ABCs, the max_{ABC} value for each stock would be determined and the TAC set equal to the lowest value. Where sufficient biological information is available, such as with EBS pollock, TAC would be distributed on a smaller spatial scale. MSSTs would be determined for all tiers.

To further mitigate the possibility of the fisheries having a detrimental biological and ecosystem impact, 20 to 50 percent of the EEZ would be designated as a No-Take Marine Reserve (i.e., no commercial fishing), covering the full range of marine habitats within the 1,000-m bathymetric line (Figure 4.2-6; specific details on the example FMP 4.1 maps are provided in Section 4.2.3). As part of this area in the Aleutian Islands, a Special Management Area would be established to protect coral and other live bottom habitats. The closed area would include spawning reserve areas for intensively fished species. Under the FMP 4.1 example, comprehensive trawl exclusion zones would be set to protect all Steller sea lion critical habitat, and trawling would be restricted to only those fisheries that cannot be prosecuted with other gear types (i.e, the flatfish fisheries).

In an effort to reduce waste and the risk of adverse impact to the environment, existing PSC limits would be halved under this bookend, as would bycatch (discard) and incidental catch rates. IR/IU would be extended to all target species. Stringent PSC limits would be set for salmon, crab, and herring in the GOA, and as information becomes available, bycatch limits would be set for non-target species also. Protection measures would be set for all seabird species.

Because this policy alternative necessitates greater research and data-gathering efforts, example FMP 4.1 would expand observer coverage to 100 percent for all vessels over 60 ft in length and require 30 percent observer coverage on vessels presently exempted from observer coverage (i.e., vessels under 60 ft in length). VMS would be made mandatory for all groundfish vessels, as would motion-compensated scales for weighing all catches at sea or at shore-based processors. Cooperative research and data-gathering programs would be initiated as well to expand the use of traditional knowledge in fisheries management.

Example FMP 4.2

Example FMP 4.2 expands the precautionary principles of Alternative 4 by suspending all fishing until the fisheries can be shown to have no adverse effect on the resource and its environment. The TAC for all species would be set at zero. All areas of the EEZ would be closed to all types of fishing (e.g., commercial, recreational, and subsistence) (Figure 4.2-7; specific details on the example FMP 4.2 map are provided in Section 4.2.3); bycatch and incidental catch, as well as the take of seabirds and marine mammals, would then be reduced to zero. Example FMP 4.2 is described in full in Table 4.2-1.

Scientific research and data-gathering efforts would continue. When a fishery can be shown to pose no significant threat of adverse biological and environmental impacts, or if adverse effects can be successfully mitigated through use of fishery-specific regulations, fishing would be allowed to resume.

Under this FMP illustration, it is assumed that each groundfish fishery currently conducted in federal waters in the BSAI and GOA would be individually reviewed by the NPFMC and NOAA Fisheries. Upon completion of this review (which may take up to 2 years), the agency would certify those fisheries that have no significant adverse impacts on the environment and authorize fishing under a specific set of regulations. If a fishery is found by this review to produce significantly adverse environmental effects, and mitigation measures can not be designed to mitigate those effects, that fishery would not be certified and would remain closed until more scientific information is known.

The Preferred Alternative

The preliminary Preferred Alternative represents a management approach that incorporates forward looking conservation measures that address differing levels of uncertainty. This management approach has, in recent years, been labeled the precautionary approach. As part of its policy, appropriate measures would be considered and adopted that accelerate the precautionary, adaptive management approach through community or rights-based management, ecosystem-based management principles that protect managed species from overfishing, and, where appropriate and practicable, increased habitat protection and bycatch constraints. This management approach recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management, and will utilize and improve upon the NPFMC and NOAA Fisheries' existing open process to involve the public in decision-making. For the full text of the alternative, see Section 2.6.9.

Example FMP PA.1

Example FMP PA.1 illustrates a conservative management approach that continues current risk-averse management practices, increases conservation-oriented constraints on the fisheries as appropriate, formalizes precautionary practices in the FMPs, and initiates scientific review of existing practices in order to assess and improve fishery management. Example FMP PA.1 is described in full in Table 4.2-2.

Example FMP PA.1 builds on the existing conservative procedure for determining ABC and annual quotas. The example FMP would implement changes to the TAC-setting process following a comprehensive review. Precautionary practices, such as setting TAC less than or equal to the ABC, and specifying MSSTs for Tiers 1 through 3 in accordance with National Standard Guidelines, would be formalized in the FMP. The NPFMC and NOAA Fisheries would continue to use and improve harvest control rules to maintain a spawning stock biomass with the potential to produce sustained yields on a continuing basis, and to distribute allocations by area, season, and gear as appropriate. Efforts to develop ecosystem indicators to be used in TAC-setting, as per ecosystem management principles, would be continued.

In order to balance the needs of social and economic stability with habitat protection and resource conservation, the NPFMC would develop an MPA efficacy methodology, including the development of definitions, program goals, objectives, and criteria for establishing MPAs. Additionally, existing habitat and bycatch area restrictions would be maintained. Measures to protect ESA-listed species would also be retained. To minimize bycatch, a moderate reduction of PSC limits in the BSAI would be initiated, and PSC limits or other appropriate measures for the protection of crab, herring, and salmon would be authorized in the GOA. Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through improvements in the observer program and existing reporting requirements.

Existing programs to address excess capacity and overcapitalization would be maintained under this example FMP, with continued development of rights-based management to be undertaken as needed. In order to mitigate any adverse impacts of fisheries management decisions on fishing communities, and to comply with other national directives, procedures to encourage increased participation of Alaska Natives in fishery management would be pursued.

Example FMP PA.2

Example FMP PA.2 accelerates adaptive, precautionary management by increasing conservation measures that provide a buffer against uncertainty, instituting research and review of existing measures, and expanding data collection and monitoring programs. Example FMP PA.2 is described in full in Table 4.2-2.

Example FMP PA.2 significantly increases precautionary management by incorporating an uncertainty correction into the estimation of ABC for all species. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. The calculation of te OY caps would be periodically reviewed to determine their relevancy to current environmental conditions and stock levels. Example FMP PA.2 would also develop and implement criteria for using key ecosystem indicators in TAC-setting, and other precautionary practices such as developing appropriate harvest strategies for rockfish stocks. In implementing this bookend, analysis and data collection would allow for specification of MSSTs for priority stocks in Tiers 4 and 5. The development of criteria to manage target and non-target species consistently, and for moving stocks from the Other Species and Non-specified Species management categories, would initially consider moving sharks (in the BSAI and GOA) and skates (in the BSAI) out of the Other Species group for setting TAC limits.

Example FMP PA.2 also re-examines area restrictions in the BSAI and the GOA by reviewing existing closure areas (for closure areas under example FMP PA.1, see Figure 4.2-8 and Section 4.2.3), and evaluating them in conjunction with the development of MPAs. The example FMP would adopt MPAs, based on a designation guideline of 0 to 20 percent of the EEZ (3 to 200 nm). The objective of these measures is to provide greater protection to a full range of marine habitats within the 1,000 m bathymetric line (Figure 4.2-9; specific details on the example FMP PA.2 map are provided in Section 4.2.3). This MPA would incorporate an Aleutian Islands management area to protect coral and live bottom habitat, and would also include any modification to the 2002 Steller sea lion closures. The guideline aims to provide greater protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species, while at the same time respecting traditional fishing grounds and maintaining open area access for coastal communities. Additionally, the bookend would extend the existing BSAI bottom-trawl ban on pollock to the GOA.

To increase precautions regarding bycatch, existing PSC limits would be reduced, and limits would be set for all prohibited species in the GOA with appropriate in-season closure areas. The achievement of these bycatch reductions would be realized through the comprehensive rationalization of all fisheries (except those already part of a cooperative or IFQ program), which reduces concentrated effort in the fisheries, or through bycatch incentive programs implemented in this example FMP.

In accordance with ecosystem principles, the NPFMC and NOAA Fisheries would seek to cooperate with USFWS to develop fishing methods that reduce incidental take of all seabird species in the longline and trawl fleets. Procedures would also be pursued to increase consultation with and representation of Alaska Natives in fishery management.

Increases in observer coverage and improvements to the observer data that are collected would enhance effective monitoring and improve the ability to react to change in the environment and the fisheries. Additionally, the bookend explores programs that would expand mandatory economic data collected from industry.

4.2.3 Description of the Example Fishery Management Plan Maps

FMP 1 Map

FMP 1 (Figure 4.2-1) illustrates different types of spatial management areas across the BSAI and GOA. All of these areas currently comprise the spatial management regime for 2003. These areas are color-coded on the map; bathymetry contours to 1,000 m are also color-coded, ranging from dark green (0 m) to a pale beige (1,000 m). In the legend, titles for measures developed specifically for protection of Steller sea lions are printed in blue. Bycatch closures that are triggered once a PSC limit is reached are not included on the map or in the spatial analysis, since in recent years some of these limits are no longer reached.

FMP 1 illustrates the current Steller sea lion-related closures west of 144°W longitude necessary for the Alaska groundfish fisheries to avoid a determination of jeopardy and adverse modification for Steller sea lions under the ESA. The Steller sea lion population west of 144°W longitude has been listed as endangered under the ESA since 1990. The portion of the Steller sea lion population found east of 144°W longitude is currently listed as threatened. Closures related to protection of Steller sea lions are color-coded as follows:

Yellow:	3 nm No-Transit Zones (No-Take Reserves)
Blue:	No Hook-and-Line and Pot or Trawl for the Steller Sea Lion Prey Species
Red:	No Trawling for Steller Sea Lion Prey Species
Red Hatching:	Seasonal and Harvest Limit Closures for Atka Mackerel and Pacific Cod
Tan Hatching:	Additional Atka Mackerel Closures
Blue Hatching:	Additional Pollock Closures

The No-Transit Zones shown on the map have been in effect since 1992, and serve to restrict all water-born vessel traffic year-round, unless under a federal scientific permit.

Areas designated as "No Hook-and-Line and Pot or Trawl for Steller Sea Lion Prey Species" are those areas that currently restrict the harvest of Steller Sea lion prey species by hook-and-line and pot and bottom and pelagic trawl gear. These restrictions are in effect year-round.

Areas labeled "No Trawling for Steller Sea Lion Prey Species" restrict both bottom and pelagic trawl fishing for Steller sea lion prey species and are in effect year-round.

In the BSAI, areas designated as "Seasonal and Harvest Limit Closures for Atka Mackerel and Pacific Cod" are those areas where Atka mackerel fishing is closed all year within 20 nm of Steller sea lion rookeries and haulout sites in waters east of 178°W longitude. In waters west of 178°W longitude, constraints on Atka mackerel harvest are triggered once 40 percent of the Aleutian Islands Atka Mackerel TAC is reached. After the 40 percent threshold is reached in the Aleutian Islands, all other Atka mackerel fishing must occur at least 20 nm from Steller sea lion rookeries and haulout sites. To prevent localized depletion of prey species, Pacific cod (which are managed under a single TAC for the BSAI) may not be targeted west of 178°W longitude after 40 percent of that BSAI TAC is reached.

Additional closures include those areas closed to directed fishing of Atka mackerel and pollock, The GOA west of 144°W longitude is closed year-round to directed fishing for Atka mackerel. The entire Aleutian Islands subarea is closed year-round to directed fishing of pollock, and both the GOA and the Bering Sea have additional seasonal pollock restrictions.

Non-Steller sea lion related spatial closures, including areas closed to all trawl, non-pelagic trawl, and all fishing, are presented in the example FMP 1, FMP 2.2, and FMP 3.1 maps (Figures 4.2-1, 4.2-3, and 4.2-4, respectively). These closures include the following areas:

Closed to All Trawl

- Nearshore Bristol Bay Closure Area: Bering Sea area closed year-round since 1996.
- Pribilof Islands Area Habitat Conservation Zone: Bering Sea area closed year-round since 1994.
- Southeast Outside Closed Area: closed year-round since 1997.
- Chiniak Gully Research Area: closed from August 1 through September 20.

Closed to Non-Pelagic Trawl

- Red King Crab Savings Area: Bering Sea area closed year-round since 1996.
- Kodiak Type I Crab Closure Areas: GOA area closed year-round.
- Kodiak Type II Crab Closure Areas: GOA area closed between February 15 to June 15.

Closed to All Fishing

- Cape Edgecumbe (Sitka) Pinnacles: closed to groundfish fishing year-round since 1997.

All of these spatial measures (closures) combined protect 10.7 percent of the EEZ (Table 4.2-3). Because groundfish resources and EFH are usually found to be associated with the continental shelf and continental slope, for purposes of this analysis we have defined "fishable area" as those waters over the continental shelf and continental slope, or all waters to a depth of 1,000 m. When examined in this way, the spatial measures described for example FMP 1 protect 28.8 percent of the fishable area of the BSAI and GOA. (Table 4.2-3).

Example FMP 2.1 Map

The map for example FMP 2.1 (Figure 4.2-2) illustrates six different types of spatial management areas across the BSAI and GOA. Example FMP 2.1 includes only the current Steller sea lion-related closures west of 144°W longitude, necessary for the Alaska groundfish fisheries to avoid a jeopardy determination for Steller sea lions under the ESA. These closure areas are color-coded on the map; bathymetry contours to 1,000 m are also color-coded, ranging from dark green (0 m) to a pale beige (1,000 m). Closures related to protection of Steller sea lions are color-coded as follows:

Yellow:	3 nm No-Transit Zones (No-Take Reserves)
Blue:	No Hook-and-Line and Pot or Trawl for the Steller Sea Lion Prey Species
Red:	No Trawling for Steller Sea Lion Prey Species
Red Hatching:	Seasonal and Harvest Limit Closures for Atka Mackerel and Pacific Cod
Tan Hatching:	Additional Atka Mackerel Closures
Blue Hatching:	Additional Pollock Closures

Descriptions of these six spatial management areas do not deviate from those presented under the FMP 1 map at the beginning of this section. All of these spatial measures (closures) combined protect 4.2 percent of the EEZ, and 14.6 percent of the fishable area of the BSAI and GOA (Table 4.2-4).

Example FMP 2.2 and Example 3.1 Maps

The maps for examples FMP 2.2 and FMP 3.1 are identical to the map for example FMP 1 (Figures 4.2-3 and 4.2-4). See Tables 4.2-5 and 4.2-6 for descriptive statistics on FMPs 2.2 and 3.1, respectively.

Example FMP 3.2 Map

The map for example FMP 3.2 (Figure 4.2-5) illustrates six color-coded spatial management areas. Bathymetry contours to 1,000 m are also color-coded, running from dark green (0 m) to pale beige (1,000 m). In the legend, titles for measures developed specifically for protection of Steller sea lions are printed in blue. Closures are color-coded as follows:

Yellow:	3 nm No-Transit Zones (No-Take Reserves)
Blue:	No-Take Marine Reserves
Dark Green:	No Steller Sea Lion Prey Species Hook-and-Line, Pot, or Trawl Fishing MPA
Purple:	No Steller Sea Lion Prey Species Trawling MPA
Light Green:	Eastern GOA No Steller Sea Lion Prey Species Hook-and-Line, Pot, or Trawl MPA
Pink:	No-Bottom-Contact Trawling MPA

The map has been developed from the following information and data sources: bathymetry; EFH from the 1997 EFH EA (NMFS 1997); Steller sea lion critical habitat; 2002 Steller sea lion closures; survey and bycatch data for coral and sponge distribution; historical commercial fisheries catch data; location of ports; locations of test and study areas; and review of various alternatives and potential mitigation measures being developed by the NPFMC EFH Committee. Using the latest data to determine Steller sea lion foraging behavior, a 15 nm buffer from the coastline in the GOA and Bering Sea was applied, as were 15 nm buffers from Steller sea lion rookeries and haulouts in the Aleutian Islands.

The ADF&G groundfish statistical areas were applied as management units to designate five different types of management areas including No-Take Marine Reserves; No Steller Sea Lion Trawling MPA; No Bottom Trawling MPA; No Steller Sea Lion Hook-and-Line, Pot or Trawl MPA; and, in the eastern GOA, No Steller Sea Lion Hook-and-Line, Pot or Trawl and No-Trawl MPA.

The ADF&G statistical areas are approximately 35 nm wide and 30 nm tall. ADF&G subdivides their statistical areas at 3 nm from the shoreline. These management units, when grouped into larger spatial regions, are presumably large enough to 1) prevent habitat fragmentation; 2) protect large portions of HAPC; 3) form clearly defined, manageable, navigable, and enforceable alternatives; 4) provide contiguous fishing restrictions for protecting spawning populations, key critical habitat, demersal and pelagic fish species, and marine mammals; and 5) where possible, provide open areas near fishing ports.

From a biological and fishery point of view, the ADF&G groundfish statistical area boundaries are arbitrary and do not always line up with the spatial distribution of significant biological and habitat resources. Therefore, a 40 percent rule was applied: when 40 percent of a statistical area had a significant concern as determined by a weighted qualitative factor, the area was tagged as a "No-Take Marine Reserve", or one of the other MPAs. This effect was normalized to a certain extent during the analysis because a statistical area that did not quite meet the benchmark would not be designated as an MPA (e.g., an area where less than 40 percent was of concern would be left entirely open). In some cases, areas would be totally closed to create a contiguous closure necessary to capture a broad range of inshore to offshore habitats.

The benthic fishing habitat used in this analysis generally follows the continental shelf and goes out to a depth of 1,000 m (500 fathoms), which we consider here to constitute the fishable bottom habitat. Blocks of closures extend from the shore to a 1,000-m depth, protecting a full range of habitat types. Area protected by FMP 3.2 spatial measures, when combined, constitutes 17.8 percent of the EEZ, and 47.8 percent of the fishable area of the BSAI and GOA (Table 4.2-7).

<u>Aleutian Islands</u>

The Aleutian Islands subarea merits special attention since the fishing grounds are all relatively nearshore. Example FMP 3.2 defines a 5 percent No-Take Reserve and 15 percent MPA rule across a full range of habitat types. Where in the Bering Sea and GOA, 15 nm buffers from shore were described in the frameworks, in the Aleutian Islands, a 15 nm buffer was applied to each of the Steller sea lion rookeries and haulouts. This buffer does not specifically implement a No-Take Reserve or other MPA, but is likely to be a weighting factor in any future development of restrictions.

Due to the narrow continental shelf along the Aleutian Island chain, and the fact that state statistical areas are utilized in this Programmatic SEIS, a much higher percentage of fishable area (79.9 percent) is afforded protection in the example FMP 3.2 in the Aleutian Islands area compared to the Bering Sea (32.6 percent) and western/central GOA (65.6 percent).

Thirty-nine Steller sea lion rookeries fall within Steller sea lion critical habitat, 19 of which are located in the Aleutian Islands. All rookeries carry a 3 nm No Transit area with an additional 10 nm (or more) designated as a No Trawling for Steller Sea Lion Prey Species area. The No Transit areas are the only No-Take reserves in the Aleutian Islands. These closures have been in effect since 1992, all of which are logical candidates for no-take marine reserves or MPAs. Many of these Steller sea lion No Transit/No-Trawl areas are clustered and transfer easily to corresponding ADF&G statistical areas. Although other non-Steller sea lion prey species fisheries such as rockfish fisheries, occur inside No Steller Sea Lion Prey Species Trawl areas, these no-trawl areas were weighted heavily in the analysis as representing conceptual No-Take reserves and less so for gear-specific MPAs. Coral data from bycatch and trawl survey data, as well as from NOAA dive test areas, were used in the development of the No-Take marine reserve examples.

The MPAs considered for analysis of example FMP 3.2 include No Steller Sea Lion Prey Species Hook-and-Line, Pot, and Trawling MPAs; No Steller Sea Lion Prey Species Trawling MPAs; and No Bottom Contact Trawling MPAs. To encompass existing closures areas, the Pacific cod Hook-and-Line and Pot and Trawling restrictions were extended to constitute No Steller Sea Lion Prey Species Hook-and-Line and Pot MPAs, if not already closed as No-Take Reserves. Other current Steller sea lion prey species restrictions include closing trawl fisheries for Atka mackerel, pollock (the entire Aleutian Islands subarea), and Pacific cod. To better protect habitat, a suite of MPAs for No Bottom Contact Trawling (currently defined simply as non-pelagic trawling) were created around areas of low and medium fishing intensity areas where bycatch or trawl survey data contained coral and sponge. Some of these low intensity areas can be seen on Bowers Ridge, west of Attu Island, and west of the Bogoslof District.

Through the development of these no-take reserves and MPAs, the 40 percent rule was applied to ADF&G statistical areas in order to illustrate a contiguous and fairly non-fragmented environment available for marine mammals, benthic habitats, seabird avoidance, and spawning fish populations without jeopardizing commercial fisheries.

Bering Sea

Guidelines in the example FMP 3.2 MPAs and EFH component define a 5 percent No-Take Reserve and a 15 percent MPA rule across a full range of habitat types. Bering Sea benthic habitat is much different than the habitat Aleutian Islands, due to its broad, muddy, and sandy shelf. The Bering Sea also contains many legacy areas established for habitat protection, such as the Near Shore Bristol Bay No-Trawl area, the Red King Crab No Non-Pelagic Trawl area, the Pribilof Habitat No-Trawl area, and a full suite of No Steller Sea Lion Prey Species Hook-and-Line and Pot and Trawl Areas. Other existing closures in the Bering Sea have been used for the creation of No-Take Reserves and MPAs (i.e., five No Transit zones and their associated 10 nm No Steller Sea Lion Prey Species Trawling areas with various sized hook-and-line and pot closures). A large section of the Steller sea lion conservation area (the Bogoslof District) is closed to all Steller sea lion prey species fishing (with a small exemption area near Dutch Harbor for catcher vessels less than 60 ft in length.

A buffer from the shore of 15 nm was used to help determine designation of the No-Take Reserves and the MPAs. As in the Aleutian Islands, we have applied a 40 percent rule to ADF&G statistical areas to illustrate contiguous and fairly non-fragmented environments.

The Bogoslof District currently contains significant amount of No-Take Reserves, along with many No Steller Sea Lion Prey Species Hook-and-Line and Pot and Trawling areas. More No Steller Sea Lion Hook-and-Line and Pot Trawling areas develop to the east along the lower Bering Sea shelf. The 3 nm statistical areas around the land bordering the rookeries are listed as No-Take Marine reserves. Other No-Take Reserves include a large area around the Cape Pierce Walrus Protection area and the Walrus Island Steller sea lion rookery in the Pribilof Islands.

The Pribilof Habitat Conservation and Nearshore Bristol Bay areas remain closed to trawling, and the Red King Crab Savings Area remains closed to non-pelagic trawling. The two northernmost haulouts and the haulouts in the Pribilofs are closed to Steller Sea Lion Prey Species Hook-and-Line and Pot and Trawling.

Along the northwestern shelf of the Bering Sea, three large No-Bottom-Contact Trawling MPAs were developed to coincide with the no-bottom-trawling areas the EFH Committee is considering to protect benthic habitat. These general areas are being considered as potential sites for a rotational MPA, where areas are periodically opened and closed to particular types of fishing.

GOA – West of 144°W

Similar to the BSAI area, example FMP 3.2 sets a 5 percent No-Take Reserve and a 15 percent MPA rule across a full range of habitat types in the GOA (west of 144°W) . Unlike the Bering Sea, however, the GOA is somewhat more restrictive as to where effective closures can be designated and leaves areas open near fishing ports.

Fifteen Steller sea lion rookeries are listed in the GOA, 13 of which include 3 nm No Transit areas and 10 nm No Steller Sea Lion Prey Species Trawling areas. These areas, along with other existing Steller sea lion restrictions (such as the 15 nm buffers from the shore, the Type I & II No-Trawl areas (areas that are closed year round to all trawling but pelagic gear, and areas that are closed to pelagic gear from Feb 15-June 15, respectively), and the Chiniak Gully Research Area); known locations of Steller sea lions and other marine mammals (such as harbor seals); pollock spawning areas; bycatch and survey data of coral and sponges; the shelf's gullies, canyons, and breaks; and EFH, were used as weighted measures for the illustration of the No-Take Reserves and MPAs in FMP 3.2.

The 40 percent rule was again applied to the ADF&G statistical areas to illustrate large, non-fragmented environments.

In order to protect a full range of habitat, perpendicular tracks of No-Take Marine Reserves were created from the shoreline to a depth of 1,000 m. Where possible, the No-Take Reserves were created at Steller sea lion rookeries and where existing No Hook-and-Line and Pot and Trawl for Steller Sea Lion Prey Species closures coexist, such as at Marmot Island, south Chignik in RPA District 4, selected Steller sea lion rookeries and haulouts, and RPA Districts 10 and 11 (below the Bogoslof District). Other areas that were designated No-Take Reserves for purposes of our analysis included a section of the shelf and slope below the Shumagin islands and Portlock Banks, and smaller sections of the shelf below Prince William Sound (PWS).

When Steller sea lion restrictions were dominant but did not reach the benchmark for creating No-Take Reserves, there were no Steller Sea Lion Prey Species Hook-and-Line and Pot and Trawl closure areas created using the weighted measure. Instead, No-Trawl for Steller Sea Lion Prey Species and No-Bottom-Contact Trawling closures were created using these same sets of weighted criteria.

GOA – East of 144°W

As in the BSAI, example FMP 3.2 for the GOA (east of 144°W longitude) defined a 5 percent No-Take Reserve and a 15 percent MPA rule across a full range of habitat types.

Currently there are no Steller sea lion closures east of 144°W. The Steller sea lion population east of 144°W is listed as threatened; therefore, we included an example measure to provide some protection to this part of the population. The No-Trawl closure east of 140°W was strengthened in this illustration to include an MPA for No Hook-and-Line and Pot or Trawl for Steller Sea Lion Prey Species. The MPA also includes a smaller area near Icy Bay and Cape Yakataga.

The example No-Take Reserves were developed to protect habitat in areas with low to medium fishing intensity and within 3 nm of three Steller sea lion rookeries. The Sitka Pinnacles are located within one of the example No-Take Reserves.

Example FMP 4.1 Map

There are two versions of the example FMP 4.1 map, both of which illustrate the same suite of spatial closures. Figure 4.2-6 provides a map illustration using the same color scheme used in maps for example FMPs 1 through 3.2, so that the maps may be easily compared. Figure 4.2-11 uses the same color scheme (magenta) as the map for example FMP 4.2 map (Figure 4.2-7). Both example FMPs 4.1 and 4.2 illustrate a major shift in management policy from current policy. Unlike current management practice, where any type of fishing is generally permitted unless specifically prohibited (e.g., the maps are blank unless closures/restrictions are shown), the maps for example FMP 4.1 illustrates a management policy where all areas and types of fishing are closed unless shown otherwise. Bathymetry contours to 1,000 m are also color-coded, ranging from dark green (0 m) to pale beige (1,000 m). In the legend, titles for measures developed specifically for protection of Steller sea lions are printed in blue. Figure 4.2-11 illustrates four types of spatial management areas that are color-coded as follows:

Yellow:	3 nm No Transit Zones (No-Take Reserve)
White:	Open to Fishing
Magenta Hatching:	Open to Commercial Fishing Except Trawling
Magenta (solid):	No-Take Marine Reserves

The map has been developed from the following information and data sources: bathymetry; EFH from the 1997 EFH EA (NMFS 1997); Steller sea lion critical habitat; 2002 Steller sea lion closures; survey and bycatch data for coral and sponge distribution; historical commercial fisheries catch data; location of ports; locations of test and study areas; the Aleutian Islands special management area; public comments; and the legacy closures and restricted areas identified in Table 4.2-1.

ADF&G statistical areas were applied as management units to designate open fishing areas, No-Trawling areas (all species, all types of trawls), and No-Take Marine Reserves (where commercial fishing is prohibited). The ADF&G groundfish statistical areas are approximately 35 nm wide and 30 nm tall. ADF&G subdivides their statistical areas at 3 nm from the shoreline. These management units, when grouped into larger spatial regions, are presumably large enough to 1) prevent habitat fragmentation; 2) protect large portions of HAPC; 3) form clearly defined, manageable, navigable, and enforceable alternatives; 4) provide contiguous fishing restrictions for protecting spawning populations, critical habitat, demersal, and pelagic fish species, and marine mammals; and 5) where possible, provide open areas near fishing ports.

From a biological and fishery point-of-view, the ADF&G statistical areas are arbitrary and do not always represent the spatial distribution of significant biological and habitat resources. Therefore, a 25 percent rule was applied in the following manner: when 25 percent of a state statistical area had a significant concern, the area was designated as either a No-Take Marine Reserve or a No-Trawl MPA. This effect was normalized to a certain extent during the analysis because a statistical area that did not quite meet the benchmark would not be designated as an MPA (e.g., an area where less than 25 percent was of concern would be left entirely open, as was the case when attempting to close Steller sea lion critical habitat). In some cases, areas were totally closed, even if the 25 percent benchmark was not reached, to create a contiguous closure that captured a broad range of inshore to offshore habitats.

Area protected by example FMP 4.1 spatial measures, when combined, is 19.0 percent of the EEZ, and 51.1 percent of the fishable area of the BSAI and GOA (Table 4.2-8). The primary difference between this map and the FMP 3.2 map is that most of the spatial closures used in this illustration are No-Take Marine Reserves where all commercial fishing is prohibited. This form of closure is intended as an extremely precautionary policy that places emphasis on protecting marine mammals, target groundfish stocks, and EFH.

Aleutian Islands

The Aleutian Islands subarea merits special attention since the fishing grounds are near the shore. Example FMP guidelines specify that 20 to 50 percent of each management area, including all representative habitats contained therein, should be managed as a No-Take Marine Reserve. The Aleutian Islands Special Management Area illustrated in example FMP 4.1 covers a contiguous area specifically to protect coral and other living substrates; and Steller sea lion critical habitat. Although the Aleutian Islands Special Management Area was originally intended to encapsulate the entire Aleutian Islands subarea, excluding a swath of fishable area at Unimak Pass, this is not shown on the map since the Bogoslof District and RPA Districts 10 and 11 are already analyzed as No-Take Marine Reserves in their own regions.

Benthic fishing habitat to a depth of 1,000 m (500 fathoms) was used in this analysis, which we considered fishable bottom habitat. In most cases, perpendicular blocks of closures extend from one side of the 1,000 ms contour to the other, protecting a full and broad range of habitat.

Thirty-nine Steller sea lion rookeries are located within designated Steller sea lion critical habitat; 19 of which are contained in the Aleutian Islands. All rookeries have a 3 nm No-Transit Zone and an additional 10 nm No Steller Sea Lion Prey Species Trawling area. These closures have been in effect since 1992, all of them making excellent candidates for No-Take Marine Reserves under Alternative 4 policy. Many of these areas are clustered and would transfer easily to the corresponding ADF&G statistical areas. Areas that currently have high densities of no-trawl, hook-and-line, and pot fishing were designated No-Take Marine Reserves in the example FMP 4.1 illustration. A good example of this can be seen in the area from 170°W to Seguam Pass. Blocks on the Petrel Banks were closed due to high coral bycatch. A string of closed statistical areas are located along the Petrel Banks because these areas have had at least some coral bycatch and are relatively unstudied. One block on the southeastern side of Petrel Banks (north slope) was left open. Historically high catch rates in this area and a need to create at least some open areas for fishing prompted this action. No-take reserves along Steller sea lion critical habitat and the 1,000 ms contour created significant contiguous benthic and biologic protection in the Aleutian Islands.

Bering Sea

Example FMP 4.1 guidelines specify that 20 to 50 percent of each management area, including all representative habitats contained therein, should be managed as No-Take Reserves. Specifically mentioned in example FMP 4.1 are submarine canyons, Unimak Pass, old Crab Pot Sanctuary, areas near the Pribilof Islands, area southwest of St. George, Misty Moons, and the Red King Crab Savings Area. These examples were recommended by public stakeholders as candidate areas for analysis in this Programmatic SEIS.

Steller sea lion critical habitat (including the entire Steller Sea Lion Conservation Area) was closed to trawling as an illustration of a No-Trawl MPA, or designated as No-Take Marine Reserves, as were other legacy closures such as the Nearshore Bristol Bay No-Trawl area. And since the Bering Sea has a much broader benthic plane, more options were available to analysts for illustrating a management scenario meeting the criteria of example FMP 4.1 by protecting a full range of habitat types using a combination of both No-Trawl MPAs and No-Take Marine Reserves.

For purposes of this analysis, we designated the Bogoslof District (RPA District 9) as a No-Take Marine Reserve, with blocks of reserve leading east to include large portions of old Crab Pot Sanctuary Area, thereby illustrating continued protection of this important crab spawning area. A tract of No-take Marine Reserve leaves the old Crab Pot Sanctuary area running north to intercept the coast near Cape Pierce and the Walrus Islands closures. A track of No-Trawl MPA extends from Cape Pierce to the west, intercepting the No-Trawl Marine Reserve formed by the Pribilof Conservation Area. Below the Pribilof Conservation Area is Misty Moon canyon; a No-Take Marine Reserve was designated here because of historically high bycatch of corals and sponges. An open fishing area was created both to the north and south of the Misty Moon area to permit groundfish fishing where catches have been historically good, but with lower bycatch. For purposes of illustrating this policy, other large No-Take Marine Reserves were designated along the inner, middle, and outer Bering Sea shelf breaks. The five northern Steller sea lion haulouts became No-Take Marine Reserves using coincident ADF&G statistical areas. Unlike the Aleutian Islands, the area analysis includes only that part of the ADF&G statistical area that coincides with 1,000 m bathymetry. The exception is that the Bogoslof foraging area is included in the percentage of Bering Sea EEZ calculation.

GOA – West of 144°W

As with the BSAI, GOA (west of 144°W) guidelines suggest that 20 to 50 percent of each management area, including all representative habitats contained therein, should be managed as No-Take Marine Reserves. Specific areas mentioned for analysis are the Davidson Banks, Shumagin Islands, the Type I & II area to the southeast of Kodiak Island, and the Gulf shelf breaks. Unlike the Bering Sea , the GOA is somewhat more restrictive as to where effective closures can be created, while leaving some areas open.

Steller sea lion critical habitat, current Steller sea lion-related closures (trawl, hook-and-line, and pot), pollock spawning areas, fishing ports, and the shelf's gullies, canyons and breaks, were taken into account in the creation of No-Take Marine Reserves and No-Trawl MPAs. In order to protect a full range of habitat, perpendicular tracks of No-Take Marine Reserves were created using ADF&G statistical areas from the shoreline to the 1,000-m break. Where possible, these No-Take Marine Reserves were created at Steller sea lion rookeries and where current Steller sea lion no-trawl and no hook-and-line and pot closures coexist, such as Marmot Island and RPA Districts 4, 10, and 11. Other areas that were designated as No-Take Marine Reserve in this example FMP included the Shumagin Islands (an important pollock spawning area and high catch area), a portion of Davidson Bank, Portlock Banks shelf break, and blocks of areas in and around PWS. Unlike the Aleutian Islands, the area analysis in the GOA (west of 144°W) includes only that part of the ADF&G statistical area that coincides with 1,000 m bathymetry.

GOA – East of 144°W

Because the Southeast Outside District does not include Steller sea lion critical habitat but currently has a trawl ban east of 140°W, this area was analyzed separately from the western and central GOA. Again, a suggested 20 to 50 percent of each management area, including all representative habitats contained therein, should be managed as No-Take Marine Reserves. The Sitka Pinnacles are is the only area currently designated as No-Take among the example FMPs. Coral and sponge bycatch, shelf breaks, and proximity to ports were used in the illustration of No-Take Marine Reserves. The No-Take Marine Reserves protect a full range of habitat from the coast to the 1,000 m (fishable area) shelf break. Unlike the Aleutian Islands, the area analysis for the GOA (east of 144°W) includes only that part of the ADF&G statistical area that coincides with 1,000 m bathymetry.

Example FMP 4.2 Map

The map for example FMP 4.2 (Figure 4.2-7) illustrates a management plan that completely closes the EEZ to groundfish fishing until such time that NPFMC and NOAA Fisheries have reviewed each fishery and determined whether the fishery will result in any significant adverse impacts on the physical or biological environment. The process of review, certification, and development of fishery-specific regulations could take up to two years, at which time those fisheries authorized to harvest groundfish would be permitted. This map would then change for those fisheries, with certain areas opening to them. Some fisheries may never receive authorization. As fisheries are authorized, their fishery-specific maps would begin to look similar to the example FMP 4.1 map illustrations, depending on the fishery (Table 4.2-9).

For purposes of this programmatic analysis, the map for example FMP 4.2 provides an opportunity to estimate the economic and social value of the commercial groundfish fisheries and realize the impact of a temporary suspension of groundfish fishing. Such a management plan serves as a useful bookend for comparing this example FMP scenario with example FMP 4.1, which illustrates a significantly reduced fishery in lieu of total suspension.

Example FMP PA.1

The map for example FMP PA.1 (Figure 4.2-8) is identical to the map for example FMP 3.1.

Example FMP PA.2

The map for example FMP PA.2 (Figure 4.2-9) is identical to the map for example FMP 3.2.

4.3 Overview of Fishery Management Plan Components and Qualitative Analysis Papers

As introduced in Section 4.1, each of the 11 FMP components in the analytical framework is analyzed in relative isolation of other components. The analysis is intended to provide insight into the range of management tools and measures that can be used to address individual or multiple policy objectives, as well as to address the specific management measures that are included in the example FMPs. Each FMP component paper presents an illustration of how the measures could work and what the environmental consequences would be, based on a review of the scientific literature and past management experience in Alaska and elsewhere. These qualitative analysis papers serve to describe the historical use of the component and provide details on the impacts of the measures themselves. Because each FMP component is analyzed in isolation of the others, however, the papers by themselves do not predict impacts at the alternative level, as they do not take into account the accumulated changes (for example, Steller sea lion protection measures are applied in combination with the creation of MPAs or the reduction in catch limits). The alternatives as a whole are analyzed later in this chapter.

This section contains the abstracts of the 11 qualitative analysis papers prepared for each of the FMP components in the analytical framework. The full text of the papers can be found in Appendix F.

4.3.1 The Total Allowable Catch-Setting Process

The different policy alternatives bear numerous implications for the annual process of setting TAC for the groundfish fisheries. The qualitative analysis paper examines how various constraints on harvest compare between the alternatives. Five aspects of the TAC-setting process are reviewed: 1) the structure and composition of groundfish management categories such as target fish; 2) the setting of OFLs and ABC; 3) the setting of OY and TAC; 4) the MSST required by the National Standards Guidelines for implementing National Standard 1 of the MSA, but which is not currently operative for certain groundfish fisheries in the BSAI and GOA; and 5) the ecosystem implications of the TAC-setting process. Under Alternative 1, existing constraints would be retained in their present configuration. The more aggressive harvest strategies proposed under Alternative 2 could lead to the relaxing of certain constraints. Conversely, the increasingly precautionary and risk-averse policies of Alternatives 3 and 4 would lead to a tightening of those constraints. For further detail on this FMP component and its likely environmental consequences, see Appendix F-1.

4.3.2 Spatial/Temporal Management of Total Allowable Catch

The times at which the groundfish fisheries may be open to allow fishing, and the areas that may be fished provide crucial variables for fisheries managers, who allocate the TACs by spatial/temporal determinations appropriate to various biological, environmental, and economic concerns. This qualitative analysis paper provides a broad overview of the current rationale for spatial/temporal management of the target fish TACs and examines how the measures identified in the alternatives and their FMP bookends would impact the spatial/temporal management of the target groundfish TACs. Potential changes would occur under Alternatives 3 and 4, where measures would be taken to manage all species on smaller spatial/temporal scales. For further detail on this FMP component and its likely environmental consequences, see Appendix F-2.

4.3.3 Marine Protected Areas and Essential Fish Habitat

Protection of marine habitats is an integral component of the groundfish FMPs for the BSAI and GOA. This qualitative analysis paper provides a review of proposed closure areas under the four policy alternatives and their direct/indirect effects on EFH and other aspects of the biological, physical, social, and economic environments. Beyond the continuation of the present risk-averse policy under Alternative 1, the more aggressive harvest policy of Alternative 2 assumes that present policy is overly conservative and may allow the opening of certain areas presently closed with the exception of Steller Sea Lion Protection Measures. Alternatives 3 and 4 represent increasingly risk-averse policies that would increase habitat protections and reduce fisheries impacts on habitat. For further detail on this FMP component and its likely environmental consequences, see Appendix F-3.

4.3.4 Steller Sea Lion Measures

Protection of Steller sea lions from potentially adverse impacts by the BSAI and GOA groundfish fisheries has been a component of the FMPs since 1990, when Steller sea lions were listed under the ESA. After a review of background information available on the decline of Steller sea lions and hypotheses for the decline, this qualitative analysis paper describes the current protection measures in place and evaluates the qualitative impacts of the four alternatives, as represented by their respective FMP bookends, on Steller sea lions. The present Steller sea lion protection measures, described in Alternative 1, are also included in the policies of Alternatives 2 and 3. Alternative 2, however, proposes a less precautionary approach that views additional regulatory safeguards as unwarranted. Alternative 3 assumes a greater impact on a number of environmental factors and consequently places more emphasis on research and on improving monitoring and enforcement of fishing restrictions within Steller sea lion critical habitat. Alternative 4 substantially increases protections for Steller sea lions by providing for a more conservative, risk-averse approach than the first three alternatives. Under Alternative 4, uncertainty about impacts and the shifting of the burden of proof would lead to significant reductions in current TACs and the establishment of larger buffer zones to further separate the groundfish fisheries from Steller sea lion critical habitat. The NPFMC could choose to suspend all fishing entirely until each fishery could be reviewed and certified as resulting in no significant adverse impacts. Certified fisheries would be subjected to more scrupulous monitoring and enforcement to ensure compliance with restrictions. A key component of all four alternatives is the requirement to remain in compliance with the ESA, and any changes that substantially alter the underlying requirements would require further Section 7 consultations under ESA. For further detail on this FMP component or its likely environmental consequences, see Appendix F-4.

4.3.5 Bycatch and Incidental Catch Restrictions

Bycatch is defined in the MSA as fish that are harvested in a fishery, but which are not sold or kept for personal use. This includes the portion of catch that is discarded back into the sea, and unobserved mortality due to a direct encounter with fishing gear that does not result in the capture of that species by a fisherman. The latter includes mortality due to lost or discarded fishing gear, as well as dropoff and escapement mortality. Discards include species that must be returned to the sea by law (known as regulatory discards), and fish that are discarded at the discretion of the fisherman because they are not worth keeping (know as economic discards). This qualitative analysis paper provides a broad overview of the different bycatch species and the four proposed policy alternatives as they pertain to the regulation of bycatch in the groundfish fisheries of the BSAI and GOA. Beyond the status quo policy of Alternative 1, the more aggressive harvest strategies of Alternative 2 could remove some of the current protections for some bycatch species. Conversely, added protections under Alternatives 3 and 4 would increase protection for at-risk bycatch species. The more restrictive bycatch limitations proposed under Alternatives 3 and 4 could place greater economic burdens on the groundfish industry. The rationalization and bycatch reduction incentive programs included in FMP 3.2 would tend to decrease the cost and increase the benefit of reducing bycatch for individual fishing operations. This would make further reductions in bycatch practicable, address the source of the problem of excess bycatch, and decrease the need for less efficient command and control solutions to the bycatch problems. For further detail on this FMP component and its likely environmental consequences, see Appendix F-5.

4.3.6 Seabird Measures

More than 70 species of seabirds occur over waters off Alaska and could potentially be affected by direct and indirect interactions with the federal groundfish fisheries off Alaska. This qualitative analysis paper compares the four policy alternatives and their respective FMP bookends specifically in regard to those management measures designed to protect seabirds. The four alternatives cover a wide range of possibilities for the evolution of seabird protection measures. Alternative 2 would require the minimum protection necessary to comply with the ESA concerning listed seabird species. Alternative 3 would place more emphasis on reducing incidental takes of all species of seabirds by improving seabird deterrent devices and avoidance techniques. Alternative 3 would also expand the Observer Program to improve the quality and amount of data collected on seabirds. Alternative 4 would seek to reduce incidental seabird take to levels approaching zero, in large part through the reduction in fishing effort until respective fisheries can be certified as having no adverse environmental impact. For further detail on this FMP component and its likely environmental consequences, see Appendix F-6.

4.3.7 Gear Restrictions and Allocations

Allocation of fishing privileges among users of different gear types is an important tool for managing the groundfish fisheries to achieve a number of biological and socioeconomic objectives. This qualitative analysis paper discusses current and proposed gear restrictions and allocations in the BSAI and GOA groundfish fisheries. The paper begins by identifying various types of management tools used to address allocation issues or implement allocation decisions, focusing particularly on gear restrictions. The paper then describes recent trends in the application of such allocation measures in the Alaska groundfish fisheries and concludes with a qualitative comparison of the impacts of the alternatives on gear restrictions. Alternative 1 would maintain current gear restrictions and allocations in the Alaska groundfish fisheries, as would FMP bookends 2.2 under Alternative 2 and 3.1 under Alternative 3. Example FMP 2.1, however, would eliminate all trawl and fixed gear restrictions, as well as trawl closure areas, with the exception of those closures implemented to protect Steller sea lions. The remaining, increasingly restrictive FMP bookends (example FMPs 3.2, 4.1, and 4.2) place greater prohibitions on the use of non-pelagic bottom trawl gear to harvest pollock in the GOA (example FMP 3.2); prohibit trawling in all fisheries that can be prosecuted with other gear types (example FMP 4.1); and prohibit all fishing for groundfish in the EEZ off Alaska (example FMP 4.2). For further detail on this FMP component and its likely environmental consequences, see Appendix F-7.

4.3.8 Overcapacity

Fishing capacity is the ability of a vessel or fleet of vessels to catch fish. Overcapacity occurs in an open access or regulated open access fishery where the race for fish induces fishermen to put increasingly more time, money, and effort into competing with other fishermen to maintain their share of the TAC. This qualitative analysis paper provides a discussion of various management systems for limiting effort and reducing excess capacity under the four policy alternatives. Alternative 1 would retain present effort limitation programs, such as the sablefish IFQ Program. Under the more aggressive harvest strategies of Alternative 2, such programs would be repealed with the exception of effort limitation measures under the AFA. The increasingly risk-averse policies represented by Alternatives 3 and 4 would either maintain or augment existing effort limitations programs. The paper speculates, however, that the extremely risk-averse policy of example FMP 4.2 would lead to extreme conditions of overcapacity. For further detail on this FMP component and its likely environmental consequences, see Appendix F-8.

4.3.9 Alaska Native Issues

Marine resources have always been an important part of the lives of Alaska Natives, both as subsistence resources and as integral parts of their different cultures. Consequently, changes in fisheries management policy proposed under the alternatives would have socioeconomic impacts on Alaska Natives. This qualitative analysis paper offers an analysis of those potential impacts, as well as the impacts that Alaska Natives themselves may have on management of the fisheries. Alaska Natives contribute to management through representation on the NPFMC and its Advisory Panel, through input into the decision-making process, and through the integration of local and Traditional Knowledge into scientific understanding of the resources and their environment. After reviewing issues of representation and input implicated by the alternatives, this paper proceeds to review impacts the alternatives may have on subsistence issues and concomitant concerns in regard to Environmental Justice for Alaska Natives. Measures contained in the FMP bookends for Alternatives 2 and 4 that would restrict or repeal the CDQ program or proscribe subsistence fishing would result in significant adverse impacts on the Native communities that rely on such fisheries. For further detail on this FMP component and its likely environmental consequences, see Appendix F-9.

4.3.10 The Observer Program

The North Pacific Groundfish Observer Program collects, maintains, and distributes data for the fisheries scientists and managers who must rely on such data to fulfill their responsibilities under the MSA. This qualitative analysis paper provides a description of the administration and operations of the Observer Program in detail and a qualitative discussion of the need for and impact on observer coverage under each of the four policy alternatives. The most drastic impacts would occur under Alternative 2. Example FMP 2.2 would leave the Observer Program essentially the same as at present, and example FMP 2.1 would virtually eliminate the Observer Program and its data collection activities. With the exception of AFA and CDQ pollock and crab fisheries, all other fisheries would cease to be monitored by observers, and the amount of data available for inseason management, as well as for scientific investigation, would be drastically reduced. Under the increasingly risk-averse policies of Alternatives 3 and 4, the Observer Program would either remain basically the same as at present (example FMP 3.1) or be modified to allow for increased observer coverage and data-collection (example FMPs 3.2, 4.1, and 4.2). For further detail on this FMP component and its likely environmental consequences, see Appendix F-10.

4.3.11 Data and Reporting Requirements

The MSA states that the collection of reliable data is essential to the effective conservation, management, and scientific understanding of the fishery resources of the United States. This qualitative analysis paper examines the effects of alternative approaches to data collection in the Alaska groundfish fisheries, focusing on the information collected from industry reporting requirements and VMS requirements for the groundfish fisheries. Alternative 1 and example FMP 2.2 would retain current reporting requirements. Example FMP 2.1 would eliminate measures requiring use of VMS and at-sea weighing of catch, except by catcher processors operating under the AFA. At present, the economic data collected on a routine basis are insufficient for a comprehensive regulatory analysis, and Alternatives 3 and 4 would create measures for the collection of economic data sufficient to give fishery managers a better understanding of socioeconomic issues. Alternatives 3 and 4 would also retain, expand, and improve upon existing reporting requirements. Example FMP 4.2, while it would effectively eliminate the need for reporting requirements, would create fishery-specific data-collection measures for those fisheries authorized to occur. For further detail on this FMP component and its likely environmental consequences, see Appendix F-11.

4.4 Summary of the Comparative Baseline

Chapter 3 of this document contains a comprehensive assessment of the human (physical, biological, and socioeconomic) environment potentially affected by the Alaska groundfish fisheries. For each of the resource categories used to analyze the impacts of the alternatives in this document, a comparative baseline has been developed. The baseline incorporates the state of the resource at a given point in time. In general, the baseline year is 2002 for physical and biological resources, and 2001 for socioeconomics. It is used to analyze the impacts of the alternatives.

The baseline does not represent a static 'snapshot' of the resource. Instead, it represents the trend of the resource, incorporating the past history of influences on the resource. The cumulative past effects of groundfish fishery activity, as well as effects external to the groundfish fishery such as other fishery impacts, human-induced impacts, and climatic events influencing the resource, all contribute to the state of the baseline condition.

In the table below, only those resource categories that were brought forward for alternatives impacts analysis are included. Some resource categories were identified in Chapter 3 as having in the past been impacted by the groundfish fisheries, but that interaction no longer occurs. More information on each resource category and the derivation of the baseline condition, can be accessed in the relevant section of Chapter 3.

The following is a list of tables containing information on resource categories and components:

Table number	Resource category	Components	Chapter 3 reference
4.4-1	Target groundfish species	Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) walleye pollock, BSAI and GOA Pacific cod, BSAI and GOA sablefish, BSAI and GOA Atka mackerel, BSAI yellowfin sole, GOA shallow water flatfish, BSAI rock sole, BSAI and GOA flathead sole, BSAI and GOA arrowtooth flounder, BSAI Greenland turbot, GOA deepwater flatfish, BSAI Alaska plaice, BSAI other flatfish, GOA rex sole, BSAI and GOA Pacific ocean perch, GOA thornyhead rockfish, BSAI and GOA northern rockfish, BSAI and GOA shortraker/rougheye rockfish, BSAI other rockfish, GOA slope rockfish, GOA pelagic shelf rockfish, GOA demersal shelf rockfish	3.5.1
4.4-2	Prohibited species	Pacific halibut, Pacific salmon and steelhead trout, Pacific herring, crab	3.5.2
4.4-3	Other species, forage fish species, non-specified species	Other species category Forage fish category Grenadier	3.5.3, 3.5.4, 3.5.5
4.4-4	Habitat	BSAI, GOA	3.6
4.4-5	Seabirds	Black-footed albatross, Laysan albatross, short-tailed albatross, northern fulmar, shearwaters, storm-petrels, cormorants, spectacled eider, Steller's eider, jaegers, gulls, kittiwakes, terns, murres, guillemots, murrelets, auklets, puffins	3.7

Table number	Resource category	Components	Chapter 3 reference
4.4-6	Marine mammals	Steller sea lion, northern fur seal, Pacific walrus, harbor seal, spotted seal, bearded seal, ringed seal, ribbon seal, northern elephant, sea otter, blue whale, fin whale, sei whale, minke whale, humpback whale, gray whale, northern right whale, bowhead whale, sperm whale, beaked whales (Baird's, Cuvier's and Stejneger's), Pacific white-sided dolphin, killer whale, beluga whale, harbor porpoise, Dall's porpoise	3.8
4.4-7	Socioeconomics	Harvesting and processing Sector (catcher vessels [CVs], catcher processors [CPs], Inshore processors and motherships) Regional socioeconomic profiles (population, processing ownership and activity, CV ownership and activity, tax revenue, employment and income) Community development quota (CDQ) allocations Subsistence (subsistence use of groundfish, subsistence use of Steller sea lions, salmon subsistence fisheries, indirect subsistence factors: income and joint production) Environmental justice Market channels and benefits to United States consumers (product quantity, product year-round availability, product quality, product diversity) Non-market goods (benefits derived from marine ecosystems and associated species)	3.9.2 3.9.3 3.9.4 3.9.5 3.9.6 3.9.7 3.9.8
4.4-8	Ecosystem	Forage fish availability, spatial/temporal concentration of fisheries, introduction of non-native species, removal of top predators, energy redirection, energy removal, species diversity, guild diversity, genetic diversity	3.10

4.5 Alternative 1 Analysis

FMP 1 models status quo management, which has the goal of maintaining sustainable fisheries, protecting threatened and endangered species, and protecting, conserving, and restoring living marine resource habitats through existing institutions and processes. This alternative is described in detail in Section 2.6.

4.5.1 Target Groundfish Species Analysis

This section examines the potential direct, indirect, and cumulative effects that the implementation of FMP 1 is expected to have on the target groundfish species. The impact analyses start with the baseline (2002) status of the BSAI and GOA target groundfish stocks described in Section 3.5.1, including past trends that are likely to persist into the foreseeable future. Then, a computer-based analytic model is used to project how specific characteristics of the target groundfish stocks would respond directly and indirectly to management actions under FMP 1. These projections from the model are the predicted direct and indirect effects (impacts) of FMP 1 on the target groundfish stocks. Section 4.1.5 describes the analytic model and explains how it is applied.

The model output for each target groundfish stock is defined in terms of collected data and calculated measures that are standards used by fisheries managers to regulate the number of fish removed from the sea so that the fisheries will be sustainable over the long-term. These data and measures include the fishing mortality rate (F), the overfishing level (OFL), total and spawning biomass levels (B), the minimum stock size threshold (MSST), maximum sustainable yield (MSY), mean age of the stock in years, and the sex ratio of the stock (number of males compared to number of females). As discussed in the following subsections, relevant data are not always available for all stocks. When data gaps prevent application of the model to a specific stock, the projected direct or indirect effect is evaluated as unknown.

Each target groundfish stock is modeled with respect to the following direct and indirect effects:

Direct/Indirect Effects

Fishing Mortality: This is the rate at which the stock is depleted by direct mortality imposed by removing the fish from the sea.

Change in Biomass Level: This is the change over time in the biomass of the stock, as measured in metric tons (mt). Two measures are used: total biomass, which is the estimated biomass of the entire stock, and spawning biomass, which is the estimated biomass of all of the spawning females in the stock.

Spatial/Temporal Concentration of Catch: This is the degree to which the fishery will concentrate in a particular geographic area during a particular period of time each season. This pattern in space and time can affect fishing mortality and can also influence habitat suitability for spawning, rearing, and feeding.

Habitat Suitability: This is the degree to which habitat has the right characteristics to support the target stock at one or more life-history stages (spawning, rearing of juveniles, availability of food at all stages, availability of refuge areas to allow escape from predators at all stages). Habitat suitability can be affected directly, for example by mechanical damage from bottom trawling, or influenced indirectly, for example by the gradual depletion of corals that provide hard substrate.

Prey Availability: This is the extent to which prey species are present in the environment and available as food to the target stock. Like habitat suitability, this measure can be affected directly, for example by the direct removal of prey species by the fishery, or indirectly, for example by a change in the structure of the food web.

To determine their probable significance, the projected direct and indirect effects in each of the impact categories listed above are evaluated against significance criteria. The criteria are designed to be relevant and meaningful in terms of the target groundfish stocks. Each significance criterion includes a threshold value above (or below) which the projected effect would be considered significant. Each criterion also includes a definition of what would constitute a beneficial (positive, +) or adverse (negative, -) effect. The possible evaluations are significant and beneficial (S+), insignificant (I), significant and adverse (S-), and unknown (U). Evaluations of conditionally significant (CS + or -) are not made for projected direct and indirect effects on target groundfish species, because the model can show only whether the significance threshold is or is not exceeded. The significance criteria used for the target groundfish stocks are presented in Appendix A, Table 4.1-1.

Each of the following subsections presents the model results and rationale for the expected direct and indirect effects of FMP 1 on the target groundfish stocks. The significance ratings for these potential direct and indirect effects are presented in Appendix A, Table 4.5-83. Following the direct and indirect effects discussions on each stock, the expected cumulative effects on that stock are evaluated and discussed. The evaluation of potential cumulative effects builds on the direct and indirect effects evaluations as a starting point, and then brings in persistent past effects as well as reasonably foreseeable future natural events and human activities external to fisheries management. The cumulative effects assessment method uses the same impact categories and significance criteria discussed above for direct and indirect effects. This method is described further in Section 4.1.4.

4.5.1.1 Pollock

Numerous fishery management actions have been implemented that affect the pollock fisheries in the EBS and GOA. These actions are described in more detail in Sections 3.5.1.1 and 3.5.1.15 of this Programmatic SEIS. Pollock is managed as separate stocks in the BSAI and GOA, and falls under Tier 1 in both the BSAI and GOA groundfish FMPs.

Direct/Indirect Effects of FMP 1

The following discussions describe the analysis of potential direct and indirect impacts of FMP 1 on EBS and GOA pollock. As summarized in Table 4.5-83, all direct and indirect effects of FMP 1 on pollock are expected to be insignificant, as defined by the criteria in Table 4.1-1.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase by about 30 percent and average 0.228 for the period 2003-2007 (Table H.4-1 of Appendix H). These values are below the $F_{35\%}$ level of 0.448 and the $F_{40\%}$ level of 0.342, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. This pattern in fishing mortality is due to the fact that the projected catch is expected to come closer to the actual ABC in future years. The proportion of SPR conserved under these mortality rates is 51 percent in 2003, decreasing to 48 percent by 2007; the average implied SPR rate of fishing from 2003-2007 is 49 percent. Fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than one percent under FMP 1 (Table H.4-2 of Appendix H). Because the projected changes are not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis, the effects of FMP 1 on fishing mortality for the EBS pollock stock are considered to be insignificant.

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.139 in 2003 followed by increases to 0.209 by 2007. The values for $F_{35\%}$ and $F_{40\%}$ are 0.350 and 0.294, respectively. The SPR rate in 2002 is estimated at 55 percent and averages about 56 percent for the period 2003-2007. This F pattern is due to the fact that under this FMP, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$. Model projections for GOA fishing mortality are shown in Table H.4-23 of Appendix H. Because they are not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis, these changes in fishing mortality levels for GOA pollock are considered to be insignificant.

Change in Biomass Level

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H. Under FMP 1, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.3 million mt in 2004, then stabilize to about 11.6 million mt. The 2003-2007 average total biomass is projected to be 11.5 million mt. The direct effects of FMP 1 are considered insignificant, because the biomass levels estimated for 2003-2007 are expected to be above the biomass proxy value necessary to sustain maximum sustainable yield (B_{MSY}) and thus maintain the ability of the EBS stock to sustain itself above the MSST.

In the Aleutian Islands region, the assessments are based on trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Given that under FMP 1 there is no directed fishing for pollock in this region (the exploitation level is quite low, less than 1 percent), the expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof Island pollock stock. For this reason, the direct effect of FMP 1 on the total biomass of the Aleutian Islands and Bogoslof Island pollock stocks is expected to be insignificant.

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,210,000 mt by 2007. The average biomass over this period is expected to be 1,030,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels. Model projections of future total GOA pollock biomass are shown in Table H.4-23 of Appendix H. The predicted direct effects of FMP 1 on GOA total pollock biomass are considered insignificant, because the biomass levels estimated for 2003-2007 are expected to maintain the ability of the GOA stock to sustain itself above the MSST.

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-1 of Appendix H. Under FMP 1, projections indicate that EBS pollock spawning biomass will decrease to about 81 percent of the 2002 level by 2007. The projected average for 2003-2007 is 3.08 million mt. Because this level of decrease in female spawning biomass would not prevent the EBS pollock stock from sustaining itself at or above the MSST, the direct effect of FMP 1 on EBS pollock spawning biomass is considered to be insignificant.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Since under FMP 1 these areas are kept at bycatch-only levels, we expect the spawning stock size to remain stable or increase in these regions. For this reason, the direct effect of FMP 1 on the spawning biomass of these stocks is expected to be insignificant.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 228,000 mt by 2007 under FMP 1. This is above the estimated B_{MSY} level of 210,000 mt although the average from 2003-2007 is 183,000 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H. Because the estimated increase in female spawning biomass is expected to maintain the ability of the GOA pollock stock to sustain itself above the MSST, this effect is considered to be insignificant.

Spatial/Temporal Concentration of Catch

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (January 20-March). Under FMP 1, an average of 1.4 million mt of EBS pollock is projected to be harvested annually from 2003-2007. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period. Because the spatial/temporal concentration of the catch under FMP 1 would not change notably from existing conditions, there is no evidence to suggest that harvest concentrations would be sufficient to alter genetic sub-populations or reproductive success in ways that affect the ability of the EBS pollock stock to sustain itself at or above the MSST. Therefore, this potential effect is considered to be insignificant.

Under FMP 1, an average of 87,300 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 133,000 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery may change from the 2002 pattern. However, there is no indication that under FMP 1, harvest concentrations would change sufficiently to alter genetic sub-populations or reproductive success in ways that affect the ability of the GOA pollock stock to sustain itself at or above the MSST. Therefore, the direct effect of FMP 1 on the spatial and temporal concentration of the catch is expected to be insignificant relative to baseline conditions.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Given the similarity of FMP 1 to the status quo, however, it is unlikely that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success sufficient to jeopardize the ability of the stocks to sustain themselves at or above the MSST. Therefore, the direct and indirect effects of FMP 1 on EBS and GOA pollock habitat suitability are expected to be insignificant.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. Because of its similarity to the status quo, however, it is unlikely that FMP 1 would introduce changes in predator-prey interactions sufficient to affect the ability of pollock stocks to maintain themselves at or above the MSST. Therefore, the direct and indirect effects of FMP 1 on EBS and GOA pollock prey availability are expected to be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on Pollock

The impact assessments discussed above indicate that the direct and indirect effects of FMP 1 on BSAI and GOA pollock would be insignificant for all of the effects categories (see Appendix A, Table 4.5-83). In addition, the fact that pollock would be fished at less than the OFL and above the MSST provides a separate rationale for considering the direct and indirect effects under FMP 1 to be insignificant. Fishing rates under this FMP would be well within accepted scientific standards, based on studies of population dynamics and estimates of natural variations in recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity. Based on extended 20-year projections (with the same model assumptions as used in the base 2003-2007 period), both the EBS and GOA pollock are expected to stabilize with catches lower than the expected long-term F_{ABC} catch levels and Bs above the B_{MSY} levels.

Status Determination from Modeling

Modeling projections for 2003-2007 indicate that under FMP 1, the future status of EBS and GOA pollock stocks would be as follows for key indicators.

Stock Size Relative to MSST

Under FMP 1, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For FMP 1, GOA pollock spawning biomass is below the B_{MSY} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007.

Age and Size Composition

Under FMP 1, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.53 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.00 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15). Model projections of EBS and GOA pollock age and size compositions are shown in Tables H.4-1 and H.4-23 of Appendix H.

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock are assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio would be affected under FMP 1.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are shown in Tables 4.5-1 and 4.5-2. For further information regarding persistent past effects listed below in the text and in the tables, see Sections 3.5.1.1 and 3.5.1.15.

EBS Pollock

Mortality

- **Direct/Indirect Effects**. As described above under direct/indirect effects, the effect of fishing mortality on the EBS pollock stock is insignificant under FMP 1.

- **Persistent Past Effects.** The past effects of the foreign, Joint Venture (JV), and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the BSAI pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Removals of pollock occur in the Russian pollock fishery, and the catch is not accounted for in the annual harvest rates set for the U.S. fishery. Therefore, the removals can be considered a potential adverse effect on fishing mortality. Catch and bycatch of pollock in the State of Alaska pollock fisheries are not contributing factors since catch is accounted for. Marine pollution is also identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** The cumulative effects under FMP 1 is identified for mortality of EBS pollock, but the effect is judged to be insignificant. Pollock are fished at less than the OFL and are above the minimum stock size threshold (MSST). The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** As described above in Section 4.5.1.1, change in biomass of the EBS pollock stock is expected to be insignificant under FMP 1.

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the Russian and State of Alaska pollock fisheries. However, the effects of any future removals are expected to be negligible and are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect on the change in biomass is identified; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1, the harvest of EBS pollock will continue to occur mostly along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W longitude during the period (January 20 - March). Under these considerations, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had a beneficial effect on pollock recruitment by reducing the adult pollock biomass, lingering beneficial effects are identified for change in reproductive success. In addition, past commercial whaling and sealing also removed large predators of pollock, adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** The Russian and State of Alaska pollock fisheries have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. On the other hand, removals in these fisheries could have a potential beneficial effect on pollock recruitment by reducing the adult pollock biomass. Cannibalism-related declines in pollock recruitment have been observed at high pollock spawning biomasses (see Section 3.5.1.1). Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see above discussion of direct/indirect effects). However, it is determined that FMP 1 would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Past effects of climate changes and regime shifts on pollock prey species could have potential beneficial or potential adverse effects. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see above discussion of direct/indirect effects). However, it is determined that FMP 1 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects identified for EBS pollock stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.1). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the EBS. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external are possible from the Russian and State of Alaska fisheries, since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock are unknown, although a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, that effect on the EBS pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 1 (see Section 4.5.1.1 Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, State of Alaska, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Catch and bycatch of pollock in the State of Alaska pollock fisheries, and State of Alaska shrimp fisheries, climate changes, and regime shifts are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. However, marine pollution could have a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized.

- **Cumulative Effects.** A cumulative effect under FMP 1 is identified for mortality of GOA pollock, but the effect is judged to be insignificant. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMP 1 (see Section 4.5.1.1).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the State of Alaska pollock fisheries. However, these removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 in the GOA, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.5.1.1 Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** While there are potential adverse effects due to the State of Alaska pollock fisheries, and the State of Alaska shrimp fishery these fisheries are not sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see Section 4.5.1.1 Direct/Indirect Effects discussion). However, it is determined that FMP 1 would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** Lingering population level effects are not expected on these species from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, the effects of the *Exxon Valdez* Oil Spill (EVOS). However, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** As described for BSAI pollock, climate changes and regime shifts could have beneficial or adverse effects depending on water temperature changes. Marine pollution is a potential contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-2 are determined have potential adverse effects due to the removal of prey species as catch and bycatch. However, they are not likely to have population level effects on pollock.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that FMP 1 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stocks include past foreign, JV, State of Alaska, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.1). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska Pollock and Shrimp fisheries, since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock are unknown, although a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, that effect on the EBS pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

4.5.1.2 Pacific Cod

Numerous fishery management actions have been implemented that affect the Pacific cod fisheries in the BSAI and GOA. These actions are described in more detail in Sections 3.5.1.2 and 3.5.1.16 of this Programmatic SEIS. Pacific cod is managed as separate stocks in the BSAI and GOA, both of which are managed under Tier 3a.

Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI and GOA Pacific cod. All direct and indirect effects of FMP 1 on Pacific cod are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The F imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI Fs are shown in Table H.4-3 of Appendix H. Under FMP 1, model projections indicate that BSAI fishing mortality will increase to a value of 0.286 in 2003, decrease to a value of 0.269 in 2005, increase to a value of 0.274 in 2006,and then decrease to a value of 0.267 in 2007, with a 2003-2007 average of 0.275. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the overfishing level for stocks above $B_{40\%}$. The projected changes in the F are considered to be insignificant, because they would not jeopardize the capacity of the stock to produce MSY on a continuing basis.

The F imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA Fs are shown in Table H.4-24 of Appendix H. Under FMP 1, model projections indicate that GOA fishing mortality is expected to decrease steadily to a value of 0.204 in 2007, with a 2003-2007 average of 0.211. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the overfishing level for stocks above $B_{40\%}$. These projected changes in the F are also considered to be insignificant, because they would not jeopardize the capacity of the GOA stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-3 of Appendix H. Under FMP 1, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,118,000 mt in 2007, with a 2003-2007 average value of 2,086,000 mt. This projected increase is considered to be insignificant, because it would tend toward a level that would maintain the existing ability of the stock to sustain itself above the MSST.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-24 of Appendix H. Under FMP 1, model projections indicate that total GOA biomass is expected to increase steadily to a value of 713,000 mt in 2007, with a 2003-2007 average value of 645,000 mt. This projected increase is considered to be insignificant, because it would tend toward a level that would maintain the existing ability of the stock to sustain itself above the MSST.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-3 of Appendix H. Under FMP 1, model projections indicate that BSAI spawning biomass is expected to decrease to a value of 403,000 mt in 2003, then increase to a value of 445,000 mt in 2006, then decrease to a value of 443,000 mt in 2007, with a 2003-2007 average value of 430,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007. The projected fluctuations in B are considered to be insignificant, because they would tend toward levels that would maintain the existing ability of the stock to sustain itself above the MSST.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-24 of Appendix H. Under FMP 1, model projections indicate that GOA spawning biomass is expected to decrease to a value of 86,400 mt in 2004, then increase to a value of 98,800 mt in 2007, with a 2003-2007 average value of 91,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007. The projected fluctuations in B are considered to be insignificant, because they would tend toward levels that would maintain the existing ability of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

Under FMP 1, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is problematic for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undertake large migrations, and a high degree of genetic mixing appears to exist. In comparison to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort on Pacific cod are probably diluted to some extent, and also that their evaluation involves a larger number of difficult-to-estimate parameters. However, there is no indication that under FMP 1, harvest concentrations would change sufficiently to alter genetic sub-populations or reproductive success in ways that affect the ability of the GOA pollock stock to sustain itself at or above the MSST. Therefore, the direct effect of FMP 1 on the spatial and temporal concentration of the catch is expected to be insignificant relative to baseline conditions.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Because fishing practices under FMP 1 would be similar to the status quo, however, it is unlikely that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success sufficient to jeopardize the ability of the stock to sustain itself at or above the

MSST. Therefore, the direct and indirect effects of FMP 1 on Pacific cod habitat suitability are expected to be insignificant.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Because of its similarity to the status quo, however, it seems unlikely that FMP 1 would introduce changes in predator-prey interactions sufficient to affect the ability of the Pacific cod stock to maintain itself at or above the MSST. Therefore, the direct and indirect effects of FMP 1 on prey availability for Pacific cod are expected to be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on Pacific Cod

The criteria used to rate the significance of impacts of FMP 1 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks and are described in Appendix A, Table 4.1-1. Appendix A, Table 4.5-83 summarizes the expected effects of FMP 1 on Pacific cod. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects in this analysis, because the analytic model yields projections that can be classified only as significant (beneficial or adverse), insignificant, or unknown.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 1 on fishing mortality and biomass is rated as insignificant, because the projection model indicates that fishing mortality would be less than the overfishing level and that biomass would be above the MSST throughout the period 2003-2007.

Because the existing spatial/temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially affect either stock's ability to maintain itself at or above the MSST, and because the impacts of spatial/temporal concentration on genetic structure under FMP 1 are expected to be no greater than those of the existing concentration, the magnitude of this effect is rated as insignificant for both stocks.

Similarly, because the existing spatial/temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially affect either stock's ability to maintain itself at or above the MSST, and because the impacts of spatial/temporal concentration on reproductive success under FMP 1 are expected to be no greater than those of the existing concentration, the magnitude of this effect is rated as insignificant for both stocks.

Because the existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially affect either stock's ability to maintain itself at or above the MSST, and because the level of groundfish harvest under FMP 1 is expected to be no greater than the existing level, the magnitude of this effect is rated as insignificant for both stocks.

Finally, because the existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success in the BSAI or GOA Pacific cod populations that materially affect either stock's ability to maintain itself at or above the MSST, and because the level of habitat disturbance under FMP 1 is expected to be no greater than the existing level, the magnitude of this effect is rated as insignificant for both stocks.

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: neither stock is overfished, the biomass of each stock is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 1, both stocks are projected to remain above MSST throughout the period 2003-2007; the biomass of the BSAI stock is projected to be above $B_{40\%}$ throughout the period 2003-2007 while the biomass of the GOA stock is projected to be below $B_{40\%}$ in 2003-2005, the biomass of each stock is expected to show an overall increase during the period 2003-2007 and beyond, and all catch and bycatch would continue to be accounted for in the management of both stocks.

Status Determination from Modeling

Modeling projections for 2003-2007 suggest that under FMP 1, the future status of the BSAI and GOA Pacific cod stocks would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI and GOA Pacific cod are below their respective overfishing levels in all years under FMP 1 (Tables H.4-3 and H.4-24 of Appendix H). The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007.

Age and Size Composition

Under FMP 1, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 1, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are depicted on Tables 4.5-3 and 4.5-4. For further information regarding persistent past effects listed below in the text and in the tables, see the past/present effects analysis section of Sections 3.5.1.2 and 3.5.1.16.

BSAI Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and Pacific cod stock is insignificant under FMP 1 (see the direct/indirect discussion above).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see above).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the International Pacific Halibut Commission (IPHC) longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 1 is identified for mortality of BSAI Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** As described in Section 4.5.1.2 direct/indirect effects, change in biomass of the BSAI Pacific cod stock is expected to be insignificant under FMP 1.

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries and bycatch and removals in the subsistence/ personal use fishery in the BSAI. However, these removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population. Pacific cod are migratory species and a large degree of genetic mixing appears to exist. This likely means that the spatial/temporal concentration of fishing effort is diluted to some extent.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, and subsistence use in the BSAI, have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that FMP 1 would have insignificant effects on Pacific cod prey availability (see the direct/indirect effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific cod prey species are unknown; however, a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown in Table 4.5-3 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effects are insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see above). Because the level of habitat disturbance under FMP 1 is expected to be no greater than the existing level, the effect is rated as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod stock include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline fishery, and climate changes and regime shifts (see Section 3.5.1.2). Previous Pacific cod fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stock are unknown, although a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, the combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST.

GOA Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stock is insignificant under FMP 1 (see direct/indirect effects discussion above).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stock. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see persistent past effects above).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries in the GOA, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 1 is identified for mortality of GOA Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stock is expected to be insignificant under FMP 1 (see Section 4.5.1.2 direct/indirect effects discussion).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery, and in the State of Alaska groundfish fisheries. However, these removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population. Pacific cod are migratory species and a large degree of genetic mixing appears to exist. This likely means that the spatial/temporal concentration of fishing effort is diluted to some extent.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment particularly in the GOA where the state groundfish fishery is very localized, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, subsistence use, and State of Alaska groundfish fisheries have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that FMP 1 would have insignificant effects on Pacific cod prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific cod prey species are unknown; however, a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-4 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see Section 4.5.1.2 direct/indirect effects discussion above). Because the level of habitat disturbance under FMP 1 is expected to be no greater than the existing level, the effect is rated as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline fishery, and climate changes and regime shifts (see Section 3.5.1.2). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA Pacific cod stock are unknown, although a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, the combination of internal and external impacts on habitat is not expected to jeopardize the ability of the Pacific cod stock to sustain itself at or above MSST.

4.5.1.3 Sablefish

This section provides the direct, indirect, and cumulative effects analyses for sablefish under FMP 1. Sablefish are managed as one stock in the BSAI and GOA under Tier 3b; therefore, BSAI and GOA areas are discussed together in this section.

Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on sablefish. All direct and indirect effects of FMP 1 on sablefish are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1. Sections 3.5.1.3 and 3.5.1.17 provide additional information on the past/present effects analysis for BSAI and GOA sablefish.

Fishing Mortality

Under FMP 1, the fishing mortalities imposed on the sablefish stock are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL. Model projections of future BSAI and GOA fishing mortalities are shown in Tables H.4-11 and H.4-30 of Appendix H. The projected changes in the F are considered to be insignificant, because they would not jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

FMP 1 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. FMP 1 assumptions are intended to replicate baseline conditions, in which biomass tends toward levels that maintain the ability of the BSAI and GOA sablefish stocks to sustain themselves above the MSST. Total biomass increases from 2002-2007 under FMP 1 because long-term average recruitment (1977-present) is used to project biomass and is higher than most of the recent recruitments. Model projections of future BSAI and GOA total biomasses are shown in Tables H.4-11 and H.4-30 of Appendix H.

Spawning Biomass

FMP 1 is projected to have an insignificant impact on spawning biomass compared to the baseline. FMP 1 assumptions are intended to replicate baseline conditions, in which biomass tends toward levels that maintain the ability of the BSAI and GOA sablefish stocks to sustain themselves above the MSST. Spawning biomass decreases from 2002-2007 under FMP 1 because the strong 1997 year-class is decreasing in abundance and is the only strong year-class among recent recruitments.

Spawning biomass is projected to decrease from 2002-2007 while total biomass is projected to increase during the same interval. Total biomass includes ages 2-30+ while spawning biomass includes ages 6.5-30+ (initial age is average age of first spawning for females) so that spawning biomass trends due to changing recruitment lag total biomass trends. Spawning biomass will likely increase for a longer projection. Model projections of future BSAI and GOA spawning biomasses are shown in Tables H.4-11 and H.4-30 of Appendix H.

Spatial/Temporal Concentration of Catch

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. FMP 1 assumptions are intended to replicate baseline conditions.

Habitat Suitability

Because fishing practices under FMP 1 would be similar baseline conditions, it is unlikely that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success sufficient to jeopardize the ability of the BSAI and GOA sablefish stocks to sustain themselves at or above the MSST. Therefore, the direct and indirect effects of FMP 1 on sablefish habitat suitability are expected to be insignificant.

Prey Availability

It is unlikely that FMP 1 would introduce changes in predator-prey interactions sufficient to affect the ability of the BSAI and GOA sablefish stocks to maintain themselves at or above the MSST, because status quo fishing practices would continue under this FMP. Therefore, the direct and indirect effects of FMP 1 on prey availability for sablefish are expected to be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on Sablefish

All direct and indirect effects are found to be insignificant for sablefish under FMP 1.

Status Determination from Modeling

Modeling projections for 2003-2007 suggest that under FMP 1, the future status of EBS and GOA sablefish stocks would be as follows for key indicators.

Catch Relative to ABC

FMP 1 is projected to have an insignificant impact on average sablefish yield compared to the baseline. Yields similar to current levels are projected because FMP 1 assumptions are intended to replicate baseline conditions. Under FMP 1, therefore, sablefish would not be overfished or approach an overfished condition.

Age and Size Composition

FMP 1 is projected to have an insignificant impact on sablefish mean age relative to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

BSAI mean age likely is overestimated. The model assumes that the lower exploitation rate for the BSAI compared to the GOA will translate into greater mean age for the BSAI. However, sablefish migration is substantial enough to erase the effects of differential exploitation rates between the BSAI and GOA. The mean age for the GOA best represents the mean age for the BSAI/GOA because sablefish abundance is much greater for the GOA.

Sex Ratio

The sex ratio of the adult population is 40 males: 60 females, based on sex ratio data collected during sablefish longline surveys. This FMP probably would have no significant effect on the sex ratio relative to the baseline.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are shown in Table 4.5-5.

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 1 (see Section 4.5.1.3 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska groundfish fisheries are identified for sablefish. Large removals of sablefish occurred, particularly in the JV, and domestic fisheries. Catches that were under-reported during the late 1980s may have contributed to abundance declines in the 1990s. (see Section 3.5.1.3).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of sablefish are predicted to continue in the IPHC longline and State of Alaska groundfish fisheries, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels and do not add additional fishing mortality. Due the highly migratory nature, Canadian fisheries fishing within Canadian waters could be harvesting sablefish considered to be part of the GOA population. These removals are not accounted for in the TAC setting process and can be considered as having a potential adverse contribution to the cumulative case. Likewise, marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality sufficient to jeopardize the capacity of the stock to produce MSY on a continuing basis. Climate changes and regime shifts are not identified as being contributors to direct sablefish mortality.

- **Cumulative Effects.** A cumulative effect under FMP 1 is identified for mortality of sablefish, but the effect is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be insignificant under FMP 1 (see Section 4.5.1.3 direct/indirect Effects discussion).

- **Persistent Past Effects.** While past large removals of sablefish and other past effects on biomass have been identified (see Section 3.5.1.3), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to catch and bycatch in the IPHC longline and State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to sablefish mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect on the change in biomass is identified; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the sablefish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population. Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. FMP 1 assumptions are intended to replicate baseline conditions.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure or reproductive success. While spatial/temporal concentration of catch occurred in the state directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Section 3.5.1.3).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline, State of Alaska groundfish, and Canadian fisheries all have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population or affect recruitment. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish prey availability.

- **Persistent Past Effects.** While lingering population level effects from catch and bycatch of sablefish prey species in past foreign and domestic and state fisheries are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on sablefish prey species (see Section 3.5.1.3).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on sablefish prey species are unknown; however, a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Section 3.5.1.3). Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-5 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the sablefish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish habitat suitability.

- **Persistent Past Effects.** Past effects identified for sablefish include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline fishery, and climate changes and regime shifts (see Section 3.5.1.3). Past fishing for sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the sablefish stock are unknown, although a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, those effects on the sablefish stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is jeopardized.

4.5.1.4 Atka Mackerel

Numerous fishery management actions have been implemented that affect the Atka mackerel fisheries in the BSAI and GOA. These actions are described in more detail in Sections 3.5.1.4 and 3.5.1.18 of this Programmatic SEIS. Atka mackerel is managed as separate stocks in the BSAI and GOA; in the BSAI it falls under Tier 3a of the ABC and OFL definitions. However, in the GOA this target species is managed under Tier 6.

Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI and GOA Atka mackerel. All direct and indirect effects of FMP 1 on BSAI Atka mackerel are expected to be insignificant. The potential effects on the GOA stock are unknown. Significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Model projections of future BSAI Atka mackerel catch and biomass levels under FMP 1 assume the maximum permissible F according to Amendment 56 ABC/OFL definitions. Currently, BSAI Atka mackerel are harvested at a more conservative rate than the maximum allowable, but the rates have varied as set by the NPFMC. Given the difficulty in predicting the future ABC levels to be set by the NPFMC, the projections assume the default Amendment 56 values. Therefore, under FMP 1, projections may suggest higher than expected catches and lower than expected biomass levels, at least in the very short-term.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown. Age-structured models were not available for evaluation of impacts for the GOA; therefore, model projections of future biomass levels were not produced.

<u>Fishing Mortality</u>

The average expected yield for BSAI Atka mackerel during the period 2003-2007 is 62,700 mt (Table H.4-17 of Appendix H). The catch and ABC values, which are nearly equivalent in the projections, are expected to decrease through 2006. The average fishing mortality imposed on the BSAI Atka mackerel stock in 2002 is 0.251. Model projections show this value will increase to 0.436 in 2004, then decrease in 2005 and increase to 0.401 in 2007. Overall, the projections show a 60 percent increase in the average fishing mortality from 2002 to 2007. These values are well below the F_{MSY} proxy ($F_{35\%}$) value of 0.564, which is the rate associated with the OFL. Therefore, the projected Fs for BSAI Atka mackerel under FMP 1 are considered to be insignificant, because they would not jeopardize the capacity of the stocks to produce MSY on a continuing basis.

The current GOA ABC and TAC level is 600 mt. This low level of TAC is intended to preclude a directed fishery and only provide for bycatch in other fisheries. This harvest strategy has been applied to GOA Atka mackerel since 1997 as a conservative measure to accommodate the lack of a reliable current estimate of biomass, and to recognize that GOA Atka mackerel may be particularly vulnerable to fishing pressure because of its patchy distribution and sporadic recruitment patterns (Lowe *et al.* 2002).

Projections of GOA Atka mackerel under FMP 1 indicate that catches will likely average 100 mt through 2007 (Table H.4-38 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g. Pacific ocean perch, pollock, northern rockfish, and Pacific cod). Because data on which to establish a reliable current estimate of biomass for GOA Atka mackerel are lacking, the effects of fishing mortality on Atka mackerel under FMP 1 are unknown.

Change in Biomass Level

Total Biomass

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. Under FMP 1, model projections indicate that total BSAI Atka mackerel is expected to decline to a value of 415,000 mt by 2005, then increase to a value of 442,000 mt by 2007, with a 2003-2007 average value of 435,000 mt. Overall, the projections show an 8 percent decrease in total biomass from 2002 to 2007 under FMP 1. This projected decrease is considered to be insignificant, because total Atka mackerel biomass in the BSAI would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. Potential effects of FMP 1 on GOA Atka mackerel total biomass are unknown, because reliable estimates of the current total biomass are not available to support modeling.

Spawning Biomass

Spawning biomass of female BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H. Under FMP 1, model projections indicate that BSAI spawning biomass is expected to decline to a value of 78,500 mt by 2005, then increase to a value of 88,000 mt by 2007, with a 2003-2007 average value of 88,900 mt. Overall, the projections show about a 26 percent decrease in female spawning biomass from 2002 to 2007 under FMP 1. Projected spawning biomass exceeds the B_{MSY} proxy value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007). Although the BSAI Atka mackerel spawning biomass is projected to decline, it would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. Therefore, this potential effect under FMP 1 is considered to be insignificant. Potential effects of FMP 1 on GOA Atka mackerel spawning biomass are unknown, because reliable estimates of the current spawning biomass are not available to support modeling.

Spatial/Temporal Concentration of Catch

Under FMP 1, the current network of spatial/temporal closed areas would remain in place. The closures designated in the Steller sea lion protection measures would probably have the largest impact relative to Atka mackerel.

The directed fishery for Atka mackerel is prosecuted by catcher processor bottom trawlers. The patterns of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring in the same few locations each year, at depths that typically range between 100 and 200 m. The localized pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next since local populations in the Aleutians appear to be replenished by immigration and recruitment. In addition, management measures are in place which have the effect of spreading out the harvest in time and space. The overall BSAI TAC is allocated to three management areas (Western, Central, and Bering Sea/Eastern Aleutians). The regional TACs are further allocated to two seasons, and there are limits to the amount of catch that can be taken inside of Steller sea lion critical habitat. Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, these measures provide protection to Atka mackerel by reducing the risk of localized depletion through effort limitations and reductions. The temporal/spatial concentration of the catch under FMP 1 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Under FMP 1, therefore, the spatial and temporal pattern of catch concentration would have an insignificant effect on BSAI Atka mackerel relative to the baseline.

Because population data are lacking on the GOA Atka mackerel stock, its MSST is unknown. Therefore, the potential effects of the spatial and temporal pattern of catch on this stock under FMP 1 are unknown.

Habitat Suitability

Because Steller sea lion critical habitat overlaps significantly with BSAI Atka mackerel habitat, Steller sea lion protection measures may provide habitat protection for Atka mackerel through effort limitations and reductions. The level of habitat disturbance caused by the fishery under FMP 1 does not appear likely to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Therefore, impacts on habitat suitability for BSAI Atka mackerel would be insignificant under FMP 1. It is not known what effect implementation of FMP 1 would have on habitat suitability for GOA Atka mackerel, although fishing practices would be similar to those under the status quo.

Prey Availability

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. The current levels and distribution of harvest do not appear to affect prey availability in ways that impair the ability of the stock to maintain itself above its MSST. Therefore, it is likely that potential effects of FMP 1 on prey availability for BSAI and GOA Atka mackerel would be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on Atka Mackerel

The criteria used to estimate the significance of potential effects of the FMPs on the BSAI and GOA stocks of Atka mackerel are outlined in Section 4.1.1.1. The expected direct and indirect effects of FMP 1 on BSAI and GOA Atka mackerel are summarized in Appendix A, Table 4.5-83. Potential direct and indirect impacts of FMP 1 on the BSAI and GOA Atka mackerel stocks are rated as either insignificant or unknown. The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis, as the model projections could yield only results that were deemed significant (beneficial or adverse), insignificant, or unknown.

The ratings use the overF (F_{OFL}), the MSST for the fishing mortality effect, and the MSST for all other effects as the bases for evaluating the potential impacts of FMP 1 on Atka mackerel. Because the mean projected BSAI Atka mackerel Fs are below the overF, and the spawning stock is above its MSST in each of the projection years (2003-2007), the fishing mortality effect of FMP 1 is rated as insignificant. As noted above, the spawning stock biomass of BSAI Atka mackerel in each of the projection years (2003-2007) is above $B_{35\%}$ (B_{MSY} proxy), and therefore the BSAI Atka mackerel stock is determined to be above its MSST under FMP 1. For all other direct and indirect effects, it was determined that FMP 1 would not jeopardize the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST, and the effects were accordingly rated as insignificant.

Relative to the comparative baseline under FMP 1, the BSAI Atka mackerel stock is not overfished. Spawning biomass declines through 2005, after which biomass increases. Long-term projections (10- and 20-year projections) of spawning biomass show a very stable trend in biomass after 2007, with levels just above the 2007 level of 88,000 mt.

The F and the MSST for GOA Atka mackerel are unknown, and thus the effect of fishing mortality is unknown under FMP 1. As the MSST cannot be estimated for GOA Atka mackerel, which are in Tier 6, the significance of the spatial/temporal concentration and habitat suitability effects is also unknown under FMP 1. Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 1 will not affect prey availability for BSAI or GOA Atka mackerel, and the potential impact on prey availability is considered to be insignificant.

Relative to the baseline, the GOA Atka mackerel stock under FMP 1 is likely to remain at a low abundance with continued low exploitation as a bycatch fishery only.

Status Determination from Modeling

Modeling projections for 2003-2007 suggest that under FMP 1, the future status of EBS and GOA atka mackerel stocks would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI Atka mackerel are below the overfishing level in all years under FMP 1 (Table H.4-17 of Appendix H). Female spawning biomass in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy). These indicators suggest that the BSAI Atka mackerel stock is not overfished and is above its MSST under FMP 1.

GOA Atka mackerel are in Tier 6, and the MSST is unknown. Therefore, a status determination cannot be made for this stock.

Age and Size Composition

Under FMP 1, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.74 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term, however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the Fs could cause a shift in the age and size compositions.

Because the level of catch of GOA Atka mackerel is very low and projected to remain at the same low level under FMP 1, it is unlikely that the age and size compositions would change in the future under this FMP. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variations in recruitment than by the effects of fishing.

Sex Ratio

A 50:50 sex ratio is assumed for the BSAI Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future under FMP 1. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio and what changes, if any, would occur in the future under FMP 1 are unknown.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are shown in Tables 4.5-6 and 4.5-7. For further information regarding persistent past effects listed below in the text and in the tables, see the past/present effects analysis section of Sections 3.5.1.4 and 3.5.1.18.

BSAI Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 1 (see Section 4.5.1.4 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the BSAI Atka mackerel stock. While large removals of Atka mackerel did occur in the past, there does not appear to be a lingering effect on the BSAI Atka mackerel populations (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as the only external event that could cause effects on the BSAI Atka mackerel population. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 1 is identified for mortality of BSAI Atka mackerel, but the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the MSS. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be insignificant under FMP 1 (see Section 4.5.1.4 direct/indirect effects discussion).

- **Persistent Past Effects.** While past large removals of Atka mackerel and other past effects on biomass have been identified (see Section 3.5.1.4), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Atka mackerel biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** As described under the internal effects section, the temporal/spatial concentration of the catch under FMP 1 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST.

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. Past commercial whaling and sealing removed large predators of Atka mackerel adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to climate changes and regime shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** As described above under the direct/indirect effects section, the current levels and distribution of harvest do not appear to impact prey availability such that it affects the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST and the effect is judged insignificant.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of Atka mackerel prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the Atka mackerel stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As described in the direct/indirect effects section above, the level of habitat disturbance caused by the fishery under FMP 1 does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST, and the effect is judged insignificant.

- **Persistent Past Effects.** Past effects are identified for BSAI Atka mackerel stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.4). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, that effect on the BSAI Atka mackerel stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Atka mackerel stock to sustain itself at or above MSST is jeopardized.

GOA Atka Mackerel

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA; therefore model projections of future biomass levels were not produced.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Atka mackerel stock is unknown under FMP 1. The F and the MSST for GOA Atka mackerel are unknown; thus the effect of fishing mortality is unknown under FMP 1 (see Section 4.5.1.4, direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the past foreign, JV, and domestic, fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, and JV fisheries and have had a lingering effect on the GOA Atka mackerel population, which has not yet recovered (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the population is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 1 is identified for mortality of GOA Atka mackerel, but the significance of the effect is unknown. GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Atka mackerel stock is unknown FMP 1. Current reliable estimates of total and spawning biomass are unknown for GOA Atka mackerel (see Section 4.5.1.4, direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the past foreign, JV, and domestic, fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, and JV fisheries and have had a lingering effect on the GOA Atka mackerel population which has not yet recovered (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the population is affected. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, the significance of the effect is unknown.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration effects is also unknown under FMP 1 (see Section 4.5.1.4, direct/indirect effects discussion).

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. The past highly localized fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Also, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Also, climate changes and regime shifts could impact spawning success since a shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 1 will not impact prey availability for BSAI Atka mackerel and the impact to the prey availability effect is determined to be insignificant (see Section 4.5.1.4, direct/indirect effects discussion).

- **Persistent Past Effects.** While lingering population level effects on the invertebrate prey of Atka mackerel from past foreign, state, and domestic fisheries, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Atka mackerel prey species could be either beneficial or adverse depending on the direction of change. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is not identified for prey availability; however, the effects are unknown since the direction of external effects is unknown.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel, which are in Tier 6, the significance of the habitat suitability effects is also unknown under FMP 1 (see Section 4.5.1.4, direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA Atka mackerel stocks include past foreign, JV, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.4). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from climate changes and regime shifts on the GOA Atka mackerel could be either favorable or unfavorable depending on the direction of change. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, their significance on the GOA Atka mackerel stock is unknown.

4.5.1.5 Yellowfin Sole and Shallow Water Flatfish

Numerous fishery management actions have been implemented that affect the yellowfin sole fisheries in the BSAI. These actions are described in more detail in Sections 3.5.1.5 and 3.5.1.19 of this Programmatic SEIS. Yellowfin sole is managed as its own stock under the BSAI groundfish FMP in the Tier 3 management category; thus MSSTs are defined for these species by the National Standard Guidelines.

Eight flatfish species inhabit shallow waters and are managed in the shallow water flatfish assemblage in the GOA. Yellowfin sole is included in this group, along with northern and southern rock sole, starry flounder, butter sole, English sole, Alaska plaice, and sand sole. Survey results from 2001 indicate that over half of the estimated biomass (54 percent) of this assemblage are northern and southern rock sole (Turnock *et al.* 2001). The shallow water group is managed as Tier 4 and Tier 5 species in the GOA.

As discussed in the following subsections, all potential direct and indirect effects of FMP 1 on this group are expected to be insignificant. External effects associated with the FMP 1 are shown in Tables 4.5-8 and 4.5-9 of Appendix A. For further information regarding persistent past effects listed below in the text and in Tables 4.5-8 and 4.5-9, see the past/present effects analysis discussion in Sections 3.5.1.5 and 3.5.1.19.

BSAI Yellowfin Sole – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI yellowfin sole. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the yellowfin sole stock in 2002 is 0.064. Model projections show that under FMP 1, this value would increase to 0.099 in 2006 and 2007 (Table H.4-4 of Appendix H). This value is well below the F_{MSY} proxy value of 0.138, the rate associated with the overfishing level. Because the capacity of the stock to produce MSY on a continuing basis would not be jeopardized under these conditions, the direct effect of FMP 1 on the mortality rate of BSAI yellowfin sole from fishing is expected to be insignificant.

Change in Biomass Level

Total Biomass

The total biomass of yellowfin sole at the start of 2002 is estimated to be 1,552,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 1, model projections indicate that the total BSAI biomass is expected to decline by slightly more than 2 percent of the 2002 value to 1,520,000 mt by 2007, with a 2003-2007 average value of 1,531,000 mt. This projected decrease is considered to be insignificant, because total yellowfin sole biomass in the BSAI would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST.

Spawning Biomass

Spawning biomass of female yellowfin sole at the start of 2002 is estimated to be 450,700 mt. Model projections of future yellowfin sole spawning biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 1, model projections indicate that female spawning biomass is expected to decline by nearly 10 percent of the 2002 value to 409,000 mt by 2007, with a 2003-2007 average value of 433,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 336,900 mt throughout the five-year projection. Although the BSAI yellowfin sole spawning biomass is projected to decline, it would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. Therefore, this potential effect under FMP 1 is considered to be insignificant.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI yellowfin sole harvest, relative to the 2002 baseline, would not be affected under FMP 1. Therefore, this potential impact is considered to be insignificant, because it is not likely to cause changes in genetic structure or reproductive success that would jeopardize the ability of the stock to maintain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP. Because fishing practices under FMP 1 would be similar to the status quo, however, it is unlikely that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success sufficient to jeopardize the ability of the stock to sustain itself at or above the MSST. Therefore, any direct or indirect effects of FMP 1 on BSAI yellowfin sole habitat suitability are expected to be insignificant.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on BSAI yellowfin sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. The current levels and distribution of harvest do not appear to affect prey availability in ways that impair the ability of the stock to maintain itself above its MSST, however, it is likely that potential effects of FMP 1 on prey availability for BSAI yellowfin sole would be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Yellowfin Sole

Appendix A, Table 4.5-83 summarizes the expected effects of FMP 1 on BSAI yellowfin sole. The rating of conditionally significant (either beneficial or adverse) is not applicable in this analysis, because the model yields projections that can be classified only as significant (beneficial or adverse), insignificant, or unknown.

The ratings utilize F_{OFL} and the MSST as a basis for predicting beneficial or adverse impacts on fishing mortality and reproductive success, respectively, for each FMP. A thorough description of the rationale for the MSST can be found in the National Standard Guidelines, 50 CFR Part 600 (FR Vol. 63, No. 84, 24212-24237). Under FMP 1, the spawning stock biomass of BSAI yellowfin sole is expected to be above the MSST. The fishing mortality does not exceed F_{OFL}, and the female spawning stock is currently above the MSST; therefore, the expected changes under this FMP would not be substantial enough to change the genetic diversity or reproductive success of the spawning stocks. For this reason, the potential indirect and direct effect sof this FMP on BSAI yellowfin sole are considered insignificant.

Relative to the 2002 comparative baseline, the yellowfin sole stock is not projected to be continually overfished under this FMP. The 20-year projection indicates that the female spawning stock would decline to B_{ABC} levels until 2010 and increase thereafter through the end of the projection in 2023.

Status Determination from Modeling

Model projections for 2003-2007 indicate that under FMP 1, the future status of the BSAI yellowfin sole stock would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI yellowfin sole are below the OFLs in all years under FMP 1. The yellowfin sole stock is above the MSST level in 2002 (Table H.4-4 of Appendix H).

Age and Size Composition

Under FMP 1, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 6.2 years. This compares with a mean age in the equilibrium unfished BSAI stock of 8.0 years. Note that the mean age and size actually observed in 2008 (as opposed to the model projections) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of yellowfin sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

External effects and the resultant cumulative effects associated with FMP 1 are shown in Table 4.5-8.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI yellowfin sole is rated as insignificant under FMP 1 (see the direct/indirect effects discussion above).

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of yellowfin sole.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI yellowfin sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As described in the direct/indirect effects section, it is not expected that FMP 1 will result in any significant adverse impact to these stocks.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse contributions on the yellowfin sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.5 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI yellowfin sole, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the spawning biomass is above the B_{MSY} value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI yellowfin sole catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of yellowfin sole due to climate changes and regime shifts are potentially beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI yellowfin sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the yellowfin sole catch; however, this effect is ranked as insignificant. The spatial/temporal distribution of yellowfin sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI yellowfin sole is ranked as insignificant (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI yellowfin sole stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted. See Sections 3.5.1.5 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for change in prey availability; however, these effects are considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI yellowfin sole is ranked as insignificant. Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that FMP 1 would have insignificant effects on yellowfin sole habitat suitability (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for BSAI yellowfin sole include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Sections 3.5.1.5 and 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for BSAI yellowfin sole habitat suitability; however, these effects are considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the yellowfin sole stock to sustain itself at or above the MSST is jeopardized.

GOA Shallow Water Flatfish – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on the GOA shallow water flatfish complex. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

<u>Fishing Fishing Mortality</u>

The catch of GOA shallow water flatfish in 2002 was estimated to be 6,800 mt. Model projections of future catch are shown in Table H.4-27 of Appendix H. Under FMP 1, model projections indicate that the catch is expected to decrease from the 2002 value to 5,400 mt in 2003-2006 and to 5,100 mt in 2007. The 2003-2007 average catch is projected to be 5,300 mt under FMP 1. Although information necessary to determine MSY is lacking for shallow water flatfish, the projected decrease in catch under this FMP suggests that effects of fishing mortality are likely to be insignificant, because they would not be expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass Level</u>

No reliable estimates for total or spawning biomass are available for GOA shallow water flatfish. Therefore, potential effects of FMP 1 relating to changes in biomass are unknown for this group.

<u>Spatial/Temporal Concentration of Catch</u>

The spatial/temporal characteristics of the annual GOA shallow water flatfish harvest under FMP 1 would be similar to baseline conditions. However, evidence is insufficient to conclude whether spatial and temporal patterns of harvest concentration would lead to a detectable change in genetic diversity or reproductive success, and MSSTs have not been established for the species in this group. Therefore, any potential effects of the spatial/temporal concentration of the catch on shallow water flatfish under this FMP are unknown.

<u>Habitat Suitability</u>

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP, and MSSTs have not been defined for the shallow water flatfish species. Therefore, potential effects of FMP 1 on habitat suitability for this group are unknown.

<u>Prey Availability</u>

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on shallow water flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP nor have MSSTs been defined for the shallow water flatfish species. Therefore, potential effects of FMP 1 on prey availability for this group are unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Shallow Water Flatfish

The direct and indirect effects of FMP 1 on GOA shallow water flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. Available information is insufficient to estimate female spawning biomass of these stocks over the five-year projection and what level of fishing mortality would correspond to the modeled catch estimated under this FMP. Because catch volumes are predicted to decline moderately over the five-year period, the effect of FMP 1 on fishing mortality is likely to be insignificant. All other direct and indirect effects of FMP 1 on the shallow water flatfish complex are unknown, because available information on the stocks is insufficient to determine MSSTs.

Status Determination from Modeling

Stock Size Relative to MSST

The available information for flatfish species in the shallow water complex requires that they be classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species in the National Standard Guidelines. Therefore, it is not possible to determine the status of their stocks relative to MSST.

Age and Size Composition

Under FMP 1, the mean age of the GOA shallow water flatfish stock in 2008, as computed in model projections, is 4.7 years. This compares with a mean age in the equilibrium unfished GOA stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of shallow water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-9 summarizes the cumulative effects analysis for GOA shallow water flatfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shallow water flatfish is rated as insignificant under FMP 1 (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past, JV, and domestic fisheries have been identified as having lingering past adverse effects on th GOA shallow water flatfish complex. See Section 3.5.1.19 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution, since acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shallow water flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since shallow water flatfish species by catch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA shallow water flatfish, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** Since the total and spawning biomass estimates for GOA shallow water species is unavailable, the effects of FMP 1 on change in biomass are unknown (see the direct/indirect effects discussion).

- **Persistent Past Effects.** The past, JV, and domestic fisheries are identified as having past lingering adverse effects on the biomass levels of GOA shallow water flatfish. See Section 3.5.1.19 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse contributions of marine pollution; acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse contributions on the shallow water flatfish species biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.19 and 3.10. The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for change in biomass of GOA shallow water flatfish, but is rated as unknown. Fishing mortality at projected levels is well below the OFL for this stock. It is unknown if the combined effects of internal and external removals are likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of the annual GOA shallow water flatfish harvest will not be affected under FMP 1, relative to the 2002 baseline year. However, little is known about the spatial/temporal characteristics of GOA shallow water flatfish, therefore the effects of FMP 1 are rated as unknown (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects have not been identified for the change in genetic structure or the change in reproductive success of GOA shallow water flatfish (see Section 3.5.1.19).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of shallow water flatfish species due to climate changes and regime shifts are potentially beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock complex. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA shallow water flatfish. The State of Alaska scallop fishery has been identified as a non-contributing factor to the change in genetic structure and reproductive success since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** Cumulative effects are possible for change in genetic structure and reproductive success of GOA shallow water flatfish, but are rated as unknown. It is unknown if the combined effects of internal removals and removals due to reasonably foreseeable future external events are likely to jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the GOA shallow water flatfish is determined to be unknown (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA shallow water flatfish stock complex and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted. See Sections 3.5.1.19 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potentially beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery is identified as a non-contributing factor since by catch of shallow water flatfish prey species is not expected to occur in this fishery.

- **Cumulative Effects.** Cumulative effects for change in prey availability are unknown. The predation-mediated impacts of FMP 1 on shallow water flatfish are governed by a complex web of indirect interactions which are currently difficult to quantify.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the GOA shallow water flatfish complex is considered to be unknown. Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for GOA shallow water flatfish include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Sections 3.5.1.19 and 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potentially beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is also identified as a potential adverse contributor to GOA shallow water flatfish habitat suitability. See Section 3.6.4 for information of the impacts of fishery gear on EFH.

- **Cumulative Effects.** Cumulative effects are identified for GOA shallow water flatfish habitat suitability; however, these effects are unknown. It is unknown if the combination of internal and external habitat disturbances will to lead to a detectable change in spawning or rearing success such that the ability of the GOA shallow water flatfish stock to maintain current population levels is jeopardized.

4.5.1.6 Rock Sole

Numerous fishery management actions have been implemented that affect the rock sole fisheries in the BSAI. These actions are described in more detail in Section 3.5.1.6 of this Programmatic SEIS. Rock sole is managed as its own stock under the BSAI groundfish FMP as a Tier 3 management category; therefore, an MSST is defined for this species.

Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI rock sole. As discussed below, all potential direct and indirect effects of FMP 1 on this group are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the rock sole stock in 2002 is 0.055. Model projections suggest this value will increase to 0.137 in 2007 (Table H.4-7 of Appendix H). These values are well below the F_{MSY} proxy value of 0.21, the rate associated with the OFL. Therefore, the projected Fs for BSAI rock sole under FMP 1 are considered to be insignificant, because they would not jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

The total biomass of rock sole at the start of 2002 is estimated to be 970,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-7 of Appendix H. Under FMP 1, the model projections indicate that the total BSAI biomass is expected to decline 30 percent of the 2002 value to 680,000 mt by 2007, with a 2003-2007 average value of 765,000 mt. This projected decrease is considered to be insignificant, because total rock sole biomass in the BSAI would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST.

Spawning Biomass

Spawning biomass of female rock sole at the start of 2002 is estimated to be 331,000 mt. Model projections of future rock sole spawning biomass estimates are shown in Table H.4-7 of Appendix H. Under FMP 1, model projections indicate that female spawning biomass is expected to decline to 53 percent of the 2002 value to 175,900 mt by 2007, with a 2003-2007 average value of 238,100 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 136,700 mt throughout the five-year projection. Although spawning biomass for BSAI rock sole is projected to decline, it would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. Therefore, this potential effect under FMP 1 is considered to be insignificant.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI rock sole harvest, relative to the 2002 baseline year, would not be affected under FMP 1. The temporal/spatial concentration of the catch under baseline conditions does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Under FMP 1, therefore, the spatial and temporal pattern of catch concentration would have an insignificant effect on BSAI rock sole relative to the baseline.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 on BSAI rock sole would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next five years under this FMP. The level of habitat disturbance caused by the fishery under baseline conditions does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Therefore, impacts on habitat suitability for BSAI rock sole are expected to be insignificant under FMP 1.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on rock sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. The current levels and distribution of harvest do not appear to affect prey availability in ways that impair the ability of the rock sole stock to maintain itself above its MSST. Therefore, it is likely that potential effects of FMP 1 on prey availability for BSAI rock sole would be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Rock Sole

Appendix A, Table 4.5-83 summarizes the expected direct and indirect effects of FMP 1 on BSAI rock sole. The rating of conditionally significant (either beneficial or adverse) is not applicable in this analysis, because the model projections yielded results that could be evaluated only as significant (beneficial or adverse), insignificant, or unknown.

The ratings utilize F_{OFL} and MSST as the bases for identifying potentially beneficial or adverse impacts on fishing mortality and reproductive success under each FMP. A thorough description of the rationale for the MSST can be found in the National Standard Guidelines, 50 CFR Part 600 (FR Vol. 63, No. 84, 24212-24237). Under FMP 1, the spawning stock biomass of BSAI rock sole is expected to be above the MSST. Since the F would not exceed F_{OFL} and the stock is expected to remain above the MSST, the expected changes under this FMP would not be substantial enough that the genetic diversity or reproductive success of the spawning stocks would be likely to change under the new management regime. Therefore, the potential direct and indirect effects on BSAI rock sole under this FMP are considered insignificant.

Relative to the 2002 comparative baseline, the rock sole stock is projected to continue not to be overfished under this FMP. The 20-year projection indicates that the female spawning stock is expected to decline to a level just less than B_{MSY} in 2010, then increase to above B_{ABC} levels by 2015, and continue to increase through the end of the projection in 2023.

Status Determination from Modeling

Model projections for 2003-2007 suggest that under FMP 1, the future status of the BSAI rock sole stock would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI rock sole are below the OFLs in all years under FMP 1, and the female spawning stock is above the MSST. The rock sole stock is projected to be above the MSST level in 2002.

Age and Size Composition

Under FMP 1, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 4.7 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean age and size actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of rock sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-10 summarizes the cumulative effects analysis for BSAI rock sole.

Mortality

- **Direct/Indirect Effects.** As stated above in the direct/indirect effects section, the effect of fishing mortality on the BSAI rock sole is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rock sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI rock sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on BSAI rock sole biomass is rated as insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse contribution of marine pollution; acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the rock sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.6 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI rock sole, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the BSAI rock sole. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of BSAI rock sole. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of rock sole due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI rock sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rock sole catch, and is ranked as insignificant. The spatial/temporal distribution of rock sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in prey availability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do affect the availability of some forage species (i.e. capelin); however, studies on benthic invertebrates have not been conducted. See Section 3.5.1.6 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in habitat suitability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI rock sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI rock sole habitat suitability; however, this effect is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the rock sole stock to sustain itself at or above the MSST is jeopardized.

4.5.1.7 Flathead Sole

Numerous fishery management actions have been implemented that affect the flathead sole fisheries in the BSAI and GOA. These actions are described in more detail in Sections 3.5.1.7 and 3.5.1.20 of this Programmatic SEIS. Flathead sole is managed as its own stock under the BSAI groundfish FMP within the Tier 3 management category; therefore, an MSST is defined for this species by the National Standard Guidelines. Beginning in 2002, flathead sole were managed independently of the other flatfish species in the GOA. Until recently, GOA flathead sole were evaluated under the Tier 4 management category; beginning in 2004, flathead sole will be managed under Tier 3. GOA flathead sole were modeled under the Tier 4 category for this analysis.

BSAI Flathead Sole – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the analyses of direct and indirect impacts of FMP 1 on BSAI flathead sole. As discussed below, all of these potential effects are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The projected fishing mortality imposed on the BSAI flathead sole stock in 2003 is 0.047. Model projections suggest that under FMP 1, this fishing mortality would increase to 0.086 in 2008, with an average fishing mortality of 0.063 from 2003-2008 (Table H.4-8 of Appendix H). These values are below the $F_{35\%}$ level of 0.355 and the $F_{40\%}$ level of 0.286, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. The proportion of spawner biomass per recruit conserved under these mortality rates is 80 percent in 2003, decreasing to 70 percent in 2008; the average implied spawner biomass per recruit (SPR) rate of fishing from 2003-2008 is 76 percent. These projections indicate that the expected effects of FMP 1 on BSAI flathead sole mortality are likely to be insignificant, because they would not jeopardize the capacity of the stocks to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

Total biomass (ages 3 through 21+) of BSAI flathead sole at the start of 2003 is estimated to be 513,000 mt. Model projections of future BSAI total flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 490,000 mt in 2006, then increase to 498,000 mt in 2008. The 2003-2008 projected average total biomass is 497,000 mt. These projections indicate that the total flathead sole biomass in the BSAI would stay within a range that would maintain the existing ability of the stock to sustain itself above the MSST. For this reason, the impact of FMP 1 on BSAI flathead sole total biomass is expected to be insignificant.

Spawning Biomass

Spawning biomass of BSAI flathead sole at the start of 2003 is estimated to be 231,200 mt. Model projections of future total BSAI flathead sole spawning biomass are shown in Table H.4-8 of Appendix H. Under FMP 1, model projections indicate that BSAI flathead sole spawning biomass would increase to a value of 164,600 mt in 2008, with a 2003-2008 average value of 196,000 mt. Under FMP 1, therefore, impacts on BSAI flathead sole spawning biomass are expected to be insignificant, because the existing ability of the stock to sustain itself above the MSST would be maintained.

Spatial/Temporal Concentration of Catch

The harvest of flathead sole occurs largely along the western edge of the EBS shelf; little harvest occurs in the Aleutian Islands. Although some directed fishing for flathead sole exists, a considerable amount of harvest occurs as bycatch in other target fisheries. Under FMP 1, an average of 12,900 mt is projected to be harvested annually from 2003-2008, almost entirely from the EBS. The EBS Pacific cod and yellowfin sole fisheries account for 3,240 mt (25 percent) and 2,530 mt (19 percent) of the average annual harvest, whereas the directed flathead sole fishery accounts for 1,910 mt (15 percent). Recent observer data indicate that the harvest of flathead sole occurs year-round, and is determined largely from the seasonal allocations of the Pacific halibut prohibited species bycatch limits for flatfish trawl fisheries (Spencer *et al.* 2001). Because these patterns would be maintained under FMP 1, the temporal/spatial concentration of the catch would not be likely to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Therefore, this potential impact is considered to be insignificant.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 1. Therefore, the effects of FMP 1 on BSAI flathead sole habitat suitability are expected to be insignificant, because the present ability of the stock to maintain itself above the MSST would not be impaired.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under this FMP. Since the current levels and distribution of harvest have not been shown to affect prey availability in ways that impair the ability of the stock to maintain itself above its MSST, potential future effects of FMP 1 on prey availability for BSAI flathead sole are likely to be insignificant.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Flathead Sole

Because BSAI flathead sole are fished at less than the OFL and are above the MSST, the direct and indirect effects of FMP 1 on this stock are considered insignificant. Fishing rates are well within accepted scientific standards based on studies of population dynamics and estimates of natural variations in recruitment. Therefore, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity.

Relative to the 2002 comparative baseline, the flathead sole stock is projected to continue not tot be overfished under this FMP. The 20-year projection indicates that the female spawning stock would decrease until 2009, then begin to increase steadily through the end of the projection. The female spawning stock is estimated to remain above B_{ABC} throughout the projection.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI flathead sole are below the ABC and OFL levels in all years. The BSAI flathead sole are above their MSST in the year 2002.

Age and Size Composition

Under FMP 1, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections, is 4.53 years. This compares with a mean age in the equilibrium unfished stock of 5.39 years.

Sex Ratio

The sex ratio of BSAI flathead sole is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-11 summarizes the cumulative effects analysis for BSAI flathead sole.

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI flathead sole is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI flathead sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass Level</u>

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fishing on the flathead sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the flathead sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.7 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI flathead sole, and is rated as insignificant. Fishing mortality at projected levels is well below the

OFL for this stock and the spawning biomass is above the B_{MSY} value. The combined effect of internal removals and removals due to reasonable foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI flathead sole catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch, and is ranked as insignificant. The spatial/temporal distribution of flathead sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects are not identified for the change in prey availability of the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.7.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI flathead sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at or above the MSST is jeopardized.

GOA Flathead Sole – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the analyses of direct and indirect impacts of FMP 1 on GOA flathead sole. The effect of fishing mortality on this stock is expected to be insignificant, whereas the significance of other potential direct and indirect effects is unknown. Significance ratings are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The catch of GOA flathead sole in 2002 was estimated to be 2,000 mt. Model projections of future catch are shown in Table H.4-28 of Appendix H. Under FMP 1, model projections indicate that the catch would decrease from the 2002 value to 1,700 mt in 2003 and then further decline to 1,500 mt in 2007 (75 percent of 2002 catch). The 2003-2007 average catch is 1,600 mt. Therefore, the projected Fs for GOA flathead sole under FMP 1 are considered to be insignificant, because they would not jeopardize the capacity of the stocks to produce MSY on a continuing basis.

Change in Biomass Level

Estimates of total and spawning biomass are not available for this species. Therefore, the potential effects of FMP 1 on biomass levels, and any resulting impact on the stock's ability to maintain itself above the MSST, are unknown.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual GOA flathead sole harvest would not be affected under FMP 1, relative to the 2002 baseline year. However, the effects of the temporal/spatial concentration of the catch on this stock under baseline conditions are unknown. Therefore, the potential effects of FMP 1 to affect the stock's genetic structure or reproductive success must also be considered unknown.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 on GOA flathead sole would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next five years under this FMP. Because habitat-mediated impacts under baseline conditions are unknown, however, the potential habitat-mediated effects of FMP 1 on the stock's ability to maintain itself above the MSST must also be considered unknown.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on GOA flathead sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. Because data on prey availability under baseline conditions are not available, however, potential predation-mediated impacts of FMP 1 on the ability of the GOA flathead sole stock to sustain itself at or above the MSST are unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Flathead Sole

Because the GOA flathead sole catch is projected to decrease moderately during the 2003-2007 period, the effect of FMP 1 on fishing mortality is expected to be insignificant. All other direct and indirect effects of FMP 1 on GOA flathead sole are unknown, because they cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks would be over the five-year projection and what level of fishing mortality would correspond to the modeled catch estimated under this FMP.

Status Determination from Modeling

Stock Size Relative to MSST

The available information for flathead sole requires that this species be classified into the Tier 4 management category. As a result, no MSSTs are defined for flathead sole, and it is not possible to determine the status of the stock size relative to MSST.

Age and Size Composition

Age and size composition estimates are not available for this species.

Sex Ratio

The sex ratio of flathead sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-12 summarizes the cumulative effects analysis for GOA flathead sole.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA flathead sole is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past, JV, and domestic fisheries. Removals by these fisheries have had a lingering adverse effect on GOA flathead sole. For more information, see Section 3.5.1.20.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole. The State of Alaska scallop fishery has also been identified as a non-contributing factor since GOA flathead sole bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA flathead sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonable foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, the change in biomass level is rated as unknown since MSST is unable to be determined at this time.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past, JV, and domestic fisheries. Large removals of flathead sole by these fisheries is determined to have had a lingering effect on the GOA flathead sole stock (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the flathead sole biomass level. For more information on climate changes and regime shifts, see Sections 3.5.1.20 and 3.10. The State of Alaska scallop fishery is identified as a non-contributing factor for change in biomass level since flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA flathead sole, but is unknown. The MSST is not able to be determined and the total and spawning biomass estimates are currently unavailable. It is unknown whether the combined effect of internal and external removals are likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is unknown since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA flathead sole stock. However, climate changes and regime shifts have been identified as having a beneficial or adverse effect on GOA flathead sole reproductive success. See Section 3.5.1.20 for more information on the effects of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA flathead sole. The State of Alaska scallop fishery has been identified as a non-contributing factor to change in genetic structure and change in reproductive success since GOA flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch; however, this effect is unknown. It is unknown whether the combined effect of internal and external removals are likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA flathead sole stock and include climate changes and regime shifts. For more information on the effects of climate changes and regime shifts on the GOA flathead sole stock, see Section 3.5.1.20.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole prey availability. The State of Alaska scallop fishery gear could impact flathead sole benthic prey availability and/or quality.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to sustain itself at current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the GOA flathead sole is unknown. Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify.

- **Persistent Past Effects.** Past effects identified for GOA flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.20.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole habitat suitability. For information on the effects of fishery gear on EFH, see Section 3.6.4.

- **Cumulative Effects.** A cumulative effect is identified for GOA flathead sole habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at current population levels.

4.5.1.8 Arrowtooth Flounder

Numerous fishery management actions have been implemented that affect the arrowtooth flounder fisheries in the BSAI and GOA. These actions are described in more detail in Sections 3.5.1.8 and 3.5.1.21 of this Programmatic SEIS. Arrowtooth flounder is managed as its own stock under the BSAI and GOA groundfish FMPs as part of the Tier 3 management category. Therefore, MSSTs are defined for these stocks.

BSAI Arrowtooth Flounder – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI arrowtooth flounder. All of these potential effects are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the BSAI arrowtooth flounder stock in 2002 is 0.015. Model projections show this value will increase to 0.26 in 2007. These values are well below the F_{MSY} proxy value of 0.38, the rate associated with the overfishing level. This impact is expected to be insignificant, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

The total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-6 of Appendix H. Under FMP 1, model projections indicate that the total BSAI biomass is expected to decline 26 percent of the 2002 value to 597,000 mt by 2007, with a 2003-2007 average value of 675,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spawning Biomass

Spawning biomass of female BSAI arrowtooth flounder at the start of 2002 is estimated to be 475,900 mt. Model projections of future arrowtooth flounder spawning biomass estimates are shown in Table H.4-6 of Appendix H. Under FMP 1, model projections indicate that female spawning biomass is expected to decline to 30 percent of the 2002 value to 329,500 mt by 2007, with a 2003-2007 average value of 387,900 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 182,900 mt throughout the five-year projection. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI arrowtooth flounder harvest, relative to the 2002 baseline, would not be affected under FMP 1. This impact is expected to be insignificant, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP. Therefore, the effects of FMP 1 on habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on BSAI arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Arrowtooth Flounder

Under FMP 1, the spawning stock biomass of BSAI arrowtooth flounder is expected to be above the MSST. Since the F does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under this FMP are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under this FMP are considered insignificant.

Relative to the 2002 comparative baseline, the BSAI arrowtooth flounder stocks are projected to continue to not be overfished under this FMP. The 20-year projection indicates that the female spawning stock in both areas is expected to remain above B_{ABC} levels through the end of the projection in 2023.

Status Determination from Modeling

Modeling projections for 2003-2007 indicate that under FMP 1, the future status of BSAI arrowtooth flounder would be as follows for key indicators.

Stock Size Relative to MSST

Model projections of future catches of BSAI arrowtooth flounder are below the overfishing levels in all years under FMP 1. The arrowtooth flounder female spawning biomass is above the MSST level in 2002.

Age and Size Composition

Under FMP 1, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-6 of Appendix H), is 4.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.4 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the BSAI have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-13 summarizes the cumulative effects analysis for BSAI arrowtooth flounder.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI arrowtooth flounder is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of arrowtooth flounder. The IPHC longline fishery is identified as a potential adverse contributor to BSAI arrowtooth flounder mortality since arrowtooth flounder are caught as bycatch in this fishery. Finally, the State of Alaska herring fishery is identified as a non-contributing factor to BSAI arrowtooth flounder mortality since bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on the BSAI arrowtooth flounder biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass level in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the arrowtooth flounder biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.8 and 3.10. The IPHC longline fishery has been identified as a potential adverse contributor to BSAI arrowtooth flounder biomass level since bycatch is expected to occur in this fishery. Finally, the State of Alaska herring fishery is identified as a non-contributing factor since arrowtooth flounder bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI arrowtooth flounder. Climate changes and regime shifts are identified as having had potential adverse or beneficial effects on the reproductive success of BSAI arrowtooth flounder (see Section 3.5.1.8 for more information).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of arrowtooth flounder due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI arrowtooth flounder. The IPHC longline fishery is identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since the removals are not expected to be significant. The State of Alaska herring fishery is also identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch, and is ranked as insignificant. The spatial/temporal distribution of arrowtooth flounder catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified include the past foreign, JV, domestic fisheries, State of Alaska groundfish fisheries, State of Alaska herring fisheries, and climate changes and regime shifts. See Section 3.5.1.8 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potentially beneficial or adverse. Some forage species (i.e. capelin and herring), shrimp and pollock respond to variations in water temperatures which vary with the climate. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor to prey availability since the bycatch of prey species is not expected in this fishery. The State of Alaska herring fishery is identified as a potential adverse contributor to prey availability by reducing the availability of herring.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI arrowtooth flounder include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.8.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery and the State of Alaska herring fishery are both identified as non-contributing factors to BSAI arrowtooth flounder habitat suitability. The impacts from the fishery gear is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for BSAI arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

GOA Arrowtooth Flounder – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA arrowtooth flounder. All of these potential effects are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the GOA arrowtooth flounder stock in 2002 is 0.017. Model projections show this value will decrease to 0.009 in 2007. These values are well below the F_{MSY} proxy value of 0.165, the rate associated with the overfishing level. This impact is expected to be insignificant, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

The total biomass of GOA arrowtooth flounder at the start of 2002 is estimated to be 1,816,000 mt. Model projections of future total GOA biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 1, model projections indicate that the total GOA biomass is expected to increase 15 percent of the 2002 value to 2,086,000 mt by 2007, with a 2003-2007 average value of 1,982,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spawning Biomass

Spawning biomass of female GOA arrowtooth flounder at the start of 2002 is estimated to be 1,113,800 mt. Model projections of future GOA arrowtooth flounder spawning biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 1, model projections indicate that female spawning biomass is expected to increase 4 percent of the 2002 value to 1,115,700 mt by 2007, with a 2003-2007 average value of 1,142,300 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 432,700 mt throughout the five-year projection. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual GOA arrowtooth flounder harvest, relative to the 2002 baseline, would not be affected under FMP 1. Therefore, this impact is expected to be insignificant, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP. Therefore, the effects of FMP 1 on habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on GOA arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Arrowtooth Flounder

Under FMP 1, the spawning stock biomass of GOA arrowtooth flounder is expected to be above the MSST. Since the F does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under this FMP are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Therefore, the indirect and direct effects under this FMP are considered insignificant.

Relative to the 2002 comparative baseline, the GOA arrowtooth flounder stocks are projected to continue not to be overfished under this FMP. The 20-year projection indicates that the female spawning stock in both areas is expected to remain above B_{ABC} levels through the end of the projection in 2023.

Status Determination from Modeling

Model projections of future catches of GOA arrowtooth flounder are below the overfishing levels in all years under FMP 1. The arrowtooth flounder female spawning biomass is above the MSST level in 2002.

Age and Size Composition

Under FMP 1, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-29 of Appendix H), is 5.0 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.1 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the GOA have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than for females. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-14 summarizes the cumulative effects analysis for GOA arrowtooth flounder.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA arrowtooth flounder is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on the biomass level is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for change in biomass in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI arowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects identified for the change in genetic structure and reproductive success of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch and is ranked as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified include climate changes and regime shifts. See Section 3.5.1.21 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey availability are the same as those discussed for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA arrowtooth flounder include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.21.

- **Reasonably Foreseeable Future External Effects.** Future external effects on habitat suitability are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for GOA arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

4.5.1.9 Greenland Turbot and Deepwater Flatfish

The numerous fishery management actions that affect the Greenland turbot fisheries in the BSAI are described in more detail in Section 3.5.1.9 of this Programmatic SEIS. Greenland turbot is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category; thus MSSTs are defined for these species by the National Standard Guidelines. The reference F and ABC for the GOA deepwater flatfish management group are determined by the amount of population information available. ABCs for Dover sole were calculated using Tier 5. Greenland turbot and deepsea sole are in Tier 6 because no reliable biomass estimates exists. Section 3.5.1.22 discusses the past/present effects analysis for GOA deepwater flatfish.

BSAI Greenland Turbot – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI Greenland turbot. All of these impacts are expected to be insignificant. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Model projections indicate that under this FMP the F will reach a maximum in 2004 of 0.19 and decrease thereafter to 0.162 by 2007. These values are well below the F_{MSY} proxy value of 0.48, the rate associated with the OFL. This impact is expected to be insignificant, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 1, model projections indicate that the total BSAI biomass is expected to decline 19 percent of the 2002 value to 86,000 mt by 2007, with a 2003-2007 average value of 92,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 1, model projections indicate that female spawning biomass is expected to decline to 31 percent of the 2002 value to 46,800 mt by 2007, with a 2003-2007 average value of 54,100 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,600 mt in the first four years of the projection, and would be below the B_{MSY} proxy rate in 2007. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI Greenland turbot harvest, relative to the 2002 baseline, would not be affected under FMP 1. This impact is expected to be insignificant, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP. Therefore, the effects of FMP 1 on habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on Greenland turbot would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Greenland Turbot

Under FMP 1, the spawning stock biomass of BSAI Greenland turbot is expected to be above the MSST. Since the F does not exceed F_{OFL} and the stock is expected to remain above the MSST, the expected changes under this FMP are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under this FMP are considered insignificant.

Relative to the 2002 comparative baseline, the Greenland turbot stock is projected to continue not to be overfished under this FMP. The 20-year projection indicates that the female spawning stock is expected to decline until 2007 to below B_{MSY} levels and will increase thereafter through the end of the projection to be above B_{ABC} in 2023.

Status Determination from Modeling

Stock Size Relative to MSST

Model projections of future catches of BSAI Greenland turbot are below the OFLs in all years under FMP 1. The Greenland turbot stock is above the MSST level in 2002.

Age and Size Composition

Under FMP 1, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.6 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects Analysis of FMP 1

Table 4.5-15 summarizes the cumulative effects analysis for BSAI Greenland Turbot.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on the change in biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the Greenland turbot biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.9 and 3.10.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is well below the

OFL for this stock and the female spawning biomass is above the B_{MSY} value from 2003-2006. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the spatial/temporal concentration of BSAI Greenland turbot catch. Climate changes and regime shifts are suspected of having an effect on the reproductive success of the Greenland turbot stock. See Section 3.5.1.9 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Greenland turbot catch and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI Greenland turbot stock. Past foreign, JV, and domestic fisheries have been identified as having influenced the availability of Greenland turbot prey, mainly pollock, which is their main prey item in the BSAI. Climate changes and regime shifts have also been identified as influencing Greenland turbot prey availability. See Section 3.5.1.9 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI Greenland turbot include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of Greenland turbot, largely through the impacts of fishing gear on benthic habitats. See Section 3.5.1.9 for more information on the persistent past effects on Greenland turbot.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Greenland turbot habitat suitability and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Greenland turbot stock to sustain itself at or above the MSST is jeopardized.

GOA Deepwater Flatfish – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on the GOA deepwater flatfish complex. The potential effect of FMP 1 on this complex through fishing mortality is expected to be insignificant. The significance of all other potential direct and indirect effects on this group is unknown. Significance ratings are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The catch of GOA deepwater flatfish in 2002 was estimated to be 600 mt. Model projections of future catch are shown in Table H.4-25 of Appendix H. Under FMP 1, model projections indicate that the catch is expected to increase two and a half times the 2002 value to 1,600 mt by 2007, with a 2003-2007 average value of 1,600 mt. This impact is expected to be insignificant, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Reliable estimates of total and spawning biomass do not exist for these species. Consequently, the potential impact of FMP 1 on GOA deepwater flatfish biomass levels is unknown, because MSSTs have not been determined for the species in this group.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual GOA deepwater flatfish harvest would not be affected under FMP 1, relative to the 2002 baseline. However, the effects of the temporal/spatial concentration of the catch on this stock under baseline conditions are unknown. Therefore, the potential effects of FMP 1 to affect genetic structure or reproductive success within the GOA deepwater flatfish populations must also be considered unknown.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 on the GOA deepwater flatfish complex would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next five years under this FMP. Therefore, evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST under FMP 1.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on deepwater flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. Therefore, evidence is insufficient to conclude whether future harvest levels and distribution of harvest under this FMP would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Deepwater Flatfish

The direct and indirect effects of FMP 1 on GOA deepwater flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks would be over the five-year projection and what level of fishing mortality would correspond to the modeled catch estimated under this FMP.

Status Determination from Modeling

Stock Size Relative to MSST

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 5 or Tier 6 management category. As a result, no MSSTs are defined for these species in the National Standard Guidelines. Therefore, it is not possible to determine the status of their stock size relative to MSST.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratio of deepwater flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-16 summarizes the cumulative effects analysis for GOA deepwater flatfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA deepwater flatfish is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA deepwater flatfish stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of deepwater flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA deepwater flatfish and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Total and spawning biomass estimates are unavailable for the deepwater flatfish species, therefore, the effects of FMP 1 on the change in biomass level are unknown.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the GOA deepwater flatfish stock complex.

- **Reasonably Foreseeable Future External Effects.** Future external effects. on the change in biomass are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the deepwater flatfish species biomass level. For more information on climate changes and regime shifts, see Sections 3.5.1.22 and 3.10. The State of Alaska scallop fishery has been identified as a non-contributing factor for change in biomass level since deepwater flatfish species bycatch is not expected to occur.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA deepwater flatfish, but is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is unknown for the stock since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts which are suspected of having an effect on the reproductive success of the deepwater flatfish stock complex. See Section 3.5.1.22 for more information on the effects of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of GOA deepwater flatfish due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor to change in genetic structure and reproductive success since bycatch of GOA deepwater flatfish species is not expected to occur.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the GOA deepwater flatfish catch; however, this effect unknown. It is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the GOA deepwater flatfish complex is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA deepwater flatfish stock complex and include climate changes and regime shifts. See Section 3.5.1.22 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery has been identified as a potential adverse contributor to benthic prey availability. See Section 3.6.4 for information of the impacts of fishery gear on EFH.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to maintain current populations.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the GOA deepwater flatfish complex is unknown.

- **Persistent Past Effects.** Past effects identified for GOA deepwater flatfish include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of deepwater flatfish, largely through the impacts of fishing gear on benthic habitats. See Section 3.5.1.22 for more information on the persistent past effects on deepwater flatfish.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery has been identified as a potential adverse contributor to habitat suitability. See Section 3.6.4 for more information on the impacts of fishery gear on EFH.

- **Cumulative Effects.** A cumulative effect is identified for GOA deepwater flatfish habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the deepwater flatfish stock complex to maintain current population levels is jeopardized.

4.5.1.10 Alaska Plaice and Other Flatfish and Rex Sole

The numerous fishery management actions that have affected the Alaska plaice, other flatfish, and rex sole fisheries in the BSAI and GOA are described in more detail in Sections 3.5.1.10 and 3.5.1.23 of this Programmatic SEIS.

Alaska plaice is evaluated under Tier 3a of Amendment 56 (Spencer *et al.* 2002b). Estimates of MSST are available for this stock. Although there are fifteen species considered as part of the "other flatfish" complex, only seven species comprise the majority of the catch. The other flatfish assemblage is managed under Tier 5, although it has been managed under Tier 4 and 3a in the past (Spencer *et al.* 2002a). Estimates of MSST are not available for this stock. The reference F and ABC for rex sole are determined by the amount of population information available. ABCs are calculated using F_{ABC} = 0.75 M and F_{OFL} = M (Tier 5), because maturity information is not available.

BSAI Alaska Plaice – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI Alaska plaice. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The projected fishing mortality imposed on the BSAI Alaska plaice stock in 2003 is 0.017. Model projections show this fishing mortality will remain at this level through 2005,then increase to 0.021 in 2006 and 2007, and lower to 0.019 in 2008 (Table H.4.9 of Appendix H). These values are below the $F_{35\%}$ level of 0.344 and the $F_{40\%}$ level of 0.279, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. The proportion of SPR conserved under these mortality rates is 92 percent in 2003, decreases to 90 percent in 2006, and increases to 91 percent in 2008. The average implied SPR rate of fishing from 2003-2008 is 91 percent. The impact of fishing mortality on BSAI Alaska plaice is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

Total biomass (ages 1 through 25+) of BSAI Alaska plaice at the start of 2003 is estimated to be 1,083,000 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4.9 of Appendix H. Under FMP 1, model projections indicate that BSAI biomass is expected to increase to a value of 1,121,000 mt in 2008, with a 2003-2008 average value of 1,104,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spawning Biomass

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 275,900 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4.9 of Appendix H. Under FMP 1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 283,300 mt in 2008, with a 2003-2008 average value of 278,800 mt. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

Alaska plaice is a relatively low-valued flatfish species that is taken as bycatch on the EBS shelf; little harvest occurs in the Aleutian Islands. Under FMP 1, an average of 10,500 mt is projected to be harvest annually from 2003-2008, coming nearly entirely from the EBS. The EBS yellowfin sole and rock sole fisheries account for most of the catch, contributing 7,450 mt (71 percent) and 1,440 mt (14 percent) of the average annual harvest. Recent observer data indicate that the harvest of Alaska plaice occurs year-round, and are determined largely from the seasonal allocations of the Pacific halibut prohibited species bycatch limits for flatfish trawl fisheries (Spencer *et al.* 2001). The impact of the spatial/temporal pattern of the harvest under FMP 1 is expected to be insignificant because the harvest concentration would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the BSAI Alaska plaice stock to sustain itself at or above its MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 1. There is no evidence that future levels of habitat disturbance would lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the BSAI Alaska plaice stock to sustain itself at or above the MSST. Therefore, this impact is expected to be insignificant under FMP 1.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 1. There is no evidence that future distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the BSAI Alaska plaice stock to sustain itself at or above the MSST. Therefore, this impact is expected to be insignificant under FMP 1.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Alaska Plaice

Because BSAI Alaska plaice are fished at less than the OFL and are above the MSST, the direct and indirect effects under FMP 1 are considered insignificant. Fishing rates are well within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity.

Relative to the 2002 comparative baseline, the Alaska plaice stock is projected to continue not to be overfished under this FMP. The 20-year projection indicates that the female spawning stock is expected to remain at a high and stable level well above B_{ABC}.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below the ABC and OFL levels in all years. The BSAI Alaska plaice are above their respective MSST in the year 2002.

Age and Size Composition

Under FMP 1, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections, is 4.40 years. This compares with a mean age in the equilibrium unfished stock of 4.51 years.

Sex Ratio

The sex ratio of BSAI Alaska plaice is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-17 summarizes the cumulative effects analysis for BSAI Alaska plaice.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Alaska plaice is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have not been identified for BSAI Alaska plaice mortality.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause other flatfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of Alaska plaice. For more information on climate changes and regime shifts, see Sections 3.5.1.10 and 3.10.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Alaska plaice and is rated as insignificant. Fs for projected years are well below the other flatfish OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, the effect of changes in biomass level is rated as insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass of BSAI Alaska plaice.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause other flatfish mortality. Climate changes and regime shifts have also been identified as having an indirect potentially beneficial or adverse effect on the Alaska plaice biomass level. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, whereas when the Aleutian Low is weak and the temperatures cooler, recruitment tends to be weak. For more information on climate changes and regime shifts, see Sections 3.5.1.10 and 3.10.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Alaska plaice and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events is not expected to jeopardize the capacity of the stock to sustain itself above the MSST.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is identified as insignificant.

- **Persistent Past Effects.** Past effects are not identified for genetic structure of the population. However, climate changes and regime shifts are identified as having persistent past effects on the reproductive success of the BSAI Alaska plaice stock. See Sections 3.5.1.10 and 3.10 for more information of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the genetic structure of other flatfish include the potential adverse effects of marine pollution; acute and/or chronic pollution events could alter the genetic structure of the population by causing localized mortality. Climate changes and regime shifts have been identified as non-contributing factors to the change in genetic structure of the Alaska plaice stocks. These events are not expected to cause localized depletions that would significantly alter the genetic sub-population structure of the Alaska plaice stock. Change in reproductive success of Alaska plaice due to climate changes and regime shifts is identified as potentially beneficial or adverse. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could also the reproductive success of BSAI Alaska plaice.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Alaska plaice catch and is rated as insignificant. The combined effect of internal removals and external removals are not expected to jeopardize the capacity of the stock to sustain itself above the MSST.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI Alaska plaice is insignificant.

- **Persistent Past Effects.** Climate changes are identified as having effected prey availability of the BSAI Alaska plaice stock. The actual effect of climate changes and regime shifts on Alaska plaice prey availability is unknown, but could have had a potentially beneficial or adverse effect. See Sections 3.5.1.10 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Alaska plaice stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events are not expected to jeopardize the capacity of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI Alaska plaice is rated as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI Alaska plaice include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. Habitat disturbances caused by the past foreign, JV, and domestic fisheries have also been identified as having persistent past effects on the BSAI Alaska plaice stock See Sections 3.5.1.10 and 3.10 for more information regarding the past fisheries and climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Alaska plaice stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Alaska plaice habitat suitability and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events is not expected to jeopardize the capacity of the stock to sustain itself above the MSST.

BSAI Other Flatfish – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on the BSAI other flatfish complex. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The catch of BSAI other flatfish in 2002 was estimated to be 2,600 mt. Model projections of future catch are shown in Table H.4.10 of Appendix H. Under FMP 1, model projections indicate that the catch is expected to decrease from the 2002 value to 2,200 mt in 2003 and then increase each year to 2,500 mt in 2007 (5 percent decrease from 2002). The 2003-2007 average catch is 2,300 mt. The impact of fishing mortality on BSAI other flatfish is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total and spawning biomass estimates are not available for these species. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual BSAI other flatfish harvest would not be affected under FMP 1, relative to the 2002 baseline year. Evidence is insufficient to conclude whether the harvest concentration under FMP 1 would lead to a detectable change in genetic diversity or reproductive success that would affect the stock's ability to sustain itself at or above the MSST. Therefore, the impact of the spatial/temporal pattern of the catch on BSAI other flatfish under FMP 1 is unknown.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP. Because evidence is not available to determine whether, under FMP 1, future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the BSAI other flatfish stocks to sustain themselves at or above their MSSTs, this potential impact is unknown.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on other flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. Consequently, evidence is not available to determine whether future harvest levels and distribution of harvest under this FMP would lead to a change in prey availability that would affect the ability of the BSAI other flatfish stocks to sustain themselves at or above their MSSTs. Therefore, this potential impact is unknown.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Other Flatfish

The direct and indirect effects of FMP 1 on BSAI other flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the five-year projection and what level of fishing mortality corresponds to the modeled catch estimated under this FMP.

Status Determination from Modeling

Stock Size Relative to MSST

The available information for flatfish species in the other flatfish complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species in the National Standard Guidelines. Therefore, it is not possible to determine the status of their stock sizes relative to their MSSTs.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratios of the species in the other flatfish category in the BSAI are assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-18 summarizes the cumulative effects analysis for BSAI other flatfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other flatfish is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects have not been identified for BSAI other flatfish mortality.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other flatfish and is rated as insignificant. Fs for projected years are well below the other flatfish OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Past effects have not been identified for the BSAI other flatfish change in biomass level effect indicator.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other flatfish, but this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the spatial/temporal concentration of catch are the same as those described for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for the spatial/temporal concentration of catch are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other flatfish catch, but this effect is unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the change in prey availability are the same as those described for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for the change in prey availability are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability. However, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for habitat suitability of BSAI other flatfish are the same as those described for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for habitat suitability are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for BSAI other flatfish habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

GOA Rex Sole – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA rex sole. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The catch of GOA rex sole in 2002 was estimated to be 3,000 mt. Model projections of future catch are shown in Table H.4.26 of Appendix H. Under FMP 1, model projections indicate that the catch is expected to increase from the 2002 value to 3,300 mt in 2003and then decrease thereafter to 2,500 mt in 2007. The 2003-2007 average catch is 3,000 mt. The impact of fishing mortality on GOA rex sole is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total and spawning biomass estimates are not available for this species, and the MSST cannot be determined. Therefore, the potential effect of FMP 1 on GOA rex sole biomass levels is unknown.

Spatial/Temporal Concentration of Catch

The spatial/temporal characteristics of the annual GOA rex sole harvest would not be affected under FMP 1, relative to the 2002 baseline year. Evidence is insufficient to conclude whether the harvest concentration under FMP 1 would lead to a detectable change in genetic diversity or reproductive success that would affect the stock's ability to sustain itself at or above the MSST. Therefore, the impact of the spatial/temporal pattern of the catch on GOA rex sole under FMP 1 is unknown.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP. The potential impact of FMP 1 is unknown because evidence is not available to determine whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the GOA rex sole stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 on rex sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. Therefore, it is unknown whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the GOA rex sole stock's ability to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Rex Sole

The direct and indirect effects of FMP 1 on GOA rex sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. Potential changes in the F would be too small to affect MSY and are therefore considered insignificant. It is unknown what the estimate of female spawning biomass of this stock would be over the five-year projection and what level of fishing mortality would correspond to the modeled catch estimated under this FMP.

Status Determination from Modeling

Stock Size Relative to MSST

The available information for rex sole requires that they are classified in the Tier 5 management category. As a result, no MSSTs are defined for these species in the National Standard Guidelines. Therefore, it is not possible to determine the status of their stock size relative to MSST.

Age and Size Composition

Age and size composition estimates are not available for this species.

Sex Ratio

The sex ratio of rex sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-19 summarizes the cumulative effects analysis for GOA rex sole.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA rex sole is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Large removals of rex sole by the past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on GOA rex sole stocks. See Section 3.5.1.23 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rex sole. The State of Alaska scallop fishery has also been identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA rex sole and is rated as insignificant. Fs for projected years are well below the rex sole OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Large removals of rex sole by past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA rex sole stocks. See Section 3.5.1.23 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts have also been identified as having an indirect potentially beneficial or adverse effect on the rex sole biomass level. The State of Alaska Scallop Fishery is identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole. For more information on climate changes and regime shifts, see Sections 3.5.1.23 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA rex sole, but is the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects are not identified for genetic structure of the population; however, climate changes and regime shifts are identified as having persistent past effects on the reproductive success of the GOA rex sole stock. See Sections 3.5.1.23 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the genetic structure of rex sole include the potential adverse effects of marine pollution; an acute and/or chronic pollution event could alter the genetic structure of the population by causing localized mortality. The State of Alaska scallop fishery and climate changes and regime shifts have both been identified as non-contributing factors to the change in genetic structure of rex sole stocks. These events are not expected to cause localized depletions that would alter the genetic sub-population structure of rex sole stock. Change in reproductive success of rex sole due to climate changes and regime shifts is identified as having a potentially beneficial or adverse effect. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could also the reproductive success of GOA rex sole. Again, the State of Alaska scallop fishery has been identified as a non-contributing factor since the scallop fishery is not expected to contribute to rex sole removals.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rex sole catch; however, these effects are unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate change and regime shifts have been identified as having effected the change in prey availability of the GOA rex sole stock. The actual effect of climate changes and regime shifts on rex sole prey availability is unknown, but could have had a potentially beneficial or adverse effect. See Sections 3.5.1.23 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The State of Alaska scallop fishery has been identified as having a potential adverse effect on rex sole prey availability since the habitat disturbances caused by dredging could influence the benthic prey availability.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for GOA rex sole include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. Habitat disturbances caused by the past foreign, JV, and domestic fisheries have also been identified as having persistent past effects on the GOA rex sole stock. See Sections 3.5.1.23 and 3.10 for more information regarding the past fisheries and climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as having potential adverse effects on rex sole habitat suitability that may cause changes in the spawning or rearing success of the stock.

- **Cumulative Effects.** A cumulative effect is identified for GOA rex sole habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

4.5.1.11 Pacific Ocean Perch

Pacific ocean perch (*Sebastes alutus*) are managed as a single stock in the EBS, Aleutian Islands, and GOA, and separate assessments are made for each region. Within the GOA, ABC limits are apportioned within four management areas in an effort to reduce the risk of localized depletion. Trawl fishing is not permitted in the southeast/east Yakutat area and the ABC (approximately 12 percent of the total GOA ABC) normally allocated to that area is not likely to be caught. Pacific ocean perch are managed under Tier 3 in both the BSAI and GOA.

BSAI Pacific Ocean Perch – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on BSAI and GOA Pacific ocean perch. All of these potential effects are expected to be insignificant. The significance ratings are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The projected fishing mortality imposed on the BSAI Pacific ocean perch stock in 2003 is 0.033. Model projections show this fishing mortality will decrease to 0.027 in 2005 and then increase to 0.033 in 2008 (Table H.4-12 of Appendix H). These values are below the $F_{35\%}$ level of 0.057 and the $F_{40\%}$ level of 0.048, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. The implied SPR fishing rates under FMP 1 is 51 percent in 2003, increasing to 56 percent in 2005, and decreasing to 51 percent in 2008. The average implied SPR rate of fishing from 2003-2008 is 51 percent. The impact of fishing mortality on BSAI Pacific ocean perch is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

Total biomass (ages 3 through 21+) of BSAI Pacific ocean perch at the start of 2003 is estimated to be 374,000 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 of Appendix H. Under FMP 1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 396,000 mt in 2008, with a 2003-2008 average value of 385,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spawning Biomass

Spawning biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 135,500 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 of Appendix H. Under FMP 1, model projections indicate that BSAI Pacific ocean perch biomass is expected to decrease to a value of 135,300 mt in 2004, then increase to a value of 138,800 mt in 2008, with a 2003-2008 average value of 136,800 mt. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

In recent years, the Pacific ocean perch directed fishery in the Aleutian Islands typically occurs in the month of July. Fishery observer data from 2000-2002 indicates that approximately 80 percent of the Pacific ocean perch in the BSAI are harvested during this month; there is no directed fishing for Pacific ocean perch in the EBS management area. Projected harvest under FMP 1 indicates that an average of 10,600 mt is harvested in the BSAI area, with 49 percent from the eastern Aleutians, 23 percent from the western Aleutians, 22 percent from the central Aleutians, and 6 percent from the EBS. This impact is expected to be insignificant, because the concentration of harvest under FMP 1 would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 1.Therefore, the effects of FMP 1 on habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Pacific Ocean Perch

Because BSAI Pacific ocean perch are fished at less than the OFL and are above the minimum stock size threshold, the direct and indirect effects under FMP 1 are considered insignificant. Fishing rates are well within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Pacific ocean perch are below the ABC and OFL levels in all years, and projected spawning stock biomass is above B_{MSY} ($B_{35\%}$) level of 120,200 mt; thus, BSAI Pacific ocean perch are determined to be above the MSST level under FMP 1 (Table H.4-12 of Appendix H).

Age and Size Composition

Under FMP 1, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections, is 10.38 years. This compares with a mean age in the equilibrium unfished stock of 14.01 years.

Sex Ratio

The sex ratio of BSAI Pacific ocean perch is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-20 summarizes the cumulative effects analysis for BSAI Pacific ocean perch.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific ocean perch stock is insignificant under FMP 1.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to BSAI Pacific ocean perch mortality since bycatch in this fishery is not expected. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific ocean perch mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific ocean perch stock is expected to be insignificant under FMP 1.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute significantly to BSAI Pacific ocean perch change in biomass since bycatch is not expected in this fishery. Therefore, the IPHC longline fishery is also not expected to cause significant changes in biomass levels. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to Pacific ocean perch change in biomass levels as a function of reproductive success.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the BSAI Pacific ocean perch population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.11) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to changes in genetic structure or reproductive success of BSAI Pacific ocean perch since bycatch of BSAI Pacific ocean perch is not expected to occur. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potentially beneficial or adverse contributor to reproductive success since changes in climate can affect prey availability and/or habitat suitability which in turn can affect recruitment. Generally, changes in climate changes that lead to increased advection of the Alaska current are believed to increase euphausiid production, a major prey item of BSAI Pacific ocean perch. Climate changes and regime shifts are not considered to contribute to changes in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** It is determined that FMP 1 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific ocean perch prey species (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific ocean perch prey species are identified as potentially beneficial or adverse contributors. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** It is determined that FMP 1 would have insignificant effects on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for BSAI Pacific ocean perch stocks include past foreign, JV, and domestic fisheries, IPHC longline fisheries, climate changes and regime shifts (see Section 3.5.1.11). Intense bottom trawling on Pacific ocean perch habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries are also identified as having adverse effects on Pacific ocean perch habitat, although these fishing gear impacts are considered to be less significant than those associated with trawl gear (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both beneficial and adverse effects on Pacific ocean perch habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is identified as making adverse contributions to Pacific ocean perch habitat through fishing gear impacts. As stated above, these impacts are expected to be of lesser magnitude than those effects associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific ocean perch stock are identified as potentially beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the BSAI Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

GOA Pacific Ocean Perch – Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA Pacific ocean perch. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1. Section 3.5.1.24 discusses the past/present effects analysis for GOA Pacific ocean perch in more detail.

Total and Spawning Biomass and Fishing Mortality

ABC is used as a proxy for TAC in model projections. The FMP 1 model projections for GOA Pacific ocean perch catch are unrealistically low relative to projected ABC. For example, from 1997 to 2001 catch of Pacific ocean perch in the western, central, and eastern GOA has averaged 76 percent of the ABC (Heifetz *et al.* 2002). Average projected catch for the years 2003-2008 under FMP 1 is only 57 percent of projected ABC. Consequently, average catch under FMP 1 would likely be higher (average of 76 percent of projected ABC) for the years 2003-2008. Spawning biomass, fishing mortality, vulnerable biomass, and implied SPR rates would also change relative to an average catch of 76 percent of projected ABC for the years 2003-2008. However, average fishing mortality during the years 2003-2008 is still expected to be less than F_{OFL} (0.060) (Table H.4-36 of Appendix H). Because total and spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1. The impact of fishing mortality on GOA Pacific ocean perch is also expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Spatial/Temporal Concentration of Catch

Under FMP 1, trawl fishing is not permitted in the southeast/east Yakutat area and the ABC (approximately 12 percent of the total GOA ABC) normally allocated to that area is not likely to be caught. Under FMP 1, GOA Pacific ocean perch are taken in the central (80 percent of GOA Pacific ocean perch captured), western (13 percent), and eastern (7 percent) GOA, primarily in directed Pacific ocean perch bottom trawl fisheries (74 percent of GOA Pacific ocean perch captured), directed Pacific ocean perch pelagic trawl fisheries (11 percent), and as bycatch in directed bottom trawl fisheries for other rockfish species (11 percent).

Under FMP 1, the ABC for Pacific ocean perch is determined for the entire GOA, and then geographically apportioned among management areas. This apportionment spreads fishery effort over the GOA and reduces the risk of localized depletion. In the GOA, Pacific ocean perch are taken largely in directed fisheries and the fishery tends to concentrate in slope areas away from the proposed closures for Steller sea lion prey species under FMP 1.

Under FMP 1, the Pacific ocean perch trawl fishery would be managed as under the current GOA FMP which has an open season that occurs in July and generally lasts a few weeks. The open fishery system compresses the fishery effort into a short time period and creates difficulty for the management of the fishery by increasing the risk of possible overfishing if the fishery is not closed before catch exceeds ABC.

For the reasons discussed above, the impact of the spatial/temporal concentration of catch on GOA Pacific ocean perch is expected to be insignificant under FMP 1, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Under FMP 1, bottom trawling or other fishing gear in contact with the ocean floor of the GOA continental shelf and upper slope could adversely affect the habitat of juvenile Pacific ocean perch. Juvenile Pacific ocean perch tend to live inshore in shallower depths than adults, and may also be associated with epifauna that provides structural relief on the bottom such as corals or sponges. If so, damage to this epifauna by bottom trawls may reduce survival of juvenile fish.

At the same time, FMP 1 would reduce impacts to GOA Pacific ocean perch habitat because it would close the eastern GOA to trawling. This would create a *de facto* no-take zone or refugium for Pacific ocean perch in this area, as trawls are generally the only effective gear for capturing this species. Biomass estimates from trawl surveys indicate that the trawl closure area in the eastern GOA contains 12 percent of the GOA biomass of Pacific ocean perch. Consequently, this refugium may be large enough to provide enhanced protection to the rockfish resource. Use of refugia as a conservation measure could be particularly effective for rockfish species, as most are generally believed to be sedentary in nature and not undergo extensive migrations. The closed areas may allow increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. The trawl closure would also prevent damage to the benthic environment in the eastern GOA, because bottom trawls would no longer be used. Although little is known about the habitat preferences of Pacific ocean perch, an undamaged benthic habitat likely provides a benefit to the adults as well as juveniles of this species.

On balance, FMP 1 would create conditions for both beneficial and adverse impacts on GOA Pacific ocean perch habitat. It is unlikely, however, that future levels of habitat disturbance under FMP 1 would lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

The major prey of Pacific ocean perch is euphausiids, and Pacific ocean perch may in turn be preyed upon by large piscivorous fish. There is no indication that existing trophic interactions would undergo significant qualitative change under FMP 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Pacific Ocean Perch

The analysis of potential direct and indirect effects on GOA Pacific ocean perch is based on stock sustainability as indexed by projection model estimates of fishing mortality relative to the overfishing limit (F_{OFL}), and by projection model estimates of female spawning stock biomass relative to the MSST.

Under FMP 1, average fishing mortality during the years 2003-2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 1, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. The direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, and the indirect effects of both the change in prey availability and the change in habitat suitability are believed to have an insignificant impact on stock sustainability.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, GOA Pacific ocean perch projected female spawning biomass for 2003 (B2003) of 113,000 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. Projected female spawning biomass for 2005 (B2005) of 113,500 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition

GOA Pacific ocean perch are slow growing and long-lived (maximum age 84 years; mean age at recruitment, 10 years; Heifetz *et al.* 2002).

Under FMP 1, the age composition of GOA Pacific ocean perch could change under fishing pressure. For example, under FMP 1, the mean age of the GOA Pacific ocean perch in 2008, as computed in model projections, is 10.6 years. This compares with an estimated mean age in the equilibrium unfished GOA stock of 14.3 years. Note that the mean ages and sizes actually observed in 2008 will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of GOA Pacific ocean perch is 50:50, but females are generally larger than males. No information is available to suggest that sex ratio would change under FMP1, but size composition of GOA Pacific ocean perch might change in proportion to the change in age composition.

Cumulative Effects of FMP 1

Table 4.5-21 summarizes the cumulative effects analysis for GOA Pacific ocean perch.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific ocean perch stock is insignificant under FMP 1.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific ocean perch stock is expected to be insignificant under FMP 1.

- **Persistent Past Effects.** Past effects on the change in biomass level are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects on the change in genetic structure and reproductive success of GOA Pacific ocean perch are the same as those indicated for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in genetic structure and reproductive success of GOA Pacific ocean perch are the same as those indicated for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** It is determined that FMP 1 would have an insignificant effect on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past effects on the change in prey availability are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** It is determined that FMP 1 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

4.5.1.12 Thornyhead Rockfish

Numerous fishery management actions have been implemented that affect the thornyhead rockfish fisheries in the GOA. These actions are described in more detail in Section 3.5.1.23 of this Programmatic SEIS. Until recently, thornyhead rockfish were managed as its own stock under the GOA groundfish FMP under the Tier 3 management category; thus MSSTs are defined for these species by the National Standard Guidelines. Beginning in 2004, thornyhead rockfish will be managed under Tier 5. GOA thornyhead rockfish were modeled under the Tier 3 category for this analysis.

Direct/Indirect Effects of FMP 1

The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA thornyhead rockfish. All of these potential effects are expected to be insignificant. The significance ratings are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The average fishing mortality imposed on the GOA thornyhead stock in 2002 is projected to be 0.032 under current management. Under FMP 1, fishing mortality is projected to decrease to 0.021 in 2003 and decrease further to 0.016 in 2007. These values are well below the F_{MSY} proxy value of 0.102 which is the rate associated with the OFL (Table H.4-37 of Appendix H). The impact of fishing mortality on GOA thornyhead rockfish is expected to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Total Biomass

Total (ages 5 through 55+) biomass of GOA thornyheads at the start of 2002 is estimated to be 54,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-37 of Appendix H. Under FMP 1, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly increase to a value of 56,000 mt by 2007, with a 2003-2007 average value of 55,000 mt. Because total biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spawning Biomass

Spawning biomass of female GOA thornyheads at the start of 2002 is estimated to be 23,500 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-37 of Appendix H. Under FMP 1, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and increasing to 24,600 mt by 2007, with a 2002-2007 average value of 24,100 mt. Because spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST, this effect would be insignificant under FMP 1.

Spatial/Temporal Concentration of Catch

Thornyhead catch is approximately evenly divided between longliners and trawlers under status quo management. There is nothing about FMP 1 that is expected to change this. Longline catches are spatially dispersed along the continental shelf break throughout the GOA (Figure 4.5-1) and temporally dispersed due to the nature of the Individual Fishing Quota (IFQ) sablefish fishery. For example, longline thornyhead catches in 2000 occurred year round, with peaks in April and September which did not exceed 60 mt per week. Trawler catch has been more concentrated in time, with some catches of 20-40 mt per week happening in late spring and a single large peak of 160 mt per week in 2000 during July, coincident with the rockfish trawl fishery. Figure 4.5-2. The distribution of thornyheads from surveys did not appear to change over the same time period (Figure 4.5-3). This apparent concentration may be the indirect result of changes in the trawl fisheries for deepwater flatfish and rockfish since thornyheads are not a primary target of trawl fisheries. However, it should be noted that the overall catch of thornyheads is low relative to both the estimated biomass and the ABC, such that this apparent concentration of catch is unlikely to have any adverse population effects. Therefore, this impact is expected to be insignificant, because the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Under FMP 1, all current management measures would be maintained. The level of habitat disturbance expected under FMP 1 would not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. There is no indication that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP. Therefore, the effects of FMP 1 on thornyhead habitat suitability are expected to be insignificant, because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

In the GOA, shortspine thornyheads prey on benthic invertebrates; according to the AFSC food habits database, much of their diet in the 1990s has been composed of shrimp. Thornyheads are rare in the diets of other groundfish, birds, or marine mammals in the GOA according to the present limited information. Therefore, the effects of status quo federal groundfish fisheries on trophic interactions involving GOA thornyheads are expected to be minor. The current levels and distribution of groundfish harvest do not appear to impact prey availability for thornyheads such that it affects the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. There is no indication that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 1. Therefore, this impact is expected to be insignificant because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Thornyhead Rockfish

The GOA thornyhead stock appears to be healthy and stable under current management, and catches have generally been below the estimated ABCs because thornyheads are taken as bycatch in other directed fisheries. To the best of our knowledge, thornyheads are widely distributed in the deeper habitats of the GOA, where fishing impacts have historically been low. As long as catches remain at or near the currently observed low levels, as predicted under FMP 1, we do not expect any significant population effects to thornyheads.

Status Determination from Modeling

Stock Size Relative to MSST

The GOA thornyhead stock is not overfished. At 23,500 mt, spawning stock biomass is expected to be well above both $B_{35\%}$ level (14,681 mt) as well as the $B_{40\%}$ level (16,045 mt) in the year 2002 and will remain above $B_{40\%}$ in all projection years under FMP 1.

Age and Size Composition

Under FMP 1, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.23 years. This compares with a mean age in the equilibrium unfished GOA stock of 12.67 years.

Sex Ratio

The sex ratio of GOA thornyheads is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-22 summarizes the cumulative effects analysis for GOA thornyhead rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA thornyhead rockfish is rated as insignificant under FMP 1.
- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. The removals of thornyhead rockfish that occurred in these fisheries have had a lingering adverse effect on the populations. See Section 3.5.1.23 for more information.
- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of thornyhead rockfish. The IPHC longline fishery is

identified as a potential adverse contributor to thornyhead rockfish mortality since they are caught as bycatch in this fishery. However, the State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA thornyhead rockfish and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** It is not expected that FMP 1 will result in a significantly adverse impact to these stocks.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. Past removals by these fisheries have had a lingering adverse effect on the GOA thornyhead rockfish populations. See Section 3.5.1.23 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the thornyhead rockfish biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.23 and 3.10. The IPHC longline fishery is identified as a potential adverse contributor to the thornyhead rockfish biomass level since they are caught as bycatch in this fishery. The State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA thornyhead rockfish and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA thornyhead rockfish. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of GOA thornyhead rockfish. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the thornyhead rockfish stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of thornyhead rockfish due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA thornyhead rockfish. The IPHC longline fishery removals could be sufficiently concentrated as to alter the genetic structure and reproductive success of GOA thornyhead rockfish populations and is therefore identified as a potential adverse contributor. The State of Alaska shrimp fishery is identified as a non-contributing factor since bycatch of thornyhead rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the thornyhead rockfish catch and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation effect the availability of some prey species (i.e. shrimp); however, studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor since bycatch of GOA thornyhead rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to prey availability since removal of shrimp, the main prey species of GOA thornyhead rockfish, occurs in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA thornyhead rockfish include climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery has been identified as a potential adverse contributor to GOA thornyhead rockfish habitat suitability. See Section 3.6.4 for information on the impacts of fishery gear on EFH. The State of Alaska shrimp fishery is identified as a non-contributing factor since habitat degradation by the shrimp fishery gear is not expected to occur.

- **Cumulative Effects.** A cumulative effect is identified for GOA thornyhead rockfish habitat suitability and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the thornyhead rockfish stock to sustain itself at or above the MSST is jeopardized.

4.5.1.13 Rockfish

At least 32 rockfish species of the genera *Sebastes* and *Sebastolobus* have been reported to occur in the GOA and BSAI (Eschmeyer *et al.* 1984), and several of these species are of commercial importance. Sections 3.5.1.12 and 3.5.1.24 describes rockfish in the BSAI and GOA in more detail.

BSAI Northern Rockfish – Direct/Indirect Effects of FMP 1

Until recently, northern rockfish, rougheye rockfish, and shortraker rockfish made up the other red rockfish assemblage in the BSAI. This group was managed under Tier 5 of Amendment 56 to the BSAI groundfish management plan. As of 2004, northern rockfish is managed separately under Tier 3, and shortraker/rougheye rockfish are managed under Tier 5. The other red rockfish group no longer exists. BSAI northern rockfish were modeled under the Tier 5 category for this analysis. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

<u>Fishing Mortality</u>

The catch of BSAI northern rockfish in 2003 was estimated as 6,400 mt. Projected catches from 2003-2008 are shown in Table H.4-15 in Appendix H. Under FMP 1, model projections indicate that the catch is expected to decrease to 5,400 mt in 2005, then increase to 5,600 mt in 2008. The 2003-2008 average catch is 5,800 mt. The impact of fishing mortality on BSAI northern rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Reliable estimates of total and spawning biomass are not available for this species. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

Northern rockfish are caught as bycatch in the BSAI area, with much of the harvest occurring in the Aleutian Islands (Spencer and Reuter 2002). Model projections indicate that the average harvest of 5,800 mt from 2003-2008 occurs largely in the eastern Aleutian Islands (3,100 mt, 55 percent), with 1,260 mt (22 percent) occurring in the central Aleutians and 1,100 mt (18 percent) occurring in the western Aleutians. The harvest of northern rockfish in the Aleutian Islands is taken largely in the Atka mackerel fishery. The potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. There is no indication that existing habitat- mediated impacts would undergo significant qualitative change under FMP 1. Evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST. Therefore, the potential effect of FMP 1 on habitat suitability for BSAI northern rockfish is unknown.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. There is no indication that trophic interactions would undergo significant qualitative change under FMP 1. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for BSAI northern rockfish is unknown.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Northern Rockfish

An age-structured population model for BSAI northern rockfish is not available, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI northern rockfish are fished at less than the OFL and the effects of mortality under FMP are considered insignificant. Since the MSST cannot be calculated, the spatial/temporal distribution of catch and other direct/indirect effects are unknown.

Status Determination from Modeling

Stock Size Relative to MSST

The catch rates are below the ABC and OFL values for all years. The MSST has not been determined for this species.

Age and Size Composition

Age and size composition estimates are not available for this species.

Sex Ratio

The sex ratio of BSAI northern rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-23 summarizes the cumulative effects analysis for BSAI northern rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI northern rockfish is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI northern rockfish. See Section 3.5.1.12 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution; acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of northern rockfish. The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI northern rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not able to be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI northern rockfish. See Section 3.5.1.12 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the northern rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.12 and 3.10. The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI northern rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI northern rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI northern rockfish. See Section 3.5.1.12 and Section 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of northern rockfish due to climate changes and regime shifts are potentially beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of northern rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI northern rockfish. The IPHC longline fishery has been identified as a non-contributing factor to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the northern rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI northern rockfish stock. The actual effect of climate changes and regime shifts on northern rockfish prey availability is unknown, but could have had a potentially beneficial or adverse effect. See Sections 3.5.1.12 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of northern rockfish prey species occurs in this fishery. See Section 3.5.1.12 for more information on the trophic interactions of BSAI northern rockfish species.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI northern rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in northern rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on northern rockfish species habitat suitability, possibly having disrupted northern rockfish species spawning and/or rearing habitats. See Section 3.5.1.12 for more information on the past events that have affected northern rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the northern rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt northern rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the northern rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

BSAI Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 1

As stated above, until recently, rougheye and shortraker rockfish made up the other red rockfish assemblage in the BSAI. These species now make up their own group and are managed under Tier 5. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The catch of BSAI shortraker/rougheye rockfish in 2003 was estimated as 800 mt. Projected catches from 2003-2008 are shown in Table H.4-16 in Appendix H. Under FMP 1, model projections indicate that the catch is expected to range between 700 and 900 mt between 2003 and 2008, with an average catch of 800 mt. The impact of fishing mortality on BSAI shortraker/rougheye rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Reliable estimates of total and spawning biomass are not available for these stocks. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

Shortraker/rougheye rockfish are caught as bycatch in the BSAI area, with much of the harvest occurring in the Aleutian Islands (Spencer and Reuter 2002). Model projections indicate that the average harvest of 800 mt from 2003-2008 occurs evenly throughout the Aleutians Islands, with between 27 percent-31 percent occurring in each of the Aleutian Islands subareas. The harvest of shortraker/rougheye rockfish in the Aleutian Islands is taken in the Pacific ocean perch and Pacific cod longline fisheries. The potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST.

Habitat Suitability

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. There is no indication that existing habitat- mediated impacts would undergo significant qualitative change under FMP 1. Evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST. Therefore, the potential effect of FMP 1 on habitat suitability for BSAI shortraker/rougheye rockfish is unknown.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. There is no indication that trophic interactions would undergo significant qualitative change under FMP 1. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for BSAI shortraker/rougheye rockfish is unknown.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Shortraker/Rougheye Rockfish

An age-structured population model is not available for either BSAI shortraker or rougheye rockfish, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI shortraker/rougheye rockfish are fished at less than the OFL and the effects of mortality under FMP 1 are considered insignificant. Since the MSST cannot be calculated, the spatial/temporal distribution of catch and other direct/indirect effects are unknown.

Status Determination from Modeling

Stock Size Relative to MSST

The catch rates are below the ABC and OFL values for all years. MSSTs have not been determined for these stocks.

Age and Size Composition

Age and size composition estimates are not available for these stocks.

Sex Ratio

The sex ratio of BSAI shortraker/ rougheye rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 1.

Cumulative Effects of FMP 1

Table 4.5-24 summarizes the cumulative effects analysis for BSAI shortraker/rougheye rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI shortraker/rougheye rockfish is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI shortraker/rougheye rockfish. See Section 3.5.1.13 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI shortraker/rougheye rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not able to be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on BSAI shortraker/rougheye rockfish. See Section 3.5.1.13 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to potential adverse effects of marine pollution; acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.13 and 3.10. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as a non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI shortraker/rougheye rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI shortraker/rougheye rockfish. See Section 3.5.1.13 and Section 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of shortraker/rougheye rockfish due to climate changes and regime shifts are potentially beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of shortraker/rougheye rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery have been identified as non-contributing factors to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the shortraker/rougheye rockfish catch, but the effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI shortraker/rougheye rockfish stock. The actual effect of climate changes and regime shifts on shortraker/rougheye rockfish prey availability is unknown, but could have had a potentially beneficial or adverse effect. See Sections 3.5.1.13 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of shortraker/rougheye rockfish prey species occurs in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to BSAI shortraker/rougheye prey availability since shrimp is one of the main prey species of rougheye rockfish. See Section 3.5.1.13 for more information on the trophic interactions of BSAI shortraker/rougheye rockfish species.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI shortraker/rougheye rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in shortraker/rougheye rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on shortraker/ rougheye rockfish species habitat suitability, possibly having disrupted shortraker/rougheye rockfish species spawning and/or rearing habitats. The State of Alaska shrimp fishery is identified as a non-contributing factor to shortraker/rougheye rockfish habitat suitability since habitat degradation by shrimp fishery gear is not expected to occur. See Section 3.5.1.13 for more information on the past events that have affected shortraker/rougheye rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the shortraker/rougheye rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt shortraker/rougheye rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the shortraker/rougheye rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

BSAI Other Rockfish – Direct/Indirect Effects of FMP 1

Twenty-nine species are included in the BSAI other rockfish assemblage (see Section 3.5.1.14), but they are dominated in abundance by the light dusky rockfish and shortspine thornyheads. Currently, this complex is assumed to be two separate stocks in the EBS and Aleutian Islands regions and is assessed as such. The BSAI other rockfish assemblage falls under Tier 5 of Amendment 56 of the BSAI groundfish FMP, relying on biomass estimates to determine ABC and OFL values. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The catch of Aleutian Islands other rockfish in 2003 was estimated as 300 mt, ranging between 200 mt and 300 mt from 2003 to 2008. In the EBS, the projected harvest was 100 mt in each projection year. Projected catches from 2003-2008 are shown in Tables H.4-13 and H.4-14 in Appendix H. The 2003 OFL for this species complex is 846 mt and 1,280 mt in the Aleutian Islands and EBS, respectively (Reuter and Spencer 2002). Fishing mortality at projected levels is well below the OFL for other rockfish, so FMP 1 is not likely to jeopardize the capacity of the stock to produce MSY on a continuing basis. Therefore, this impact is considered insignificant.

When species are managed as complexes rather than individual species, more abundant species may be disproportionately exploited and thus suffer higher mortality. For example, Reuter and Spencer (2002) recommended that light dusky rockfish be split out of the other rockfish group and assigned a separate ABC. Their findings indicate that light dusky rockfish make up a large amount of the other rockfish catch in the Aleutian Islands and may be disproportionally exploited. Furthermore, Reuter and Spencer (2002) have recommended that EBS and Aleutian Islands biomass estimate for light dusky rockfish be combined for the BSAI. This recommendation comes in light of new catch and survey distribution maps which show continuous spatial distribution of light dusky rockfish along the Aleutian Islands and EBS slope.

Change in Biomass Level

Estimates of total and spawning biomass are not available for these species. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

Species included in the other rockfish category are caught as bycatch in the BSAI area, with much of the harvest occurring in the Aleutian Islands (Reuter and Spencer 2002). In the Aleutian Islands, 89 percent of the average harvest of 300 mt occurs largely in the western and central Aleutian Islands, taken largely in the Atka mackerel trawl fishery and the sablefish longline fishery. In the EBS, the average catch of 100 mt is taken largely in the Pacific cod bottom trawl fishery, and the sablefish and Greenland turbot longline fisheries. Information is insufficient to determine whether existing harvest patterns would undergo any significant change under FMP 1. Consequently, the potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST.

Habitat Suitability

Any habitat suitability impacts of FMP 1, such as adverse effects to spawning habitat, nursery grounds, and benthic structures, as a result of commercial fishing would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST. Therefore, the potential effect of FMP 1 on habitat suitability for BSAI shortraker/rougheye rockfish is unknown.

Prey Availability

As with habitat related impacts, any effects of FMP 1 on predator-prey relationships would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that such trophic interactions would undergo any significant change from the current condition. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for BSAI shortraker/rougheye rockfish is unknown.

Summary of Direct and Indirect Effects of FMP 1 on BSAI Other Rockfish

An age-structured population model is not available for either Aleutian Islands or EBS other rockfish, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, other rockfish are fished at less than the ABC in each area, and the direct and indirect effects under FMP 1 are considered either insignificant or unknown. The spatial/temporal distribution of catch should have no significant direct impact on stock productivity.

Status Determination from Modeling

Stock Size Relative to MSST

The F is below the ABC and OFL values for the other rockfish complex. MSSTs have not been determined for these species.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The estimated sex ratio is not available for these species.

Cumulative Effects of FMP 1

Table 4.5-25 summarizes the cumulative effects analysis for BSAI other rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other rockfish is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for BSAI shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, the effect of changes in biomass level is rated as unknown since the MSST for this stock complex is not able to be determined.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those described for BSAI shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those described for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI other rockfish catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of other rockfish are the same as those described for shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in prey availability of other rockfish are the same as those described for shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of other rockfish are the same as those described for shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in habitat suitability of other rockfish are the same as those described for shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of other rockfish are the same as those described for shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the other rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

GOA Northern Rockfish – Direct/Indirect Effects of FMP 1

Tier 3a is used to compute the ABC and OFL values for northern rockfish. Northern rockfish are combined with other slope rockfish in the eastern GOA (Heifetz *et al.* 2002). The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA northern rockfish. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality and Change in Biomass Level

Average projected catch under FMP 1 is only 49 percent of projected ABC during the years 2003 to 2008. Consequently, average catch under FMP 1 would likely be higher (average catch of 71 percent of projected ABC) during the years 2003 - 2008. Spawning biomass, fishing mortality, vulnerable biomass, and implied SPR rates would also change relative to an average catch of 71 percent of ABC during the years 2003 to 2008. However, average fishing mortality during the years 2003 to 2008 is still expected to be less than F_{OFL} (0.066). A lack of recent strong year-classes to the age structured model for GOA northern rockfish also leads to the projected ABC and catch decreasing with time, which is adequately represented in the projection model (Table H.4-35 of Appendix H). The impact of fishing mortality on GOA northern rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The potential impact of FMP 1 on GOA northern biomass levels is also expected to be insignificant, because total and spawning biomass would tend toward levels that would maintain the ability of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

Under FMP 1, GOA northern rockfish are taken in the central (89 percent of GOA northern rockfish captured) and the western (11 percent) GOA, primarily in directed rockfish bottom trawl fisheries (60 percent of GOA northern rockfish captured) and as bycatch in Pacific ocean perch bottom trawl fisheries (22 percent).

The ABC for northern rockfish is determined for the entire GOA and then geographically apportioned among management areas. This apportionment spreads fishery effort over the GOA in an effort to reduce the risk of localized depletion. However, the majority of EBS and GOA northern rockfish commercial catches have historically come from the same localized geographic regions year after year. The largest GOA commercial catches occurred in one area known as the Snakehead which accounted for 45.8 percent of all GOA northern rockfish catches from 1990-1998 (Clausen and Heifetz, in preparation). Similarly, the largest EBS commercial catches occurred in one area known as the Zhemchug Canyon which accounted for 57.05 percent of all EBS northern rockfish catches from 1990-1998 (Clausen and Heifetz, in preparation). Aleutian Islands northern rockfish commercial catches were also concentrated in several geographic regions, but there was no single localized aggregation that dominated the catch year after year. Based upon these highly localized catches, northern rockfish are not believed to be highly mobile or migratory as adults and there may be a potential for localized depletion of this stock even with apportionment among management areas.

Northern rockfish catches in the GOA are largely taken in directed rockfish fisheries and are highly localized in areas away from the proposed Steller sea lion prey species closures found in FMP 1.

Under FMP 1, the northern rockfish trawl fishery would be managed as under the current GOA FMP which has an open season that occurs in July and generally lasts a few weeks. The open fishery system compresses the fishery effort into a short time period and creates difficulty for the management of the fishery by increasing the risk of possible overfishing if the fishery is not closed before catch exceeds ABC.

This impact is expected to be insignificant; the concentration of harvest would not be sufficient to alter the genetic sub-population structure or reproductive success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Habitat Suitability

Under FMP 1, bottom trawling or other fishing gear in contact with the ocean floor on the GOA continental shelf or upper slope could adversely impact juvenile northern rockfish habitat. Juvenile northern rockfish tend to live inshore in shallower depths than adults which are captured primarily between 75 to 175 m. Juvenile northern rockfish may also be associated with epifauna that provides structural relief such as corals or sponges. If so, damage to this epifauna by bottom trawls may reduce survival of juvenile fish.

FMP 1 closes the eastern GOA to trawling. However, the eastern GOA contains less than one percent of the GOA biomass of northern rockfish (Heifetz *et al.* 2002). Consequently, this closure probably has little effect on the GOA stock of northern rockfish.

The effects of FMP 1 on habitat suitability for GOA northern rockfish are expected to be insignificant because future levels of habitat disturbance would not lead to a detectable change in spawning or rearing success such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Prey Availability

The major prey of northern rockfish is euphausiids, and northern rockfish may in turn be preyed upon by large piscivorous fish. There is no indication that existing trophic interactions would undergo significant qualitative change under FMP 1. Therefore, this impact is expected to be insignificant, because there is no evidence that future FMP 1 harvest levels or distribution of harvest would lead to a change in prey availability such that it would jeopardize the ability of the stock to sustain itself at or above the MSST.

Summary of Direct and Indirect Effects of FMP 1 on GOA Northern Rockfish

The comparative baseline for effects on GOA northern rockfish is the impact on stock sustainability as indexed by projection model estimates of fishing mortality relative to overfishing limits (F_{OFL}) and by projection model estimates of female spawning stock biomass relative to the MSST.

Under FMP 1, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently, fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 1, the stock is projected to sustain itself at or above MSST. Consequently, change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability, are believed to have an insignificant impact on stock sustainability.

Status Determination from Modeling

Stock Size Relative to MSST

Under FMP 1, GOA northern rockfish projected female spawning biomass for 2003 (B2003) of 42,700 mt is greater than $B_{35\%}$. Thus, the stock is projected to be above its MSST and is not projected to be in an overfished condition. Projected female spawning biomass for 2005 (B2005) of 39,100 mt is greater than $B_{35\%}$; consequently, the stock is not projected to be approaching an overfished condition.

Age and Size Composition

Under FMP 1, the age composition of GOA northern rockfish could change under fishing pressure. For example, under FMP 1 the mean age of the GOA northern rockfish in 2008, as computed in model projections, is 11.2 years. This compares with a mean age in the equilibrium unfished GOA stock of 12.6 years. Note that the mean ages and sizes actually observed in 2008 will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of GOA northern rockfish is 50:50. No information is available to suggest that sex ratio would change under FMP 1, but size composition of GOA northern rockfish might change in proportion to the change in age composition.

Cumulative Effects of FMP 1

Table 4.5-26 summarizes the cumulative effects analysis for GOA northern rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA northern rockfish stock is insignificant under FMP 1.

- **Persistent Past Effects.** Past effects of the foreign fisheries for the GOA northern rockfish stock. Include large removals, which appear to have a lingering effect on the populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch in this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to northern rockfish mortality.

- **Cumulative Effects.** A cumulative effect under FMP 1 is identified for mortality of GOA northern rockfish and is rated as insignificant. Northern rockfish are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA northern rockfish stock is expected to be insignificant under FMP 1.

- **Persistent Past Effects.** Past effects of the foreign fisheries for the GOA northern rockfish stock. Include large removals, which appear to have a lingering effect on the populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch in this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to northern rockfish change in biomass levels as a function of change in reproductive success.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the northern rockfish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.24) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch in this fishery has already been accounted for by domestic groundfish management and is not expected to contribute to changes in genetic structure or reproductive success of northern rockfish. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potentially beneficial or adverse contributors to reproductive success since changes in climate can affect prey availability and/or habitat suitability which in turn can affect recruitment. The magnitude and direction of the change in reproductive success with water temperatures is currently unknown. Climate changes and regime shifts are not considered to be contributors to change in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** It is determined that FMP 1 would have an insignificant effect on northern rockfish prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both benficial and adverse) on northern rockfish prey species (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since northern rockfish prey species bycatch is not expected to occur. Climate changes and regime shifts are identified as making potentially beneficial or adverse contributions on prey availability, although the magnitude and the direction of change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the northern rockfish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** It is determined that FMP 1 would have an insignificant effect on northern rockfish habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA northern rockfish stocks include past foreign, JV, and domestic fisheries, IPHC longline fishery and climate changes and regime shifts (see Section 3.5.1.24). Intense bottom trawling on northern rockfish habitat in the past likely disrupted spawning and/or rearing habitats in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries have also been identified as having adverse effects on northern rockfish habitat, although these effects are not expected to have been as intense as those effects associated with trawl gear (see Section 3.6.4 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both beneficial and adverse effects on northern rockfish habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has been identified as an adverse contributing factor since the fishery gear could disrupt spawning and/or rearing habitats. Although, as stated above, the impacts associated with longline gear are not as significant as those associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the GOA northern rockfish stock are identified as potentially beneficial or adverse contributors, although the magnitude and direction of the change are unknown in relation to strong and weak Aleutian Low systems. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the northern rockfish stock to sustain itself at or above MSST is jeopardized.

GOA Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 1

Shortraker/rougheye and other slope rockfish groups are placed in Tier 4 and 5. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on GOA shortraker/rougheye rockfish. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The model projections for catch of shortraker/rougheye show relatively constant catches of about 1,000 mt over the years 2003-2007 (Table H.4-34 of Appendix H). These projected catches are less than would be expected if the present management policies were to remain in place, which this FMP assumes. ABC for shortraker/rougheye in the model (1,600 mt) is virtually the same as that for the fishery in the years 1997-2002 (ABCs of 1,590-1,730 mt, depending on the year), but catches in the fishery have averaged 1,602 mt over this period versus the 1,000 mt projected in the model. The reason for the lower-than-expected catch projections in the model for this FMP is uncertain. The impact of fishing mortality on GOA shortraker/rougheye rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter. Therefore, the potential impact of FMP 1 on biomass level is unknown, because the MSST cannot be determined.

Spatial/Temporal Concentration of Catch

The ABCs are geographically apportioned amongst the major management areas of the GOA which helps to spread out the catch and reduces the risk of localized depletion of the resource. Recent genetic studies of shortraker and rougheye rockfish indicate that there is stock structure for each species in the GOA, but additional research is needed for further verification and to better define the geographic extent of this structure. Until more information is available on this possible stock structure, there is a possibility that localized depletion may be occurring, despite the effort of geographic apportionment.

Shortraker/rougheye are to be taken only as bycatch in the GOA. The bycatch of these two species is taken in both bottom trawl and longline fisheries; the annual proportion caught by bottom trawl is usually a little higher than that caught by longline. The sablefish and halibut longline fisheries, in which shortraker/rougheye are taken as bycatch, have been IFQ fisheries since 1995. As a result, these two fisheries have been open concurrently between March 15 and November 15 each year, which spreads out the catch of shortraker/rougheye over this entire eight month period. In contrast, bottom trawl fisheries that catch shortraker/rougheye are much shorter in duration, and are usually open for only a few weeks per year. This compresses the shortraker/rougheye trawl catch into a relatively short time period and may cause a greater risk of possible overfishing, because it is difficult to manage the TAC within this short time span.

The potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST.

Habitat Suitability

This FMP may beneficially affect habitat for shortraker/rougheye because it closes the eastern GOA to trawling. This closure prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of shortraker/rougheye, an undamaged benthic habitat may provide a benefit to these species. For example, observations from a manned submersible in the eastern GOA have found shortraker and/or rougheye rockfish associated with boulders along steep slopes (Krieger and Ito 1999) and with colonies of Primnoa coral (Krieger and Wing 2002). The eastern GOA trawl closure presumably causes a reduction in the alteration or destruction of these habitats, which may have a beneficial effect on shortraker/rougheye in this region. However, evidence is insufficient to conclude whether future levels of habitat disturbance would lead to a change in spawning or rearing success that would affect the ability of the stock to sustain itself at or above the MSST. Therefore, the potential effect of FMP 1 on habitat suitability for shortraker/rougheye is unknown.

Prey Availability

The major prey of adult rougheye rockfish in Alaska appears to be shrimp (Yang 1993 and 1996; Yang and Nelson 2000). Food habit information for shortraker rockfish is very limited, but the sparse data available at present indicate that squid, myctophids, and shrimp are the major items consumed (Yang 1993 and 1996; Yang and Nelson 2000). Pacific cod, and to a lesser extent walleye pollock, are also species that are known to prey on shrimp, so any changes in their abundance as a result of FMP 1 hypothetically could affect the food supply of shortraker/rougheye. To protect Steller sea lions, FMP 1 has two measures that may reduce the catch and increase the abundance of Pacific cod and walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for two species. However, whether a change in abundance of Pacific cod or walleye pollock would actually affect the food supply for shortraker/rougheye is unknown, as there is no quantitative information on trophic interactions between all these species. Moreover, shortraker and rougheye rockfish reside in deeper depths than Pacific cod or walleye pollock, so they may not be competing for the same spatial aggregations of food.

There is no documentation of predation on either shortraker or rougheye rockfish. Consequently, it is not possible to determine how changes in predator abundance as a result of FMP 1 would affect these rockfish. Presumably, larger fishes such as Pacific halibut that are known to prey on other rockfish may also prey on rougheye rockfish, but adult shortraker rockfish are so large that they probably have few predators. Predator effects would likely be more important on juveniles of either species.

Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for shortraker/rougheye is unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Shortraker/Rougheye Rockfish

The effects of FMP 1 on shortraker/rougheye in the GOA are summarized in Table 4.5-83. The effect of FMP 1 on these species through direct mortality from fishing is expected to be insignificant. All other potential direct and indirect effects of FMP 1 on this group are unknown.

Status Determination from Modeling

Stock Size Relative to MSST

The catch rates are below the ABC and OFL values for all years. The MSST has not been determined.

Age and Size Composition

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter.

Sex Ratio

There is no information on the sex ratio of shortraker/rougheye, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 1 is unknown.

Cumulative Effects of FMP 1

Table 4.5-27 summarizes the cumulative effects analysis for GOA shortraker/rougheye rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shortraker/rougheye rockfish is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on GOA shortraker/rougheye rockfish stocks. See Section 3.5.1.24 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would

  fishery and State of Alaska shrimp fishery are identified as non-contributing factors since bycatch of rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA shortraker/rougheye rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, the effect of changes in biomass level is unknown since the MSST for this stock is not able to be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA shortraker/rougheye rockfish stocks. See Section 3.5.1.24 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.24 and 3.10. The IPHC longline fishery and State of Alaska shrimp are identified as non-contributing factors to GOA slope rockfish biomass level since bycatch is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal concentration of catch under FMP 1 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA shortraker/rougheye rockfish; however, climate changes and regime shifts have been identified as having had potentially beneficial or adverse effects on shortraker/rougheye rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability, which in combination effect reproductive success. See Sections 3.5.1.24 and 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA shortraker/rougheye rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, they could affect reproductive success by driving changes in prey availability and habitat suitability. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors to the change in genetic structure and reproductive success of GOA shortraker/rougheye rockfish since bycatch in these fisheries is unlikely to occur.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA shortraker/rougheye rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA shortraker/rougheye rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 1 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on shortraker/rougheye rockfish prey availability. See Sections 3.5.1.24 and 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability. See Sections 3.5.1.24 and 3.10 for more information. The IPHC longline fishery is identified as a non-contributing factor to shortraker/rougheye rockfish prey availability since bycatch of shortraker/rougheye rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since shrimp is a main prey item of rougheye rockfish.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA shortraker/rougheye rockfish; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 1.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA shortraker/rougheye rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA shortraker/rougheye rockfish habitat suitability. See Section 3.5.1.24 for more information.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potentially beneficial or adverse contribution to shortraker/rougheye rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. The IPHC longline fishery has been identified as a potential adverse contributor to shortraker/rougheye rockfish habitat suitability due to impacts from fishery gear. The State of Alaska shrimp fishery is a non-contributing factor since habitat degradation from shrimp fishery gear is not expected to occur. See Section 3.6.4 for more information on the impacts of fishery gear on EFH.

- **Cumulative Effect.** Although a cumulative effect is possible for habitat suitability of GOA shortraker/rougheye rockfish, the effect is currently unknown due to lack of scientific information.

GOA Slope Rockfish – Direct/Indirect Effects of FMP 1

Other slope rockfish groups are placed in Tier 5 where ABC is determined by F = 0.75M. Sharpchin rockfish are assessed under Tier 4 where OFL is calculated by F = M. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

A measure in this FMP that has a major influence on protecting slope rockfish species from over-harvest is the fact that under FMP 1, the eastern GOA is closed to all trawling. Trawl surveys show the biomass for all species of slope rockfish in the GOA is concentrated in the eastern GOA (Heifetz *et al.* 2002). Because most species of slope rockfish are only taken in trawls and not caught in other gear types such as longlines or traps, the eastern GOA trawl closure creates a *de facto* refugium in which most of the GOA population of slope rockfish is protected from any fishing pressure.

The model projections for catch of slope rockfish show relatively constant catches of about 700 mt in the years 2003-2007. These catches are similar to those seen in recent past years, so the projections for catch appear to be reasonable (Table H.4-31 of Appendix H). The impact of fishing mortality on GOA slope rockfish is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

No projections are possible for these two parameters, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either total or spawning biomass or the MSST. Therefore, the potential impact of FMP 1 on biomass level is unknown.

Spatial/Temporal Concentration of Catch

The ABCs are geographically apportioned amongst the major management areas of the GOA which helps to spread out the catch over the GOA and reduces the risk of localized depletion of the resource. There have been no studies to determine stock structure for any species of slope rockfish, and it is unknown if subpopulations exist. Consequently, there is a possibility that localized depletion may be occurring, despite the effort of geographic apportionment. However, because most of the biomass of slope rockfish occurs in the eastern GOA, which is closed to trawling in this FMP, localized depletion is unlikely under this FMP.

There are no measures in FMP 1 for IFQs or cooperatives for rockfish trawlers, who historically have taken most of the catch of slope rockfish in the form of bycatch. Because these measures do not exist in this FMP, rockfish trawl fisheries in the GOA in past years have only been open for a few weeks in July. This greatly compresses the catch into a short time period and has caused a greater risk of possibly overfishing slope rockfish, because it is difficult to manage the fishery within this short time span.

The potential impact of FMP 1 on GOA slope rockfish is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect the stock's ability to sustain itself at or above the MSST (which has not been determined for these stocks).

Habitat Suitability

This FMP greatly impacts habitat for slope rockfish because it closes the eastern GOA to trawling. This creates a *de facto* no-take zone or refugium for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species. As noted above, nearly all the biomass of slope rockfish is found in the eastern GOA, which means the trawl closure in this region protects most of the GOA population from any fishing pressure. Use of refugia as a conservation measure could be particularly effective for rockfish species, as most rockfish are generally believed to be sedentary in nature and not undergo extensive migrations. The closed areas may allow increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. The trawl closure also prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of slope rockfish, an undamaged benthic habitat likely provides a benefit to these species. Juvenile slope rockfish may also be associated with epifauna such as corals or sponges that provide structural relief on the bottom. Prevention of possible damage by bottom trawls to corals and other "living substrates" may increase the amount of protective cover available to slope rockfish to escape predation, increase survival of juvenile fish and thus have a beneficial impact on the stocks. On balance, however, evidence is insufficient to conclude whether, or to what extent, future levels of habitat protection would lead to a change in spawning or rearing success that would measurably affect the ability of the GOA slope rockfish stock to sustain itself at or above the MSST (which has not been determined for these stocks). Therefore, the potential effect of FMP 1 on habitat suitability for this group must be considered unknown.

Prey Availability

No studies have been done in Alaska to determine the food habits for any of the slope rockfish species. Many of the abundant species, such as sharpchin, harlequin, and redstripe rockfish, are relatively small in size and may be plankton-feeders, but this is conjecture. There is also no documentation of predation on slope rockfish, although larger fishes such as Pacific halibut, which are known to prey on other rockfish, presumably also prey on slope rockfish. Because of this lack of information, the effect of FMP 1 on predator-prey relationships for slope rockfish is unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Slope Rockfish

The effects of FMP 1 on GOA slope rockfish are summarized in Table 4.5-83. The effect of FMP 1 on these species through direct mortality from fishing is expected to be insignificant. All other potential direct and indirect effects of FMP 1 on this group are unknown.

Status Determination from Modeling

No projections are possible for the F or MSST, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

There is no information on the sex ratio of slope rockfish, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 1 is unknown.

Cumulative Effects of FMP 1

Table 4.5-28 summarizes the cumulative effects analysis for GOA other slope rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA other slope rockfish is rated as insignificant under FMP 1.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries and State of Alaska groundfish fisheries have been identified as having had an adverse persistent past effect on GOA other slope rockfish stocks. See Section 3.5.1.24 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of other slope rockfish. The State of Alaska groundfish fisheries are identified as a non-contributing factor since catch and bycatch of slope rockfish species are already accounted for by the domestic groundfish fishery management. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA other slope rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 1, the effect of changes in biomass level is unknown since the MSST for this stock is not able to be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA other slope rockfish stocks. See Section 3.5.1.24 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the other slope rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.24 and 3.10. The State of Alaska groundfish fisheries are identified as non-contributing factors to GOA slope rockfish biomass level. Although catch and bycatch do occur in these fisheries, the removals are already accounted for by the domestic groundfish fishery management. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA other slope rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal concentration of catch under FMP 1 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA slope rockfish; however, climate changes and regime shifts have been identified as having had potentially beneficial or adverse effects on slope rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability, which in combination affect reproductive success. See Sections 3.5.1.24 and 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA slope rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure and could affect reproductive success by driving changes in prey availability and habitat suitability. The State of Alaska groundfish fishery is identified as a non-contributing factor to the change in genetic structure and reproductive success of GOA slope rockfish. Although catch and bycatch of slope rockfish species occur in these fisheries, they are not expected to contribute to localized depletion such that it leads to a detectable reduction in genetic diversity or reproductive success. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA slope rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA slope rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 1 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on slope rockfish prey availability. See Sections 3.5.1.24 and 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to slope rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability. See Sections 3.5.1.24 and 3.10 for more information. The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to slope rockfish prey availability since bycatch of slope rockfish prey species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA slope rockfish; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 1.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, State of Alaska groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA slope rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA slope rockfish habitat suitability. See Section 3.5.1.24 for more information.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potentially beneficial or adverse contribution to slope rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. The State of Alaska groundfish fishery and the IPHC longline fishery have been identified as potential adverse contributors to slope rockfish habitat suitability due to impacts from fishery gear. See Section 3.6.4 for more information on the impacts of fishery gear on EFH.

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA slope rockfish, the effect is currently unknown due to lack of scientific information.

GOA Pelagic Shelf Rockfish – Direct/Indirect Effects of FMP 1

Until recently, dusky rockfish fell under Tier 4 of Amendment 56 of the GOA groundfish FMP, while yellowtail and widow rockfish are managed under Tier 5. As of 2004, dusky rockfish will be managed as a Tier 3 species, while the remaining pelagic shelf rockfish (PSR) species will continue under Tier 5. GOA dusky rockfish were modeled under the Tier 4 category for this analysis. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

The model projections for catch of PSR show a progressive decline from 3,300 mt in the baseline year of 2002 to a minimum of 2,000 mt in 2005, and only a slight increase to 2,100 mt in 2006 and 2007. These projected catches are less than would be expected if the present management regime were to remain in place, which this FMP assumes. ABC for the projections remains a constant 5,500 mt for each year, which means less than40 percent of the ABC would be taken in each of the years 2005-2007. In most years before present, at least 60 percent of the ABC for PSR has been caught. The reasons for the lower-than-expected catch projections in the model for this FMP are uncertain (Table H.4-32 for Appendix H). The impact of fishing mortality on this group is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Total and Spawning Biomass

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish. Therefore, the potential impact of FMP 1 on biomass level is unknown, because biomass levels and MSSTs have not been determined.

Spatial/Temporal Concentration of Catch

The ABCs are geographically apportioned amongst the major management areas of the GOA which helps to spread out the fishery over the GOA and reduces the risk of localized depletion of the resource. However, there have been no studies to determine stock structure of dusky rockfish, and it is unknown if subpopulations exist. Because there is no information on stock structure, there is a possibility that localized depletion may be occurring, despite the effort of geographic apportionment.

In FMP 1, there is no system for IFQs or cooperatives for rockfish trawlers, who take nearly all the catch of PSR. As a result, the PSR trawl fishery in past years has only been open for a few weeks in July. This greatly compresses the catch into a short time period and has caused a greater risk of possible overfishing, because it is difficult to manage the fishery within this short time span. The potential impact of FMP 1 is unknown, because evidence is insufficient to conclude whether the spatial and/or temporal concentration of harvest would lead to a detectable change in genetic diversity or reproductive success that would materially affect this group's ability to sustain itself at or above the MSST, and MSSTs have not been established for these stocks.

Habitat Suitability

This FMP would affect habitat for PSR because it closes the eastern GOA to trawling. This creates a *de facto* no-take zone or refugium for PSR in this area, as trawls are generally the only effective gear for capturing these species. Although biomass estimates from trawl surveys indicate that the trawl closure area in the eastern GOA only contains about 10-15 percent of the GOA biomass of dusky biomass, this is still large enough that it may provide enhanced protection to the dusky rockfish resource. Use of refugia as a conservation measure could be particularly effective for rockfish species, as most are generally believed to be sedentary in nature and not undergo extensive migrations. The closed areas may allow increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. The trawl closure also prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. On balance, however, evidence is insufficient to conclude whether, or to what extent, future levels of habitat protection would lead to a change in spawning or rearing success that would measurably affect the ability of the GOA slope rockfish stock to sustain itself at or above the MSST (which has not been determined for these stocks). Therefore, the potential effect of FMP 1 on habitat suitability for this group must be considered unknown.

Prey Availability

The major prey of dusky rockfish appears to be euphausiids, based on the limited food information available for this species (Yang 1993). Euphausiids are also the major prey of walleye pollock, which means dusky rockfish and walleye pollock may be competing for the same food resource. Thus, any measures in FMP 1 that affect the commercial catch of walleye pollock could have an subsequent indirect effect on dusky rockfish by increasing or decreasing the amount of euphausiids available as food to dusky rockfish. To protect Steller sea lions, FMP 1 has two measures that may reduce catch of walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for walleye pollock. Hypothetically, these two measures could increase the abundance of walleye pollock, resulting in the consumption of more euphausiids and having an adverse effect on the food supply for dusky rockfish. How adverse this effect would really be, however, is unknown, as there is little or no quantitative information on trophic interactions between dusky rockfish and walleye pollock or data on whether they even feed on the same spatial aggregations of euphausiids.

There is no documentation of predation on dusky rockfish. Consequently, it is not possible to determine how changes in predator abundance as a result of FMP 1 would affect dusky rockfish. Presumably, larger fishes such as Pacific halibut that are known to prey on other rockfish may also prey on adult dusky rockfish, but it unknown what impact this predation has on stock condition. Predator effects would likely be more important on juvenile dusky rockfish. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for PSR is unknown.

Summary of Direct and Indirect Effects of FMP 1 on GOA Pelagic Shelf Rockfish

The effects of FMP 1 on GOA slope rockfish are summarized in Table 4.5-83. The effect of FMP 1 on these species through direct mortality from fishing is expected to be insignificant. All other potential direct and indirect effects of FMP 1 on this group are unknown.

Status Determination from Modeling

The catch rates are below the ABC and OFL values. The MSST cannot be determined for this stock complex.

Age and Size Composition

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish.

Sex Ratio

There is no information on the sex ratio of PSR, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 1 is unknown.

Cumulative Effects of FMP 1

Table 4.5-29 summarizes the cumulative effects analysis for GOA pelagic slope rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA PSR complex is insignificant under FMP 1.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA PSR population. See Section 3.5.1.24 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR mortality since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA PSR and is rated as insignificant. PSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effects of FMP 1 on the change in biomass level are unknown.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA demersal shelf rockfish (DSR) population. See Section 3.5.1.24 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR biomass levels since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass; however, the effect is unknown since total and Bs and MSST are currently unavailable.

Spatial/Temporal Concentration of Catch
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The effects of the fishery on the spatial/temporal characteristics of PSR under FMP 1 are unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA PSR; however, climate changes and regime shifts have been identified as having had potentially beneficial or adverse effects on PSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination affect reproductive success. See Sections 3.5.1.24 and 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery has been identified as a non-contributing factor to GOA PSR genetic structure and reproductive success since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure. However, they could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** Although a cumulative effect of the spatial/temporal characteristics of the GOA PSR complex is possible, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fishery on the change in prey availability of PSR is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on PSR prey availability. See Sections 3.5.1.24 and 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a potential adverse contributor to GOA PSR prey availability. The catch of shrimp in the shrimp fishery is expected to continue in the future. Marine pollution is identified as a potential adverse contributor to PSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability. See Sections 3.5.1.24 and 3.10 for more information.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA PSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The effect of the fishery on the change in habitat suitability of PSR is unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries have been identified as having past persisting adverse effects on GOA PSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA PSR habitat suitability. See Section 3.5.1.24 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR habitat suitability since the gear associated with this fishery is not expected to cause a significant impact to the benthic habitat. See Sections 3.5.1.24 and 3.6 for more information on the effects of fishery gear on EFH. Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potentially beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA PSR, the effect is currently unknown due to lack of scientific information.

GOA Demersal Shelf Rockfish – Direct/Indirect Effects of FMP 1

The DSR rockfish complex comprises seven species of nearshore, bottom-dwelling rockfishes (see Section 3.5.1.24). In the eastern GOA this group of rockfishes is subject of a directed longline fishery and consequently the NPFMC manages these species separately from the other rockfish category in the eastern GOA. For purposes of this Programmatic SEIS, emphasis is placed on yelloweye rockfish as it is the predominant species in the DSR assemblage and in the fishery. DSR fall into Tier 4 of the ABC and OFL definitions. The following discussions briefly describe the direct and indirect impact analyses of FMP 1 on this group. The significance ratings for these potential effects are summarized in Appendix A, Table 4.5-83. For significance criteria, see Appendix A, Table 4.1-1.

Fishing Mortality

DSR are taken in a small directed fishery with hook and line gear and as bycatch in the halibut longline fishery. Reported catch of DSR has been relatively constant over the last five years with landings ranging from 226 mt to 363 mt in large part due to very conservative management practices. Estimated bycatch mortality of DSR in the halibut fishery has ranged about 130 mt to 355 mt annually. A DSR bycatch limit is established during the halibut season to limit mortality of DSR in this fishery. The NPFMC has also recently approved a management measure that requires full retention of DSR species. Once approved by NOAA Fisheries, the measure will improve catch statistics and reduce discards and waste. These factors, and the recognized uncertainty in estimating DSR biomass in the eastern GOA, has led managers to set a conservative TAC of 390 mt for 2003 (O'Connell *et al.* 2002). The OFL for DSR is 540 mt (Table H.4-33 for Appendix H).

Under FMP 1, we expect both the TAC and reported landings to remain stable at present levels. Status quo policies are likely to have no significant impact on the ability of DSR to sustain current population levels. Fishing mortality will remain below the OFL. The impact of fishing mortality on these stocks is considered to be insignificant under FMP 1, because it is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

Reliable total and spawning biomass statistics are not available for DSR species. Therefore, the potential impact of FMP 1 on biomass level is unknown, because biomass levels and MSSTs have not been determined.

Spatial/Temporal Concentration of Catch

Although management of this assemblage has been conservative, and overall the population appears stable, a decline in the density estimates in the Fairweather Grounds may be an indication that localized overfishing is occurring (O'Connell *et al.* 2002). The TAC for the eastern GOA is partitioned by management district based on biomass density and known habitat. The current harvest strategy indicates that two percent of the exploitable biomass is taken per year and that this level of exploitation is sustainable. However, fishing effort on the Fairweather Grounds appears to be concentrated in areas of best habitat and highest density and it may be that local overfishing occurs. If occurring, such localized overfishing could have a long-term adverse effect on DSR stocks due to their longevity and slow growth rate (O'Connell *et al.* 2002). Rockfish stocks typically require long periods to recover from high fishing pressure. We are unable to conclusively determine the effects of the fisheries on the spatial/temporal characteristics of GOA demersal rockfish species at this time.

Habitat Suitability

Any habitat suitability impacts of FMP 1, as illustrated through the GOA groundfish FMP, would be governed by a complex web of direct and indirect interactions which are difficult to quantify. These type of impacts would include adverse effects to spawning habitat, nursery grounds, and benthic structures, as a result of commercial fishing. Unfortunately, scientific information is insufficient at the present time to conclude whether existing habitat suitability indexes would undergo any significant change under the current FMP. Therefore, the effects of FMP 1 on habitat suitability are unknown.

Prey Availability

As with habitat suitability impacts, any effects to predator-prey relationships resulting from FMP 1 management would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Because evidence is insufficient to conclude whether future harvest levels and distribution of harvest would lead to a change in prey availability that would affect the stock's ability to sustain itself at or above the MSST, the potential effect of FMP 1 on prey availability for this species or group is unknown.

Summary of Effects of FMP 1 – GOA Demersal Shelf Rockfish

An age-structured population model for DSR rockfish is not used as we believe the current assessment more accurately reflects present biomass. Projections of future catch ABC and OFL levels were made by carrying forward the 2002 baseline values into the future. Under these assumptions, DSR rockfish stocks remain stable and are fished at less than the ABC in the eastern GOA, and the direct and indirect effects under FMP 1 are considered insignificant or unknown. Additional information is needed to determine whether current abundance levels are truly sustainable over the long-term, including improved time series of catch (and bycatch) by species, and age and size composition data of bycatch. Better estimates of important life history parameters and maturity schedules are also required. Improved survey techniques are needed to more accurately assess the DSR assemblage as well as more knowledge about the variety and location of complex rocky habitats in the eastern GOA.

Status Determination from Modeling

The MSST has not been determined for this stock complex.

Age and Size Composition

Age and size composition data are not available for GOA DSR species.

Sex Ratio

The sex ratio of GOA DSR species is unknown.

Cumulative Effects of FMP 1

Table 4.5-30 summarizes the cumulative effects analysis for GOA demersal slope rockfish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA DSR complex is insignificant under FMP 1.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population. See Section 3.5.1.24 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR mortality since catch and bycatch in these fisheries are already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA DSR and is rated as insignificant. DSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effect of the fishery on the change in biomass under FMP 1 is unknown.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population. See Section 3.5.1.24 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR biomass levels since catch and bycatch in these fisheries are already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass; however, the effect is unknown since total and Bs are currently unavailable.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA DSR is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA DSR; however, climate changes and regime shifts have been identified as having had potentially beneficial or adverse effects on DSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success. See Sections 3.5.1.24 and 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and IPHC longline fisheries have been identified as non-contributing factors to GOA DSR genetic structure and reproductive success. Catch and bycatch of these fisheries are already accounted for by the domestic groundfish management or bycatch is not expected to occur (as in the case of the State of Alaska herring and shrimp fisheries). Marine pollution is identified as a potential adverse contributor to GOA DSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure. However, they could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** Although a cumulative effect on the spatial/temporal characteristics of the GOA DSR complex is possible, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability under FMP 1 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on DSR prey availability. See Sections 3.5.1.24 and 3.10 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as potential adverse contributors to GOA DSR prey availability. Catch of herring in the herring fishery and the catch of shrimp in the shrimp fishery are expected to continue in the future. The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to GOA DSR prey availability since bycatch of DSR prey species in not expected to occur. Marine pollution is identified as a potential adverse contributor to DSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability. See Sections 3.5.1.24 and 3.10 for more information.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA DSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Scientific information is insufficient at the present time to conclude whether existing habitat suitability indexes would undergo any significant change under the current FMP.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries and the IPHC longline fisheries have been identified as having past persisting adverse effects on GOA DSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA DSR habitat suitability. See Section 3.5.1.24 for more information.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as non-contributing factors to GOA DSR habitat suitability since the gear associated with these fisheries are not expected to cause a significant impact to the benthic habitat. The State of Alaska groundfish fisheries and the IPHC longline fisheries are identified as potential adverse contributors to DSR habitat suitability. See Sections 3.5.1.24 and 3.6 for more information on the effects of fishery gear on EFH. Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potentially beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA DSR, the effect is currently unknown due to lack of scientific information.

4.5.2 Prohibited Species Alternative 1 Analysis

Throughout these analyses, the prohibited species category is discussed separately from the non-target groundfish species groups since their management strategies are implemented by various agencies outside of NOAA Fisheries. Retention of prohibited species is forbidden in the BSAI and GOA groundfish fisheries. The prohibited species include:

- Pacific halibut (*Hippoglossus stenolepis*).

- Pacific salmon and steelhead trout (*Oncorhynchus mykiss*).
- Pacific herring (*Clupea pallasi*).
- Red king crab (*Paralithodes camtschaticus*), blue king crab (*P. Platypus*), golden or brown king crab (*Lithodes aequispinus*), bairdi Tanner crabs (*Chionoecetes bairdi*), and opilio Tanner crabs *(C. opilio*).

4.5.2.1 Pacific Halibut

Pacific halibut are managed by the IPHC. Halibut bycatch in federal groundfish fisheries is controlled by the use of PSC limits. IPHC provides for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery.

Under the present groundfish FMPs, halibut bycatch mortality in the Alaska groundfish fisheries is limited by NOAA Fisheries to approximately 4,500 mt in the BSAI and 2,300 mt in the GOA, for a total of 6,800 mt. Total removals from both areas in 2002 were limited by IPHC to a conservative target of 48,800 mt (Clark and Hare 2003). This was achieved by limiting the directed commercial fishery to a catch of 37,100 mt, which allowed for the expected total of 11,700 mt in sport catch, bycatch, and subsistence.

Direct/Indirect Effects

Direct and indirect effects for Pacific halibut include mortality along with changes in reproductive success and prey availability. These effects, which are associated with changes in catch and bycatch, are considered insignificant because annual quota setting processes implemented by IPHC account for all removals of halibut including bycatch in other fisheries. Thus, if changes to the baseline condition of the stock occur, they are reflected in the quotas set for the directed fishery. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of FMP 1. No evidence of fishery impacts to habitat of halibut has been shown, so this effect will not be considered in the cumulative effects analysis that follows.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 1 is shown in Table 4.5-31. For further information on persistent past effects included in this analysis, see Section 3.5.2.1 of this SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 1 because current management of halibut by IPHC accounts for all removals of halibut including bycatch in other fisheries when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects.** The directed longline fishery for Pacific halibut remains in effect but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered to be contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 1. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 1.

- **Persistent Past Effects.** No persistent past effects have been identified on changes in reproductive success of Pacific halibut. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 1.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 1. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of FMP 1.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of halibut have been identified.

- **Reasonably Foreseeable Future External Effects.** Halibut are opportunistic predators with a wide range of prey species. Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 1.

4.5.2.2 Pacific Salmon or Steelhead Trout

Pacific salmon are managed by the ADF&G, which also manages the salmon sport fisheries and permitted subsistence harvesting, to ensure that escapement goals are met for the spawning population in order to maintain sustained yields from the stock as a whole. Annual harvest levels are responsive to fluctuations in run sizes.

Most Alaska salmon fisheries are stable with bycatch representing a very small proportion of the directed fisheries catch. Pollock fisheries account for approximately 90 percent of the salmon bycatch in the BSAI. However, the western Alaska chinook and chum salmon stocks are currently considered depressed. Stock composition of BSAI groundfish fisheries bycatch shows that approximately 58-70 percent of chinook bycatch and 19 percent of chum bycatch may originate in western Alaska stocks. Many western Alaska rivers from Bristol Bay to Kotzebue are major producers of chinook or chum salmon. Although these species occur in a large number of drainages throughout the region, the largest runs exist in the Nushagak, Kuskokwim, and Yukon Rivers. Throughout the region these species are subject to intense subsistence and commercial fisheries. These runs have been poor since 1998 when the Arctic-Yukon-Kuskokwim (AYK) region was declared an economic disaster area. In 2001, the Alaska Board of Fisheries designated many AYK chinook and chum salmon stocks as Stocks of Concern under the State of Alaska's Policy for the Management of Sustainable Salmon Fisheries. Among the stocks designated were Kuskokwim River chinook and chum salmon, Yukon River chinook and chum salmon, and Norton Sound chum salmon.

Annual commercial and subsistence harvest of chinook and chum salmon for Bristol Bay and AYK combined averaged approximately 300,000 chinook salmon and 1,100,000 chum salmon from 1998 through 2000 (Burkey *et al.* 2001, Vania *et al.* 2002, Weiland *et al.* 2001, Brennan *et al.* 2002). Year 2000 was particularly poor for both chinook and chum salmon throughout the region. Total chinook catch for the region was approximately 190,000 fish, down from almost 400,000 fish in 1998. Total chum salmon catch for the region was approximately 640,000 fish, down from about one million in the previous two years, which were considered depressed as well. These poor runs resulted in extensive commercial closures for chinook and chum and subsistence closures for chum salmon in the AYK region since 1998.

Of the Northwest salmon species listed as endangered or threatened under the ESA, chinook and steelhead stocks are thought to migrate into areas managed by BSAI and GOA groundfish FMPs. Steelhead trout have not been observed in BSAI or GOA groundfish fisheries salmon bycatch. Bycatch of chinook salmon originating in the Northwest may occur in groundfish fisheries; however, ADF&G intensely manages this stock to ensure that bycatch does not exceed limits set forth by the ESA. Thus, ESA-listed Pacific Northwest chinook salmon and steelhead trout were not specifically considered in this cumulative effects analysis.

Of the 407 chinook stocks harvested in the regioneast, 81 percent are classified as not threatened, and 15 percent are special concern or at risk (Slaney *et al.* 1996). Large portions of the regioneast chinook harvest originate from the Columbia River upriver bright chinook, Middle Columbia River bright chinook, and north-migrating Oregon coastal chinook; these stocks are considered stable (NMFS 2002). Chinook stocks listed under the ESA make up a small portion of the regioneast harvest, and nearly all coho salmon harvested originate from Alaskan streams (Weitkamp *et al.* 1995).

Management of Alaskan salmon stocks is challenging due to the lack of precise information on total return and the inability to predict future returns to most rivers or tributaries with any degree of certainty. In most cases, total return and escapement are not known. As a result of this lack of information, estimates of significant impacts of bycatch on various runs are unreliable. Another factor to consider in salmon management is the Alaska subsistence preference law cite. This law requires that commercial, recreational, and personal use fisheries be restricted before restriction of subsistence fisheries. Therefore, management of all fisheries for these stocks in state waters incorporates conservative measures.

For analysis of the impacts of the FMPs presented here, the following assumptions have been made:

- 96 percent of "other salmon" caught in the BSAI are chum salmon (taken from observer data 1997-1999).

- BSAI chinook and other salmon bycatch is comprised of 58 to 70 percent of western Alaska chinook, and 19 percent of western Alaska chum salmon. Western runs occur in Bristol Bay, Kuskokwim, Nushagak, Yukon, Norton Sound, and Kotzebue regions. Runs in this region are considered depressed, due to severely poor runs in the Yukon and Kuskokwim River drainages in recent years.

- GOA chinook and other salmon bycatch is comprised of approximately 58 percent of western Alaska chinook and an unknown percentage of western Alaska chum salmon. Other GOA salmon bycatch originates from southeast Alaska and British Columbia runs. Spawning escapement of chinook and other salmon in southeast Alaska are stable and increasing in many of the management units.

The cumulative effects analysis was based on two groupings of Alaska salmon in BSAI and GOA: chinook salmon and other salmon. As stated in the assumptions above, 96 percent of other salmon caught in BSAI is considered to be chum salmon.

Direct/Indirect Effects

Direct and indirect effects to chinook salmon and other salmon in BSAI and GOA include mortality, changes to prey availability, genetic structure of population, and reproductive success.

BSAI – Chinook Salmon

Under FMP 1, chinook salmon bycatch in the BSAI varies from approximately 26,000 in 2003 down to 23,000 in 2008. Assuming 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 13,000 to 18,000 fish during the next six years. This harvest represents approximately 4.3 to 6.0 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. The effects of this level of bycatch are not detectable in natal streams and would have little or no effect on commercial or subsistence harvests or escapement. It is unlikely that this level of bycatch, when considered across all chinook salmon runs in western Alaska, would impact the sustainability of the stock and is therefore considered insignificant under FMP 1. However, given the current poor stock status of chinook salmon runs in western Alaska and considering the combined bycatch potential in BSAI and GOA, bycatch levels significantly higher from those predicted for FMP 1 could adversely impact recovery of depressed stocks.

BSAI – Other Salmon

Under FMP 1, bycatch of other salmon in BSAI varies from approximately 69,000 in 2003 down to 58,000 in 2008. Assuming 96 percent of other salmon bycatch is chum salmon and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 11,000 to 13,000 fish during the next six years. This harvest represents approximately 1.0 to 1.2 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. The effects of this level of bycatch are not detectable in natal streams and would have little or no effect on commercial or subsistence harvests or escapement. It is unlikely that this level of bycatch, when considered across all chum salmon runs in western Alaska, would impact the sustainability of the stock and is therefore considered insignificant under FMP 1. However, given the current poor stock status of chum salmon runs in western Alaska, harvest level higher than those predicted under FMP 1 could adversely impact recovery of depressed stocks.

GOA – Chinook Salmon

Under FMP 1, chinook salmon bycatch in the GOA varies from approximately 13,000 in 2003 up to 28,000 in 2008. Assuming 58 percent of GOA chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 8,000 to 16,000 fish during the next six years. This harvest level represents approximately 2.6 to 5.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. The effects of this level of harvest are not detectable in natal streams and would have little or no effect on commercial or subsistence harvests and escapement. It is unlikely that this level of bycatch, when considered across all chinook salmon runs in western Alaska, would impact the sustainability of the stock and is therefore considered insignificant under FMP 1. Population-level effects of bycatch on depressed stocks are difficult to determine. However, given the poor stock status of chinook salmon runs in western Alaska and considering the combined bycatch potential in BSAI and GOA fisheries, bycatch levels significantly higher than those predicted for FMP 1 could adversely impact recovery of depressed stocks.

GOA – Other Salmon

Under FMP 1, bycatch of other salmon in GOA varies from approximately 5,000 in 2003 up to 11,000 in 2008. Assuming 56 percent of other salmon bycatch is chum salmon, the bycatch could range from 3,000 to 6,000 fish during the next six years. The proportion of these fish originating in western Alaska is unknown. Assuming that 100 percent of these fish were of western Alaska origin, this harvest represents approximately 0.3 to 0.5 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This level of bycatch is not detectable in natal streams and would have little or no effect on commercial or subsistence harvests and escapement. It is unlikely that this level of bycatch, when considered across all chum salmon runs in western Alaska, would impact the sustainability of the stock and is therefore considered insignificant under FMP 1.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 1 is shown in Tables 4.5-32 and 4.5-33. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant for FMP 1. The predicted level of bycatch would not be detectable in natal streams and would have little or no effect on commercial or subsistence harvests or escapement. It is unlikely that this level of bycatch, when considered across all salmon runs in western Alaska, would impact the sustainability of the stock. However, if currently depressed stocks continue to decline in the future, then possible adverse effects of mortality could exist for BSAI and GOA chinook and BSAI other salmon. The likelihood of these potential trends in salmon stocks throughout Alaska cannot be determined at this time.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow, and by the 1970s the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries exert effects on mortality of BSAI and GOA chinook and other salmon populations. The magnitude of this effect cannot be determined; however, current stock status of salmon runs in western Alaska are depressed. These fisheries are not considered contributing factors in mortality of other non-western chinook or other salmon populations. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. Land management practices heavily influence the condition of watersheds used by spawning salmon but are not considered contributing factors in direct mortality of salmon. State hatchery enhancement programs were initiated in GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI and GOA chinook and BSAI other salmon resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for FMP 1. Combined bycatch potential in the BSAI and GOA fisheries under this FMP could impact the successful recovery of depressed stocks in the BSAI and GOA and sustainability of the stocks as a whole. Current stock status GOA other salmon is considered stable, and combined effects of mortality on other salmon in this region resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 1 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of salmon prey items and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, a relationship between state commercial, subsistence, and (in the GOA) sport fisheries bycatch of prey and salmon prey availability has not been defined and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon as it is not likely that they would impact the marine environment in which salmon forage. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time. State hatchery enhancement programs exist in the GOA but do not include prey species of salmon.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 1 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, salmon bycatch composition has not been determined. Potential effects of state commercial and subsistence fisheries, along with sport fisheries in the GOA, on genetic structure of salmon populations are unknown. Significant impacts to genetic structure of salmon populations by land management practices are not expected and are not considered contributing factors to a possible change in baseline condition. Long-term climate change and regime shifts are not expected to result in direct mortality that would potentially affect genetic structure of the BSAI and GOA chinook and other salmon stocks. In the GOA, state hatchery enhancement programs focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 1 on reproductive success for BSAI and GOA chinook and other salmon are unknown.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska it may be inferred that reproductive success has been impacted in certain salmon populations originating in the BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may also play a role in the reproductive success of certain salmon populations. Non-western Alaska salmon stocks in GOA are currently considered stable so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. Degradation of watersheds used by spawning salmon resulting from poor land management practices, could significantly impact the reproductive success of BSAI and GOA chinook and BSAI other salmon stocks. Thus, these practices are considered potential adverse contributions to changes in reproductive success of these populations.

Other salmon stocks in GOA are considered stable; so potential effects of state commercial, subsistence, and sport fisheries on reproductive success of these stocks are considered insignificant. For reasons stated above, land management practices are considered potential adverse contributors to the reproductive success of GOA salmon stocks. Hatchery enhancement programs in the GOA may help to restore depressed stocks and maintain stable stocks in Alaska and are considered potentially beneficial to populations of chinook and other salmon.

Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential in the BSAI and GOA fisheries, the sustainability of BSAI and GOA chinook and BSAI other salmon stocks could be impacted. However, it is unknown whether these potential changes to stock status would be driven by changes in reproductive success, specifically, as a result of persisting past effects and reasonably foreseeable future external effects (human controlled and natural events). Current stock status of GOA other salmon is stable, but combined effects of changes in reproductive success in Alaskan salmon populations resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) cannot be determined at this time for GOA other salmon stocks under FMP 1.

4.5.2.3 Pacific Herring

Pacific herring are managed by the ADF&G. Harvest policy and allocations among gear (user) groups are established by the Alaska Board of Fisheries. Annual harvest quotas are set by ADF&G under an exploitation rate harvest policy; herring exploitation rates are capped at a maximum level of 20 percent statewide. All directed herring fisheries occur in state waters and are managed by regulatory stocks.

Direct/Indirect Effects

Direct and indirect effects for Pacific herring include mortality along with changes in reproductive success, prey availability, and habitat. These effects, which are associated with changes in catch, are considered insignificant for the following reasons: bycatch of herring in the groundfish fisheries is low, the fisheries do not target herring prey, and spatial/temporal overlap between the groundfish fisheries and herring habitat is minimal. In addition, annual quota setting processes implemented by ADF&G are responsive to fluctuations in herring biomass.

Under all FMPs, Pacific herring bycatch in groundfish fisheries is considerably lower than some of the highest catch years recorded following passage of Amendment 16A in 1991. Only under the relatively unrestricted fishing of FMP 2.1 does herring bycatch even begin to approach the levels of herring bycatch in the early 1990s.

However, it is somewhat disturbing that even with the relatively unrestricted fishing, the model's estimates of herring bycatch are less than those actually observed in 1990-92. Herring stock levels are thought to be approximately similar to those in the early 1990s. The lower herring bycatch portrayed by the model likely results from the use of highly aggregated and temporally-averaged bycatch rates. In the early 1990s, fishing vessels likely encountered dense concentrations of herring schools by chance. Temporally and spatially averaged bycatch rates will not simulate these occasional encounters, but will still represent an average herring bycatch long-term.

While these are the best data available for this modeling approach, they do represent averages over time and space. For a species with dense spatial aggregations that move dynamically through time, this may not be the best prediction of specific future scenarios. These scenarios assume that future distributions of fishing effort in space and time will be similar to those in the past. Given the available data, it is the best that can be done.

Population dynamics of Pacific herring are not explicitly modeled. Therefore the effects of the management measures on herring biomass are not evaluated. However, given the low herring bycatch levels under all of the scenarios, bycatch removals would not be expected to have a detectably different impact on herring abundance estimates.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 1 is shown in Table 4.5-34. For further information on persistent past effects included in this analysis, see Section 3.5.2.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA herring is insignificant under FMP 1 given the low amounts predicted for herring bycatch, and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. The herring savings areas reduce herring bycatch potential by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Domestic herring fisheries became prominent in the early 1900s with peak catches occurring in the 1920s and 1930s. Foreign herring harvests became prominent in the BSAI in the late 1950s, with highs in the late 1960s and early 1970s. Overexploitation of herring likely resulted during these years of high catch rates. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have impacted herring populations long-term. In addition, past federal groundfish fisheries bycatch combined with the directed state fisheries have exceeded the state's herring harvest policy in the past and may still exert lingering effects on current herring populations in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur but are closely managed by the state (ADF&G). Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. State subsistence catch is also accounted for in ADF&G herring management plans. These fisheries are not considered contributing factors to changes in herring mortality. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring mortality, especially for those populations that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** ADF&G's Pacific herring management plans are responsive to changes in herring biomass and fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. Thus, although some persistent past effects may still be present on certain herring populations in the BSAI and GOA, the combined effects of mortality on Pacific herring resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on reproductive success of BSAI and GOA herring is insignificant under FMP 1, due to the low amounts of estimated herring bycatch and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in reproductive success occurs, it would most likely be reflected in corresponding changes to biomass, which are incorporated into ADF&G management plans for Pacific herring.

- **Persistent Past Effects.** Domestic herring fisheries became prominent in the early 1900s with peak catches occurring in the 1920s and 1930s. Foreign herring harvests became prominent in the BSAI in the late 1950s, with highs in the late 1960s and early 1970s. Overexploitation of herring likely resulted during these years of high catch. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have had long-term impacts on herring populations. In addition, past federal groundfish fisheries bycatch combined with the directed state fisheries have exceeded the state's herring harvest policy in the past and may still exert lingering effects on current herring populations in the BSAI and GOA. Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. It has been found that this type of contamination exposure to adult and larval herring can result in many adverse effects such as: increased rates of egg mortality, larval deformities, and immune system deficiencies. It is presumed that the effects of EVOS still exist and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur but are closely managed by the state (ADF&G). Fishing quotas are based on variable exploitation rates that account for declines in stock. State subsistence and other state groundfish fisheries catch are also accounted for in ADF&G herring management plans. Thus, these fisheries are not considered contributing factors to changes in herring reproductive success. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring reproductive success, especially for those populations that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific herring depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass and fishing quotas are based on variable exploitation rates that account for declines in stock. Although certain herring populations in the GOA have been impacted by EVOS, the stock as a whole is considered recovering. Thus, some persistent past effects may still be present on certain herring populations in the BSAI and GOA, but the combined effects on Pacific herring reproductive success resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 1.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on prey availability for BSAI and GOA herring is insignificant under FMP 1 because groundfish fisheries do not target herring prey and current management by ADF&G is responsive to fluctuations in herring biomass regardless of the cause associated with the change. Thus, if a change in prey availability did occur, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of herring have been identified.

- **Reasonably Foreseeable Future External Effects.** Pacific herring prey primarily on zooplankton which are not a component of bycatch from state directed herring fisheries, state commercial fisheries, or state subsistence fisheries. Thus, these fisheries are not considered contributing factors to changes in prey availability for herring. Future acute and chronic marine pollution could occur but effects on prey, such as zooplankton, are unknown. Long-term climate change and regime shifts could have impacts to many species that contribute to the prey structure of Pacific herring. The nature of these impacts depends on the direction of the climatic shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** Potential effects of future natural events, such as marine pollution and climatic shifts, on prey availability for Pacific herring are unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on habitat of BSAI and GOA herring is insignificant under FMP 1, because current management of herring by ADF&G is responsive to fluctuations in herring biomass and spatial/temporal overlap between the fisheries and herring habitat is minimal. However, if the groundfish fisheries were to somehow impact herring habitat, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring. In addition, the herring savings areas reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. The long-term effects of this event to herring habitat are unknown. It is presumed that the effects of EVOS still exist and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** No evidence of fishery impact on habitat of herring exists. Thus, fisheries are not considered contributing factors to changes in herring habitat at this time. Future acute and chronic marine pollution could occur and is considered potentially adverse to some herring habitat, especially those that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts are not expected to significantly change physical habitat of Pacific herring.

- **Cumulative Effects.** Potential impacts of future natural events, such as marine pollution and climatic shifts, in addition to lingering contamination from EVOS on certain habitat of herring in the GOA exist but effects are not known.

4.5.2.4 Crab

Alaska king, bairdi Tanner crab, and opilio Tanner crab (also called snow crab) fisheries are managed by the State of Alaska with federal oversight and following guidelines established in the BSAI king and Tanner crab FMP (NPFMC 1989). King, bairdi, and opilio Tanner crab are prohibited species for the state scallop and groundfish fisheries and Federal groundfish fisheries. This means that any crab bycatch must be discarded. Crab regulations focus on concerns about direct impacts to crab populations by trawling, considered trawl-induced mortality, and indirect impacts through habitat degradation as well. Because bycatch mortality is currently considered to be minor relative to other sources of mortality for crab, temporal and spatial closures are thought to be more effective than PSC limits in reducing impacts of trawling on crab stocks (Witherell and Harrington 1996). As such, numerous trawl closure areas have been instituted to address concerns about unobserved mortality (crab wounded or killed but not captured), and possible habitat degradation due to trawling and dredging.

With the exception of Norton Sound, Bristol Bay, and potentially the Pribilof Islands, all major western red king crab stocks are depressed and their associated fisheries are closed (ADF&G 2000). St. Matthew Island blue king crab was declared overfished in 1999 and the fishery closed. A rebuilding plan has been implemented. Red and blue king crab fisheries in the Pribilof Islands are closed and stocks considered either overfished or in decline. A rebuilding plan for the Pribilof Islands blue king crab stock is currently being developed. Golden king crab stock status in the BSAI and GOA is unknown due to lack of survey information. Bering Sea Tanner crab fisheries were closed in 1997 and stocks were declared overfished. A rebuilding plan is currently in effect for these stocks. Opilio Tanner crab populations in the BSAI are in decline and have been declared overfished. Overall status of bairdi Tanner and red king crab species in the GOA reflects population declines. However, blue and golden king crab are not actively assessed in the GOA at this time.

For the cumulative effects analysis, crab stocks in the BSAI and GOA will be placed in the following groups: bairdi Tanner, opilio Tanner (only BSAI), red king, blue king, and golden king.

Direct/Indirect Effects

Direct and indirect effects for all species of crab in the BSAI and GOA include mortality along with changes in biomass, reproductive success, prey availability, and habitat. These effects may be attributed to fishing activities (both directed and undirected), but may also be linked to natural events such as long-term climatic change and decadal regime shifts. Significance of these effects is based on the likelihood that population-level changes will result from internal events within the groundfish fishery. An effect that is considered insignificant corresponds to a change that is not likely to result in population-level effects on crab or that lies within the range of natural variability for the species.

Cumulative Effects Analysis

Summaries of the cumulative effects analyses associated with FMP 1 are shown in Tables 4.5-35 through 4.5-42 . For further information on persistent past effects included in this analysis, see Section 3.5.2.4 of this Programmatic SEIS.

The foundation of the cumulative effects analysis is the baseline description for each species that includes population status and trends, if known, and the major human and natural influences that have affected the population in the past and that continue up to the present.

For each species, the predicted direct and indirect effects of the groundfish fishery are then analyzed for their contribution to the overall impacts from all sources, including reasonably foreseeable future events resulting from human and natural events external to the fishery. The reasonably foreseeable future events also include other U.S. and foreign fisheries, acute and chronic environmental pollution, and natural events such as climatic and oceanographic fluctuations. Cumulative effects are each rated according to the same significance criteria as the direct/indirect effects of the fishery and are based on the potential for population-level effects.

<u>Mortality</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Under FMP 1, predicted catch of these crab species does not significantly change from the current baseline condition although catch trends do increase and decrease throughout the five-year period. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. The level of crab bycatch predicted for 2003 through 2007 would not be expected to further impede the recovery of these already depressed stocks. Thus, the effects of FMP 1 on mortality of bairdi Tanner, opilio Tanner, red king, and blue king crab are considered insignificant, due to the lack of significant recovery of these stocks while protective measures have been in place.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey in review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur, and although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. Thus, these fisheries are considered to have potential adverse effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed but is not in effect at the time of this writing. Rebuilding plans may have beneficial effects on recovery of these stocks as a whole, over time. BSAI red king crab stocks do not have rebuilding plans in effect but the populations are currently considered depressed. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G's crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. Thus, these combined effects of mortality, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events, are considered conditionally significant adverse for FMP 1. These effects could further impede the recovery of the population, although the driving factor(s) behind the BSAI crab stocks' lack of recovery have not been determined.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Under FMP 1, predicted catch rates of golden king crab in BSAI and GOA were combined with those for blue king crab. The BSAI predictions showed increases and decreases in catch over the next five years when compared to current catch rates. Model projections for GOA catch showed decreases in catch compared to current catch in this region. However, the significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status. Thus, effects of FMP 1 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab in the BSAI during this time increased proportionally with the direct catch of these fisheries. However, this is only applicable for the BSAI because BSAI fisheries would not influence GOA stocks. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures, providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA is currently unknown. Thus, the potential effects of crab bycatch in other fisheries are not known. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G's crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed but the overall stock status of golden king crab in BSAI and GOA is unknown. Thus, potential combined effects of mortality, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 1.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under FMP 1, predicted catch of bairdi Tanner, red king, and blue king crab in GOA showed decreases from the current catch levels over the next five years. However, significance of these predicted changes in catch on mortality is unknown for blue king and bairdi Tanner crab due to lack of survey information for determining current stock status. Thus, the effects of FMP 1 on mortality of GOA blue king and bairdi Tanner crab are unknown. GOA red king crab surveys indicate the stock is depressed, with no signs of rebuilding. The level of red king crab bycatch predicted for 2003 through 2007 (63% lower than baseline conditions) would not be expected to further impede the recovery of the stock. Thus, the effects of FMP 1 on mortality of red king crab stocks are considered insignificant, due to the lack of recovery of these stocks while protective measures have been in place.

- **Persistent Past Effects.** Crab bycatch is common in bottom trawl fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of external fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in the GOA. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in the GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed but their overall stock status is unknown. Thus, potential combined effects of mortality, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time under FMP 1. Potential combined effects of mortality on red king crab stocks in the GOA are considered conditionally significant adverse. These effects could further impede the recovery of the population, although the driving factor(s) behind the red king crab stocks' lack of recovery have not been determined.

<u>Change in Biomass</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. Thus, FMP 1 would have an insignificant effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI, when compared to the current baseline condition of these stocks. The level of crab bycatch predicted for 2003 through 2007 would not be expected to further impede the recovery of these already depressed stocks. Thus, the effects of FMP 1 on the change in biomass of bairdi Tanner, opilio Tanner, red king, and blue king crab are considered to be insignificant, due to the lack of significant recovery of these stocks while protective measures have been in place.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey in review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. Thus, these fisheries are considered to have potential adverse effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole, over time. BSAI red king crab stocks do not have rebuilding plans in effect but the population is currently considered depressed. Effects of long-term climate change and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G's crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. Thus, these combined effects resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events, are considered conditionally significant adverse. These effects could further jeopardize the sustainability of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI under FMP 1, although the driving factor(s) behind the BSAI crab stocks' lack of recovery have not been determined.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 1 on changes to biomass cannot be determined.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. However, this is only applicable for the BSAI because BSAI fisheries would not influence GOA stocks. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures, providing no benefit or protection to crab stocks overall. The potential effects of past fishing mortality on biomass of golden king crab stocks in the BSAI and GOA cannot be determined because catch composition is unknown and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in the BSAI and GOA is unknown and biomass estimates have not been determined. Thus, the potential effects of external fisheries on biomass are not known. Effects of long-term climate change and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G's crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed but the overall stock status of golden king crab in the BSAI and GOA is unknown and biomass estimates have not been determined. Thus, potential effects on biomass of BSAI and GOA golden king crab stocks, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 1.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in GOA, potential effects of FMP 1 on biomass of this species is unknown. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery while other GOA stocks are still considered depressed. Thus, potential effects of FMP 1 on biomass of GOA bairdi Tanner crab as a whole cannot be determined. Red king crab populations in GOA are at historic lows according to ADF&G survey information. Considering the severely depressed state of this stock as a whole, the predicted reduction in bycatch of red king crab under FMP 1 would have an insignificant effect on the biomass of these stocks when compared to the current baseline condition.

- **Persistent Past Effects.** Crab bycatch is common in certain fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Adverse effects of past fishing and unobserved mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in the GOA may still exist, as recovery of depressed stocks has not occurred.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on biomass of bairdi Tanner and blue king crab stocks cannot be determined. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in the GOA. Effects of long-term climate change and regime shifts on biomass have not been determined.

- **Cumulative Effects.** ADF&G's crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed but their overall stock status is unknown. Thus, potential effects on biomass of bairdi Tanner and blue king crab in the GOA, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 1. Potential effects on biomass of red king crab in the GOA are considered conditionally significant adverse. The combined effects could further impede the recovery of the population, although the driving factor(s) behind the red king crab stocks' lack of recovery have not been determined.

Change in Reproductive Success

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. Changes in reproductive success within BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causation between spawning-recruitment success and depressed stock status cannot be concluded at this time. Thus the potential effects of FMP 1 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey in review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures, providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Directed crab fishing seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect and the population is currently considered depressed. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. A relationship between spawning-recruitment success and other factors impeding on reproductive potential with depressed stock status cannot be drawn at this time, the potential effects on reproductive success, resulting from past events, direct catch, bycatch, and future events, are unknown under FMP 1.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in the BSAI and GOA, potential effects of FMP 1 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. However, this is only applicable for the BSAI because BSAI fisheries would not influence GOA stocks. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined so potential past effects on reproductive success are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting periods so these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA may exist, and internal effects are uncertain due to the lack of survey information. Potential effects on reproductive success, resulting from past events, direct catch, bycatch, and future events, are therefore, unknown for FMP 1.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in the GOA, potential effects of FMP 1 on changes to reproductive success cannot be determined. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery while other GOA stocks are still considered depressed. Red king crab populations in GOA are at historic lows according to ADF&G survey information. Changes in reproductive success within GOA crab populations may be an underlying factor in the depressed nature of these stocks. However, the relationship between reproductive success and depressed stock status for these stocks cannot be concluded at this time. Therefore, the potential effects of FMP 1 on changes to reproductive success cannot be determined for bairdi Tanner and red king crab populations in the GOA.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures, providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** Crab seasons are set as to avoid mating and molting periods so these fisheries are not considered contributing factors to changes in reproductive success of these stocks. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the GOA may still exist and some stocks are considered depressed with no signs of recovery to date. Because a direct causation between reproductive success and depressed stock status cannot be concluded at this time, the potential effects on reproductive success, resulting from past events, direct catch, bycatch, and reasonably foreseeable future events are unknown under FMP 1.

Change in Prey Availability

Bairdi Tanner, Opilio Tanner, Red King, Blue King, and Golden King Crab in BSAI and GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, only BSAI opilio Tanner crab is included in this analysis.

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown and it is unclear if FMP 1 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of FMP 1 on changes in prey availability cannot be determined.

- **Persistent Past Effects.** Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past fisheries is minimal. Thus, past effects on crab prey structure and availability in the BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown and these fisheries are not considered contributing factors to changes in prey availability. Rebuilding plans currently in effect in the BSAI do not address crab prey structure and availability and are not considered contributing factors to potential changes in prey availability. Long-term climate change and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the possible effects that these changes may have on crab populations throughout BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined and potential changes to prey structure, resulting from past, present, and future events, cannot be determined for all species of crab in the BSAI and GOA.

<u>Change in Habitat</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. However, a direct link between changes to habitat and the depressed stock status of these crab species in the BSAI cannot be concluded at this time. Numerous ADF&G management measures, rebuilding plans, trawl closures, and conservation areas have been implemented to address declining and overfished crab stocks in the BSAI. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for most crab stocks, thus the potential effects of FMP 1 on changes to habitat are considered insignificant.

- **Persistent Past Effects.** The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey in review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures, providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat areas as a result of trawling and using other types of fishing gear that interact with bottom habitat. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Although some of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. These fisheries are considered potential adverse factors in changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Formal stock rebuilding plans are in place for BSAI bairdi and opilio

Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole, over time, and also offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect but the population is currently considered depressed, and possible habitat-related effects have not been determined. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. However the relationship between changes to habitat and depressed stock status cannot be drawn at this time. Although some of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. Thus, potential effects on crab habitat, resulting from past, present, and future events cannot be determined for FMP 1.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in the BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout the BSAI and GOA. Therefore, the potential effects of FMP 1 to crab habitat are unknown.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures, providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined so potential past effects on essential habitat are also unknown.

- **Reasonably Foreseeable Future External Effects.** Although some of the known habitat areas of the BSAI and GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. These fisheries are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for many of the crab stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** It is unclear if persistent past effects on golden king crab habitat in the BSAI and GOA exist. Population estimates are not available for BSAI and GOA golden crab, although some GOA golden king crab stocks are considered depressed. The relationship between habitat and depressed stock status cannot be drawn at this time. Although some of the known habitat areas of BSAI and GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. Thus, the potential effects on golden king crab habitat, resulting from past, present, and future events cannot be determined for FMP 1 without first establishing the overall population status of this species.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Red king and bairdi Tanner stocks in the GOA are currently considered depressed while blue king crab stock status is unknown, but presumed to be depressed based on limited survey data. However, the relationship between changes to habitat and depressed stock status cannot be drawn at this time. Numerous ADF&G management measures, rebuilding plans, trawl closures, and conservation areas have been implemented to address declining crab stocks in the GOA. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks, thus the potential effects of FMP 1 on changes to habitat for bairdi Tanner, red king, and blue king crab stocks in GOA are considered insignificant.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures, providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat areas as a result of bottom trawling. Past effects may still exist as some of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** Although some known habitat areas of GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. These fisheries are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist and stocks are considered depressed with no signs of recovery to date. However, the relationship between changes to habitat and depressed stock status cannot be drawn at this time. Although some of the known habitat areas of GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. Thus, potential effects on GOA bairdi Tanner, red king, and blue king crab habitat, resulting from past, present, and future events cannot be determined for FMP 1.

4.5.3 Other Species Alternative 1 Analysis

The other species category consists of the following species:

- Squid (order Teuthoidea).

- Sculpin (family Cottidae).

- Shark (*Somniosus pacificus, Squalus acanthias, Lamna ditropis*).

- Skate (genera *Bathyraja and Raja*).

- Octopi (*Ocotopus dofleini, Opistholeutis california,* and *Octopus leioderma*).

An aggregate TAC limits the catch of species in this category. Within the other species category, only shark are identified to the species level by fishery observers. Furthermore, accuracy of catch estimates depends on the level of coverage in each fishery. Observer coverage in the BSAI is estimated at 70-80 percent, whereas the GOA has only approximately 30 percent observer coverage. Coverage can also vary for certain target fisheries and vessel sizes (Gaichas 2002). Management of the Other Species category is described in detail in Section 3.5.3.

Formal stock assessments for other species are not currently conducted in the BSAI and GOA and biomass estimates for the species included in this category are limited and often unreliable. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. With the exception of skates, none of the species in the other species category is currently targeted by the BSAI and GOA groundfish fisheries. Other species are only caught as bycatch by fisheries targeting groundfish. While we report changes in bycatch relative to the comparative baseline, determinations cannot be made as to how these changes in catch actually impact other species populations, or whether these impacts might be adverse, beneficial, or neutral. Numerous direct and indirect effects may impact the current and future status of individual species within this group or this group as a whole. These effects are presented in detail in the section that follows.

Direct/Indirect Effects FMP 1 – Other Species

Direct and indirect effects for other species include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups is unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 1 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 1, total catch of both BSAI squid and other species and GOA other species is predicted to increase by several thousand mt per year, due to predicted increases in catches of the target species that other species are caught with. Most of this increase is predicted in the catch of skate and sculpin in both the BSAI and GOA. Catch projections for specific groups within BSAI and GOA other species are presented below.

Squid

In the BSAI, squid catch is predicted to increase slightly and then decrease to the current level over the five projection years, likely following trends in the pollock fishery. In the GOA, squid catch is predicted to double over the five year projection period, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so doubling may not cause different population impacts than current catch levels.

Sculpin

Catches of BSAI sculpins are predicted to increase slightly (by 500 mt relative to current catches). GOA sculpin catch is predicted to increase by 200 mt per year over the projection period.

Shark

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of all of these species are predicted to remain stable throughout the projection period under FMP 1. As in the BSAI, shark catches in the GOA are partitioned into Pacific sleeper shark, salmon shark, dogfish, and other shark. Although all shark catch in the GOA is predicted to be relatively low, catches of other shark are predicted to increase by an order of magnitude, catches of salmon shark are predicted to decrease slightly, and catches of sleeper shark and dogfish will remain relatively similar to current levels.

Skate

Skate currently make up the largest portion of bycatch for the other species complex. The catch of BSAI skate is predicted to increase by nearly 2000 mt to over 21,000 mt within the first three projection years, and remains in that range for the remainder of the modeled period. The increased catch of skate may reflect increased catches in both longline fisheries for Pacific cod and in bottom trawl fisheries for cod and flatfish. In the GOA, skate catch is predicted to increase by about 1,300 mt, which is the same order of magnitude as current catches. This projected catch trend may warrant increased management attention if it actually occurred.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the Other Species complex. In turn, they would be added to the Target Species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined Big and Longnose skates in the Central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway and improved collection of data is expected under this amendment.

Octopi

Octopus catch in the BSAI is predicted to remain stable at 300-400 mt per year. Observed GOA octopus catch has been low historically, so changes to catch level may not cause different population impacts than current catch levels. The trace amounts of octopus catch reported in the GOA are predicted to decrease slightly over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects FMP 1 – Other Species

A summary of the cumulative effects analysis associated with FMP 1 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA other species is unknown under FMP 1. The current baseline condition is unknown and species-specific catch information is lacking for this complex since species identification does not occur in the fisheries.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA that a species or even a species group could be disproportionately exploited while the overall aggregate of other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA other species are unknown under FMP 1. The current baseline condition is unknown and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex is unknown and persistent past effects have not been identified. The combined effects of changes to reproductive success on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in the BSAI and GOA are unknown under FMP 1. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups have been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex is unknown and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the other species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA other species is unknown under FMP 1. The current baseline condition is unknown and species-specific catch information is lacking for this complex since species identification does not occur in the fisheries. Formal stock assessments are not conducted for other species and most biomass estimates for BSAI and GOA other species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species are unknown under FMP 1. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the other species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species also have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown.

4.5.4 Forage Fish Alternative 1 Analysis

The BSAI and GOA FMPs were amended in 1998 to establish a forage species category to prevent the development of directed fisheries on these ecologically important non-target species. Forage fish are described in more detail in Section 3.5.4.

Direct/Indirect Effects FMP 1 – BSAI and GOA Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. It is thought that the effects of FMP1 are unlikely to affect biomass of forage species.

Catch/Fishing Mortality

A directed fishery on forage species is prohibited by Amendments 36 and 39 in the FMPs for the BSAI and GOA, respectively. However, forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (greater than 90 percent most years) of the forage fish bycatch, in both the BSAI and GOA, is made up of smelt species (Osmeridae) from the pollock fishery.

In the BSAI region, model projections for FMP 1 indicate incidental catch of forage fish would remain low at a level similar to the current catch (Table H.4-22 in Appendix H).

Over the next 5 years the pollock catch in the GOA is projected to grow rapidly under FMP 1 (Table H.4-41 of Appendix H). This increased pollock catch under this alternative is projected to lead to greater incidental catches of forage fish.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. Spatial or temporal concentration of fishing effort is not expected to change from the current pattern under FMP 1. Consequently, there is no evidence that any change in spatial or temporal fishing mortality of forage fish would occur.

Status Determination

The MSST of forage fish species is unknown at this time but it is highly unlikely that management practices under FMP 1 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. However, it is thought that FMP 1 would have little affect on the age and size composition of forage fish. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest this would change under FMP 1.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. Attempting to accurately model the predator-prey impacts of different management FMPs is problematic. However, since FMP 1 is similar to the current management practices it seems unlikely that any significant changes would occur.

Summary of Effects of FMP 1 – BSAI and GOA Forage Fish

Information on forage fish species is very limited. Total biomass, spawning biomass and fishing mortality are not estimated in the model used for this analysis. Therefore, only qualitative analysis of the FMP's effects on these measures can be described.

A directed fishery for forage fish is prohibited by Amendment 36 and 39 in the BSAI and GOA FMPs. Therefore the only direct effect of FMP 1 is incidental take of forage fish in other fisheries.

The model projects future bycatch of forage fish by averaging the 1997-2001 bycatch matrix. Model output for forage fish bycatch is closely linked to pollock catch. Smelts make up the vast majority of the forage fish bycatch in the BSAI and GOA, taken mainly by the pollock fishery. Therefore, the projected level of incidental catch of forage fish is highly correlated with the pollock TAC set for the FMP.

Under FMP 1 the bycatch of forage fish in the BSAI remains consistently low at a level slightly higher than the baseline (Table H.4-22 in Appendix H). In the GOA the bycatch of forage species is projected to increase considerably in the next 5 years (Table H.4-41 in Appendix H). Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 1 is thought to be a relatively small fraction of the biomass and unlikely to effect the abundance of the stock in the BSAI.

Indirect effects of FMP 1 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 1.

Cumulative Effects FMP 1 – BSAI and GOA Forage Fish

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 1.

- **Persistent Past Effects** have not been identified for fishing mortality in the BSAI or GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of forage fish. See Sections 3.5.4 and 3.10 for more information. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish mortality; however, the removal of these species is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The change in biomass level under FMP 1 is rated as unknown.

- **Persistent Past Effects** have not been identified for the change in biomass of the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on the change in biomass are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the forage fish biomass level. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.4 and 3.10. The Alaska subsistence and personal use fisheries have been identified as a potential adverse contributors to the change in biomass level of BSAI and GOA forage fish. Subsistence and personal use fisheries concentrate mostly on the smelt species; however, it is unlikely that these fisheries would have a population level effect.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 1 the effect of the spatial/temporal concentration of catch is unknown.

- **Persistent Past Effects** are not identified for the genetic structure of the BSAI and GOA forage fish. Climate changes and regime shifts are identified as influencing the reproductive success of BSAI and GOA forage fish. For example, some Osmeridae species have shown a decline in recruitment since the late 1970s, coinciding with the increase in water temperature.

- **Reasonably Foreseeable Future External Effects** on the reproductive success of forage fish due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI and GOA forage fish. The Alaska subsistence and personal use fisheries are identified as having potential adverse contributions to the genetic structure and reproductive success of BSAI and GOA forage species. As stated above, these fisheries mainly target smelt species; however it is unlikely the removals in these fisheries would be large enough and taken in such a localized manner that would jeopardize the capacity of the stocks to maintain current population levels.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the forage fish catch; however, this effect is unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 1, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** are identified for the change in prey availability of the BSAI and GOA forage fish stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted. See Sections 3.5.4 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects** of the climate changes and regime shifts on the BSAI and GOA forage fish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stocks ability to maintain current population levels. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to the prey availability of BSAI and GOA forage fish. However, the catch/bycatch of these species is expected to be minimal and unlikely to have a population level impact.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown, because the information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 1, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for BSAI and GOA forage fish include climate changes and regime shifts. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. For more information, see Sections 3.5.4 and 3.10.

- **Reasonably Foreseeable Future External Effects** of the climate changes and regime shifts on the BSAI and GOA forage fish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish habitat suitability. For more information on the effects of fishery gear on EFH, see Section 3.6.4.

- **Cumulative Effects.** A cumulative effect is identified for BSAI and GOA forage fish habitat suitability; however this effect is unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

Summary of Cumulative Effects – BSAI and GOA Forage Fish

Although cumulative effects have been identified for mortality, change in biomass level, change in genetic structure, change in reproductive success, change in prey availability and change in habitat suitability, all effects are unknown except for mortality. Mortality has been identified as insignificant (see Tables 4.5-44 and 4.5-45).

4.5.5 Non-Specified Species Alternative 1 Analysis

Grenadiers have been chosen to illustrate potential effects to non-specified species because they are currently the major catch in the non-specified FMP category. Non-specified species make up a huge and diverse category encompassing every species not listed in the current FMP as target, prohibited, forage, or other species. Considering a single species group from this category, such as grenadier, cannot possibly represent the diverse effects to all species in the category. However, because information is lacking for nearly all of these groups, and they are caught in small or unknown amounts (due to a lack of reporting requirements in this category), we discuss potential effects to grenadier only.

Formal stock assessments are not conducted for grenadiers. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. Changes in bycatch of grenadiers were predicted based on modeled changes in target species catches and population trajectories (sablefish target fisheries have the most grenadier bycatch). While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact grenadier populations, or whether these impacts might be adverse, beneficial, or neutral.

Direct/Indirect Effects FMP 1 – Non-Specified Species

Direct and indirect effects for grenadier include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 1 are relatively small, such that diverse alternatives may have similar (though unknown) effects on each stock.

Under FMP 1, catch of grenadiers in both the BSAI and GOA is predicted to remain within the currently observed range. In both areas, grenadier catch is predicted to increase slightly initially and then decrease, following trends in the sablefish fishery.

Cumulative Effects FMP 1 – Non-Specified Species

A summary of the cumulative effects analysis associated with FMP 1 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis, see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 1. The current baseline condition is unknown and catch information is lacking for all members of the non-specified category since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist and there are no catch limitations or stock assessments. It is possible that grenadier, and all other species included in the non-specified category, in the BSAI and GOA, could be disproportionately exploited but stock status remains unknown. Grenadier continue to constitute the largest portion of the non-target species bycatch in the GOA, and mortality is therefore considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown since the current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** For grenadiers and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on grenadiers, and other species with the non-specified complex, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown for FMP 1.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadiers is unknown under FMP 1. The current baseline condition is unknown for all members of the non-specified complex and species-specific catch information is lacking since species identification does not occur in the fisheries. Formal stock assessments are not conducted and biomass estimates in the BSAI and GOA for grenadiers, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier, and all other species included in the non-specified category, in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. The current non-management of grenadiers could mask declines in individual grenadier species and therefore, lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadiers, and all other members of the non-specified group, depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment but it is currently not known how these non-specified species would respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadiers, and all other species in the non-specified group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown for FMP 1.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier, and presumably all other species within the non-specified complex, are unknown under FMP 1. The current baseline condition is unknown and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier, and all other species included in the non-specified category, in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. Such overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of grenadiers (and other non-specified species) depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadiers, and all other members of the non-specified category, would respond to climatic fluctuations.

- **Cumulative Effects.** For grenadiers, and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown and persistent past effects have not been identified. The combined effects of changes to reproductive success on grenadiers and other non-specified species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown for FMP 1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier, and other species within the non-specified complex, populations in BSAI and GOA are unknown under FMP 1. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier, and all other species included in the non-specified category, in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups have been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For grenadiers, and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown for FMP 1.

4.5.6 Habitat Alternative 1 Analysis

Habitat protection measures under FMP 1 result from a long history of fishery management actions. The majority of historical management actions that addressed habitat concerns focused on protection of crab habitat.

Figure 4.2-1 illustrates the current suite of year-round closures in the BSAI and GOA management areas. Table 4.5-47 summarizes the baseline and FMP 1 geographic and habitat type distribution of bottom trawl closures in waters less than 1000 m. In the GOA and Aleutians Islands, nearly all of these closures are located in shallow waters (less than 100 m); near-shore state waters (GOA only), within 3 miles of sea lion rookeries, or Type I closures around Kodiak Island. In deeper areas, with the exception of the eastern GOA (area 650), only 0-7 percent of the fishable area is currently protected from the impacts of bottom trawling. In the Bering Sea most of the closures are concentrated on sand substrate believed important to crab. There are limited closures on sand/mud substrate and no closures on mud habitat. There are no closures on the upper slope of the Bering Sea, although this area is not considered by some to be a distinct habitat type (see Section 3.6 for a discussion of existing closures and their intended habitat effects).

Direct/Indirect Effects of FMP 1

Direct and indirect effects of FMP 1 are discussed for changes to living habitat through direct mortality of benthic organisms, changes to benthic community structure through benthic community diversity, and geographic diversity of impacts and protection. Due to habitat type differences, the BSAI and GOA are rated and discussed separately.

Changes to Living Habitat through Direct Mortality of Benthic Organisms

In the GOA, based on the bycatch projection model, the catch of most living habitats is projected to decline (Table 4.5-48). In the BSAI, the bycatch levels are predicted to be within about plus or minus 20 percent of the baseline. The model projections for the GOA are unrealistically low relative to the baseline. This is because specific fisheries that have high bycatch of living substrates, such as aggregated rockfish, are constrained within the model framework (Jim Ianelli, AFSC personal communication). Based on past performance, it is doubtful that such constraints will severely curtail the rockfish fishery. A more realistic assumption is that bycatch levels would be about the same as the baseline, which are at levels considered to cause adverse impacts to habitat.

The habitat impacts model predicts the following effects for biostructure relative to the baseline:

- **Bering Sea.** There is no predictable difference from the baseline. Mean impacts are low when averaged over entire fishable EEZ. As with the baseline, impacts to biostructure range from 1.8 to 9.3 percent of the fishable EEZ and from 8.2 to 41.9 percent of the fished area. A large expanse (8,000 square miles) of high fishing intensity potentially causes an 83 percent reduction in equilibrium biostructure level for scenario 2 (i.e., 15 year recovery rate). Based on these results, we conclude that change to mortality and damage to living habitat would be insignificant as a result of FMP 1. Thus the rating is based on the insignificant change between FMP 1 projections and the comparative baseline.

- **Aleutian Islands.** There is no predictable difference from baseline where mean impacts ranged from 1.1 to 6.8 percent of the fishable EEZ and from 5.4 to 32.6 percent of the fished areas. Therefore, the change resulting from FMP 1 is rated as insignificant. However, prevalence of long-lived species of coral in the bycatch makes impacts a particular concern under FMP 1. With a recovery rate for red tree coral possibly as low as $\rho = 0.005$ (200 years) and sensitivity $q_h = 0.27$, the habitat impact model indicates that fishing intensity as low as $f = 0.10$ (total area swept once every 10 years) results in an equilibrium level reduction of 85 percent relative to the unfished level. About 9 percent of the area is estimated to be fished at $f = 0.10$ or greater. This amounts to 3,590 square miles of area. Based on these results, we conclude that there would be an insignificant change to mortality and damage to living habitat as a result of FMP 1; however, as with the baseline, FMP 1 bycatch levels may have adverse consequences on habitat quality and FMP 1 would not change this risk.

- **GOA.** There is no predictable difference from the baseline where estimates of equilibrium impact on biostructure averaged over the entire fishable EEZ range from 0.9 to 6.9 percent of the fishable area and from 3.8 percent to 29.0 percent of the fished areas. Only 2 percent of the fishable EEZ is impacted to a level potentially below 32 percent (Scenario 2) of unfished levels, but this amounts to about 2,418 square miles of habitat in scattered concentrations. Therefore, for FMP 1, the change to mortality and damage to living habitat is rated as insignificant. However, as described above, the baseline condition is considered to already be adversely impacted.

Changes to Benthic Community Structure including Benthic Community Diversity and Geographic Diversity of Impacts and Protection

- **Bering Sea.** Identical to the baseline, FMP 1 closures in the Bering Sea are mostly concentrated on sand substrate (Table 4.5-47). Only 27 percent of the geographical- habitat zones have greater than or equal to 20 percent of their area closed to bottom trawling. Figure 4.1-10 shows that the amount of large contiguous areas of high fishing intensity—that is, areas that are swept at least once each year with bottom trawls—exceeds 8,000 square miles (Table 4.1-26). Table 4.5-49 shows that of the Bering Sea fishable area, 19.3 percent is closed to bottom trawling under FMP 1. However, very little geographic diversity of fishing impacts occurs within the closed habitats and nearly all of the closures are not year-round. Figure 4.5-4 shows areas closed to trawling only at various times of the year under this FMP, while Figure 4.5-5 depicts just those areas closed to fixed gear only.

  Application of the habitat impacts model indicated that, depending on the sensitivity and recovery parameters thought plausible, fishing of this intensity could reduce the amount of biostructure in the area by 13 to 75 percent of its unfished equilibrium level (Table 4.1-26). Such biostructure includes sponges, soft corals, tunicates, and anemones (Heifetz *et al.* 2002, Malecha et al. 2003). In these habitat areas, no existing closure areas abut these intensely fished areas to provide a diverse level of impact. While existing closures tend to be large and cover all of particular habitat, they provide little diversity in fishing impacts. The primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear; therefore, the closures do not necessarily cross a wide range of habitat types. Some of the trawl closures are in effect year-round while others are seasonal (see Section 3.6). Compared to the existing baseline, the predicted effects of FMP 1 on benthic community diversity are insignificant. Similarly, the predicted effects of FMP 1 on geographic diversity of impacts are also predicted to be insignificant. However, as described above for direct mortality, the baseline condition is considered to already be adversely impacted.

- **Aleutian Islands.** Identical to the baseline, FMP 1 closures in the Aleutian Islands are concentrated in shallow water where only 4 percent of the area is closed to bottom trawling year round for all species. However, as shown on Table 4.5-49, about 43 percent of the fishable area in the Aleutians is closed to bottom trawling at one time or another during the year under this FMP. These closures are associated with sea lion rookeries. As in the baseline, there is very little diversity in protection. Less than one percent of the deep area is closed to bottom trawling. Figure 4.1-10 shows that none of the closure areas extends over any blocks of significant fishing effort. Figures 4.5-4 and 4.5-5 show the closure areas under FMP 1 broken down by gear type, bottom trawl and fixed gear, respectively. The Aleutian Islands bathymetry and habitat are distributed on a very fine scale, with fishing effort that is very patchy and in very small clusters. Based on these observations as compared to the baseline, the predicted effects of FMP 1 on benthic community diversity and geographic diversity of impacts are insignificant, but the baseline condition is considered to have experienced adverse impacts.

- **GOA.** Figure 4.5-6 shows that, as in the baseline, minimal geographic diversity of impact or protection results from the current suite of closed areas. Except for the southeast trawl closure, which covers several entire habitat types, all other closures are inshore, none exist on the outer shelf or slope (see Figure 4.5-6). As shown on Table 4.5-49 and Figures 4.5-4 and 4.5-5, FMP 1 closes nearly 46 percent of the fishable area in the GOA to trawling at one time or another during the year. The inshore closure areas tend to be large relative to the size of bathymetric and habitat resolution scale and thus tend to encompass much of a bathymetric feature. Based on these results, the predicted effects of FMP 1 on benthic community diversity and geographic diversity of impacts are insignificant, but the baseline condition is considered to be in an adversely impacted state.

Cumulative Effects FMP 1

Cumulative effects on Habitat for FMP 1 are summarized on Table 4.5-50. The following discussion of the results presented on the table is broken down by geographic area.

Bering Sea

<u>Changes to Living Habitat through Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Mortality of sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts which include mortality due to smothering and/or reduced oxygen are expected to be more prevalent in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use are possible at several locations in the Bering Sea area including Port Moller, Port Heiden, Dillingham, St. Paul and St. George. Again the impacts include mortality due to smothering, and/or burying and, of course, would only affect nearshore zones and bays. Marine pollution is also identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Again areas more likely to be impacted would be located nearer to shore. Natural events such as storm surges and waves also have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Conditionally significant adverse effects are identified for mortality of Bering Sea benthic organisms. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the effect of FMP 1 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue and add to the adverse consequences to benthic living habitat.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant; however, the community structure is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, all have the potential to cause changes to benthic communities. If long-term, as in the case of a change to a weather pattern, wind-induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above, all of these impacts are more likely to be observed in nearshore areas. Regime shifts and large-scale environmental fluctuations associated with El Niño and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific. These changes could have either beneficial or adverse effects on the benthic community (see Sections 3.6 and 3.10).

- **Cumulative Effects.** Conditionally significant adverse effects are identified for changes in benthic community structure of the Bering Sea. The additional external impacts will add to the lingering past impacts described above. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 1 are rated as insignificant, continued bycatch and damage to living habitats in the Bering Sea will add to the adverse effects of fishing on the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant; however, the geographic diversity is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 illustrate the spatial measures that were in effect before 1980 or were later established by regulations following the publication of the Final Groundfish SEIS in November of 1980. As discussed in Section 3.6, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most of the restricted areas were implemented to spatially and temporarily restrict the foreign fishery to prevent conflicts with domestic fisheries through bycatch of species important to U.S. fishermen, or grounds preemption and gear conflicts. At the time, most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. This again was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 almost 9 percent of the fishable area in the Bering Sea was closed to trawling with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time.

- **Reasonably Foreseeable Future External Effects.** These include port expansion and the potential resultant changes to offal discharge and marine pollution episodes. As ports in the Bering Sea are expanded and new ports created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, the opening of new ports may allow vessels of all sizes to access new or relatively unfished areas. On the other hand, depending on distribution, fishing pressure in heavily fished areas may be eased as access to other areas becomes available. Of course, closed areas proposed to continue under this FMP would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 1 would protect more benthic habitat from trawl gear in the future (19 percent) than was protected in 1980 (8.6 percent). However, the spatial distribution of the closed areas under FMP 1 will not protect the full range of habitat types, or provide for a diversity of impacts within fished areas. (Existing closures tend to be large and cover all of particular habitat, and they provide little diversity in fishing impacts since the primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear; see internal effects discussion and baseline description in Section 3.6). The additional external impacts do not provide any protection and could add to the lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 1 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished and impacts would occur in areas not previously impacted.

Aleutian Islands

Changes to Living Habitat through Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long lived species of coral makes impacts a particular concern in the Aleutians. Mortality of long lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Dredging due to scallop fisheries and/or navigation can occur in localized areas (often in conjunction with port development) and can cause burial or smothering of benthic fauna. Damage to living substrates by longline and pot fisheries (see Section 3.6) has been documented and is expected to continue in those heavily fished areas. Offal discharge can occur from offshore catcher processors and onshore processors, causing mortality in nearshore areas. As with Bering Sea processors, improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use is possible at several locations in the Aleutian Islands including Atkutan, Adak, Unalaska, Cold Bay Dutch Harbor and King Cove. The impacts include mortality due to smothering, and/or burying and, would affect only nearshore zones and bays. Marine pollution is also identified as having a reasonably foreseeable potential adverse contribution, since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events such as storm surges and waves also have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organism.

- **Cumulative Effects.** Conditionally significant adverse effects are identified for mortality of Aleutian Islands benthic organisms. Long lived species such as tree coral are more prevalent in the Aleutian Islands. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 1 are rated as insignificant, bycatch and damage to living habitat will continue and will add to the adverse consequences to benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant; however, the community structure is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutians. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline and pot fisheries, offal discharge, port expansion and use, and marine pollution, all have the potential to cause changes to benthic communities. If long-term, as in the case of a change to a weather pattern, wind-induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above for mortality, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with El Niño and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific (see Sections 3.6 and 3.10). These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse effects are identified for changes in benthic community structure of the Aleutians. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident, particularly in the case of long-lived coral species. Thus, even though the direct/indirect effects of FMP 1 are rated as insignificant, continued bycatch and damage to living habitat will add to the adverse consequences on the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed above for the Bering Sea, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries, in order to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 about 31 percent of the fishable area in the Aleutians was closed to trawling with about 6 percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time.

- **Reasonably Foreseeable Future External Effects.** These effects include other fisheries, port expansion and the potential resultant changes to offal discharge and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either additionally be impacted or allowed to recover. As with the Bering Sea, ports in the Aleutians are expanded and new ports created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, these additional ports and harbor space could change the distribution of fishing efforts. Of course, closed areas proposed to continue under this FMP would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by disturbance to the bottom, offal discharge and marine pollution. For example, under FMP 1, areas previously closed to foreign trawl fishing, such as Unimak Pass, are now fished by the domestic trawl fleet. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 1 would protect more benthic habitat from trawl gear in the future (43 percent) than was protected in 1980 (31 percent). However, the spatial distribution of the closed areas under the current FMPs will not protect the full range of habitat types, or provide for a diversity of impacts within fished areas. The additional external impacts do not provide any protection and could add to the lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 1 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished and impacts would occur in areas not previously impacted.

GOA

Changes to Living Habitat through Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As described for the Bering Sea and Aleutian Islands, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Port expansion and increased use is possible at several locations in the GOA including Kodiak, Sand Point, Chignik, Port Lions, Ouzinkie, Valdez, and Seward. The impacts, which include mortality due to smothering and/or burying, would likely only affect nearshore zones and bays. Marine pollution is also identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events such as storm surges and waves also have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organism.

- **Cumulative Effects.** Conditionally significant adverse effects are identified for mortality of GOA benthic organisms. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 1 are rated as insignificant, bycatch and damage to living habitat will continue and add to the adverse consequences to benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to be insignificant; however, the community structure is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline and pot fisheries, offal discharge, port expansion and use, and marine pollution, all have the potential to cause changes to benthic communities. If long-term, as in the case of a change to a weather pattern, wind-induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with El Niño and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific (see Sections 3.6 and 3.10). These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse effects are identified for changes in benthic community structure of the GOA. The additional external impacts described above will add to the lingering past impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 1 are rated as insignificant, bycatch and damage to living habitat will continue and will add to the adverse consequences to benthic living habitat.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.5.6, this effect is judged to insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed for the other regions, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring and there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries (Figures 3.6-6 and 3.6-7). This again was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 about 5 percent of the fishable area in the GOA was closed to trawling, with about 7 percent closed to all fishing. The largest closures in the GOA concerned longline fishing where almost 61 percent of the fishable area was closed to longlining. Therefore, in 1980 about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at one time or another throughout the year.

- **Reasonably Foreseeable Future External Effects.** These effects include other fisheries, port expansion and the potential resultant changes to offal discharge and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As described for the other areas, as ports in the GOA are expanded, new ports created, and additional dock space for harboring the fishing fleet is made available, and changes in the distribution of fishing effort could result. Closed areas proposed to continue under this FMP would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 1 would protect much more benthic habitat from trawl gear in the future (46 percent) than was protected in 1980 (16 percent). However, the spatial distribution of the closed areas under FMP 1 may not protect the full range of habitat types. Also, in 1980 more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under FMP 1 (less than one percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. The additional external impacts described above will add to the lingering impacts and contribute to impacts that are already evident. This is particularly important since FMP 1 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished and impacts would occur in areas not previously impacted.

4.5.7 Seabirds Alternative 1 Analysis

4.5.7.1 Short-Tailed Albatross

Direct/Indirect Effects of FMP 1

Incidental Take

Incidental take of the endangered short-tailed albatross in the groundfish fishery is a very rare event, with the last recorded takes occurring in 1998 (see Section 3.7.4 for a history of takes and agency actions taken to protect this species under the ESA). The seabird protection measures on the longline fleet have been in place since 1997 and constitute the baseline condition for this analysis (see Appendix F-6). These measures have been strongly influenced by the goal of protecting short-tailed albatross. These measures did not eliminate incidental take of short-tailed albatross, as evidenced by two takes in one month in 1998. A great deal of research and development has been conducted since that time to improve the current seabird protection measures. FMP 1 would institute new protection measures based on the joint recommendations of NOAA Fisheries, USFWS, and the Washington Sea Grant Program. These new regulations are currently undergoing agency and public review before being enacted (68 FR 6386). These new regulations are expected to substantially reduce the incidental take of all surface-feeding seabirds and therefore reduce the chance of taking short-tailed albatross. NOAA Fisheries and USFWS are currently researching the risk of short-tailed albatross incidental take due to collisions with trawl third wires. FMP 1 would incorporate any mitigation measures that arise from this research if it is considered necessary to protect the species.

Given the extreme rarity of short-tailed albatross, numbering less than 2,000 birds worldwide, any level of mortality is a conservation concern. For this reason, management actions that substantially reduce the chance of human-caused mortality even if the chance is not totally eliminated, have been pursued under the ESA and are included under FMP 1. From the perspective of research, management, and fishing industry efforts to reduce the chance of taking short-tailed albatross, the new protection measures have been very substantial. However, the short-tailed albatross population has been increasing at a near-maximum rate under the baseline conditions so a reduced chance of mortality in the fishery, when the measurable frequency of that mortality already approaches zero, may not result in measurable benefits for the population. The reduced level of incidental take under FMP 1 is therefore considered to be insignificant at the population level for short-tailed albatross.

Changes in Food Availability

Short-tailed albatross forage over vast areas of ocean on prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Sections 4.5.4 and 4.5.10). Short-tailed albatross are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 1. FMP 1 is therefore considered to have insignificant effects on short-tailed albatross.

Benthic Habitat

Short-tailed albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 1. FMP 1 is therefore considered to have no effects on short-tailed albatross.

Cumulative Effects of FMP 1

The past/present effects on short-tailed albatross are described in Section 3.7.4 (Table 3.7-12) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-52.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures on the longline fleet should substantially reduce the chances of taking short-tailed albatross incidentally in the groundfish fishery, although the risk would not be eliminated. Incidental take of short-tailed albatross is therefore predicted to be a very rare event in the groundfish fishery and is considered insignificant at the population level.

- **Persistent Past Effects.** The most important persistent influence on the short-tailed albatross population is their near extinction due to commercial feather hunting from the late 1800s to 1932 (Hasegawa and DeGange 1982). Conservation efforts in Japan and the U.S. have helped secure and expand nesting locations and reduce human-caused mortality factors such as incidental take in fisheries, allowing the population to recover at or near to its biologically maximum rate. Given the lack of observers and incidental take data from most of the fisheries in their range, the total fishery-related mortality of short-tailed albatross is unknown. However, considering their recent rate of population growth, overall mortality does not appear to be having an overriding effect on the population.

- **Reasonably Foreseeable Future External Effects.** The primary concern for the future of the species' complete recovery is the risk presented by volcanic eruptions on their main breeding site, Torishima Island. If a major eruption occurred while the birds were nesting, a significant proportion of the breeding adults could be killed along with their eggs/chicks. Such a disaster would not cause the species' extinction, since many non-breeding birds would be at sea and there are alternative nesting sites, but it would place even greater importance on each human-caused mortality, no matter how rarely it occurred. It may lead to further efforts to protect the species from fishery interactions. The recovery rate of the species will also depend on maintaining a very low incidental take rate for all fisheries in their range. Major expansions in fishing effort, changes in gear types, or creation of new fisheries could lead to small changes in overall incidental take that could have measurable population level effects.

- **Cumulative Effects.** Since the population of short-tailed albatross is susceptible to several natural and human-caused mortality factors that may or may not occur in the future, including incidental take in the groundfish fisheries under FMP 1, the cumulative effect on short-tailed albatross is considered to be conditionally significant adverse at the population level.

<u>Changes in Food Availability</u>

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under FMP 1. This effect is considered insignificant at the population level for short-tailed albatross. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on short-tailed albatross prey populations cannot be assessed at this time.

- **Persistent Past Effects.** Short-tailed albatross primarily prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to natural fluctuations in primary productivity and oceanographic factors. Pollution from a variety of land and marine sources have potentially affected short-tailed albatross prey in the past but specific toxicological effects are unknown.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on short-tailed albatross prey availability. The collapse of the short-tailed albatross population was due to direct harvest rather than loss or change of habitat. The growth rate of the population should therefore not be limited by the carrying capacity of the environment, which once supported millions of birds, in the foreseeable future. Pollution is likely to affect short-tailed albatross prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to short-tailed albatross, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of short-tailed albatross prey is considered to be insignificant at the population level.

Benthic Habitat

Since short-tailed albatross feed at the surface and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for short-tailed albatross.

4.5.7.2 Laysan Albatross and Black-Footed Albatross

Direct/Indirect Effects of FMP 1

Incidental Take

The incidental take of Laysan and black-footed albatross are reported in the Observer Program data from 1993-2001 and include the unidentified albatross and an unknown number of the unidentified tubenoses (Tables 3.7-1 through 3.7-5). The number of albatross taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated number of Laysan albatross taken in this period averaged 650 birds per year in the BSAI longline sector (including a share of the unidentified albatross category), 126 birds per year on GOA longlines, and 90 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for a total estimated average take of 866 birds per year in the groundfish fishery. The latest population estimate for the species is 2.4 million birds (Cousins *et al.* 2000). Mortality from the groundfish fishery under the baseline conditions is thus estimated at 0.04 percent of the population and is therefore considered insignificant. For black-footed albatross, estimated mortality in the groundfish fisheries averaged 12 birds per year in the BSAI longline sector (including a share of the unidentified albatross category) and 158 birds per year on GOA longlines (with no observed takes in the BSAI and GOA trawls), for a total estimated average take of 170 birds per year in the groundfish fishery. The latest population estimate for the species is 300,000 birds (Cousins and Cooper 2000). Mortality from the groundfish fishery under the baseline conditions is thus estimated at 0.06 percent of the population and is therefore considered insignificant.

The baseline seabird protection measures for longline vessels were developed in large part to protect short-tailed albatross but were based on the deterrence of northern fulmars and the albatross species in this group (see Appendix F-6 for a discussion of the effectiveness of the present seabird protection measures). Similarly, the new seabird protection measures that would be enacted under FMP 1 (68 FR 6386) were based in part on the substantial reduction of incidental take of Laysan and black-footed albatross using paired tori lines (Melvin *et al.* 2001). NOAA Fisheries is currently in the process of finalizing the new seabird deterrent regulations for the longline fleet. However, most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season. Incidental take data from the 2002 season should therefore give some indication of the potential effectiveness of the new regulations in reducing take of albatross. Seabird incidental take data are reported in the annual SAFE, Ecosystems Considerations Report. Data from the 2002 season will be available in the 2003 SAFE (NPFMC 2003b) (see Comment Analysis Report for updated statistics and analysis).

NOAA Fisheries and USFWS are currently researching the potential impact of incidental take due to collisions with trawl third wires. FMP 1 would incorporate any mitigation measures that arise from this research if it appears to reduce the chances of incidentally taking short-tailed albatross. This assessment would likely be made on the basis of a measured reduction in the take of Laysan albatross in lieu of short-tailed albatross, as was done for the longline protection measures. Potential future mitigation of take from trawl third wire collisions would therefore reduce incidental take of Laysan albatross and perhaps black-footed albatross as well.

While the management measures proposed under FMP 1 can be justified by various statutory conservation directives and would be expected to reduce the incidental take of albatross relative to the baseline condition, the level of incidental take for these species under the baseline conditions is considered to be insignificant at the population level.

Changes in Availability of Food

Albatross forage over vast areas of ocean on prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections 4.5.4 and 4.5.10). Albatross are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 1. FMP 1 is therefore considered to have insignificant effects on albatross.

Benthic Habitat

Albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 1. FMP 1 is therefore considered to have no effects on these species.

Cumulative Effects of FMP 1

The past/present effects on these albatross species are described in Sections 3.7.2 and 3.7.3 (Tables 3.7-6 and 3.7-7) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above (Table 4.5-53). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the contribution of this fishery to the overall mortality of albatross. Expected incidental take of both species is considered insignificant at the population level.

- **Persistent Past Effects.** Both of these albatross species have been subjected to various human-caused mortality factors in the past, including hunting on their nesting colonies and incidental take in net and longline fisheries. For black-footed albatross, estimated incidental take in U.S. and foreign North Pacific longline fisheries has exceeded the maximum amount of anthropogenic mortality (10,000 birds per year) that can be sustained by a stable population according to population modeling (Cousins and Cooper 2000). Census data from their breeding grounds in Hawaii indicate an overall decline in population of 1.3 percent per year over the past decade (NMFS 2001d). The great majority of past mortality has been in the foreign longline fleets (estimated at approximately 20,000 birds per year) while the Hawaiian longline fleet has taken an average of 1,700 birds per year and the BSAI/GOA groundfish fisheries have averaged about 250 birds per year since 1997.

  Laysan albatross have been taken in huge numbers in the past by feather hunters and in fisheries. Numbers of breeding pairs in Hawaii have declined substantially in the past decade. Since Laysan albatross have a conservative life history strategy that depends on high adult survival rates, mortality of adults in fisheries (or any other source) can have delayed and lingering adverse effects on the population. While some major sources of mortality have been eliminated (feather hunting ended in the 1930s, high-seas driftnet fishing ended in 1991), incidental take in longline fisheries has been substantial in the recent past. Applying the results of the black-footed albatross population model as an approximation for Laysan albatross, the threshold of maximum anthropogenic mortality that could be sustained by a stable population would be about 80,000 birds per year (3.3 percent of the estimated population). Mortality rates less than this value could also have measurable population level effects by reducing the rate of recovery from a decline, especially during periods of poor reproductive success such as might occur from oceanic regime shifts. Foreign North Pacific longline fisheries have taken an estimated 15,000 Laysan albatross per year while the Hawaiian pelagic longline fisheries took an average of 1,330 birds per year and the BSAI/GOA groundfish fisheries took an average of about 770 birds per year on longlines. There are no reliable incidental take data from other North Pacific longline fisheries such as the halibut fisheries. A smaller number of Laysan albatross were taken in groundfish trawls and were killed in vessel strikes. The numbers of Laysan albatross killed in similar trawl and net fisheries throughout their range is unknown. The known mortality from these fisheries adds up to less than one percent of the estimated population and does not appear to be enough to account for the observed decline in Hawaiian breeding pairs. A number of other factors may be partly responsible for the decline, including lingering effects from high-seas driftnet mortality, mortality from acute and chronic effects of pollution such as plastics and toxic compounds, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation). It is not known what combination and proportion of factors are responsible for the observed population decline.

- **Reasonably Foreseeable Future Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets and are expected to reduce take of albatross in those fisheries. The United Nations Committee on Fisheries established an international plan for reducing seabird bycatch in longline fisheries (FAO 1999) that calls on member states to voluntarily develop guidelines or regulations for their fisheries. However, these national plans are likely to be inconsistent in their efficacy and enforcement in the foreseeable future. It is therefore expected that incidental take of black-footed and Laysan albatross in foreign longline fisheries will remain high and will continue to exceed the threshold for population level effects.

- **Cumulative Effects.** Since the populations of black-footed and Laysan albatross are undergoing measurable declines and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries under FMP 1, the cumulative effects on black-footed and Laysan albatross are considered to be significantly adverse at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under FMP 1. This effect is considered insignificant at the population level for both albatross species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on seabird prey populations cannot be assessed at this time.

- **Persistent Past Effects.** Albatross primarily prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since albatross can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected albatross prey in the past. However, very little is known about the specific toxicological effects on prey species important to these albatross or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on albatross prey availability. Pollution is likely to affect albatross prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to albatross, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of albatross prey is considered to be insignificant at the population level for all species.

Benthic Habitat

Since albatross feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.5.7.3 Shearwaters

Direct/Indirect Effects of FMP 1

Incidental Take

The incidental take of shearwaters is reported in the Observer Program data from 1993-2001, including an unknown number of the unidentified tubenoses (Tables 3.7-1 through 3.7-5). The number of shearwaters taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated mortality of shearwaters in the groundfish fisheries averaged 578 birds per year in the BSAI longline sector, 18 birds per year on GOA longlines, and 799 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for a total estimated average take of 1395 birds per year in the groundfish fishery. Population estimates of short-tailed and sooty shearwaters are 23 million and 30 million birds, respectively (Everett and Pitman 1993, Springer *et al.* 1999). Incidental take of these species in the groundfish fisheries under the baseline conditions is much less than 0.01 percent of their populations and is thus considered insignificant.

The new seabird protection measures that would be enacted under FMP 1 (68 FR 6386) were developed in large part to protect short-tailed albatross and were based on the substantial reduction of incidental take of other albatross using paired tori lines (Melvin *et al.* 2001). However, shearwaters are able to dive deeper than albatross and the new deterrent devices did not change the rate of incidental take of these species. NOAA Fisheries and USFWS are currently researching the potential impact of incidental take due to collisions with trawl third wires. FMP 1 would incorporate any mitigation measures that arise from this research if it appears to reduce the chances of incidentally taking short-tailed albatross. It is not clear at this point whether shearwaters are also susceptible to collisions with trawl gear or whether any potential mitigation measures for albatross would reduce incidental take of shearwaters as well. Although the seabird protection measures proposed under FMP 1 may not reduce incidental take of shearwaters, there is no indication that they would increase take of these species. Since the level of incidental take for both shearwater species is considered to be insignificant under the baseline conditions, incidental take under FMP 1 is also considered to be insignificant at the population level for both shearwater species.

Changes in Food Availability

Shearwaters forage over vast areas of ocean on planktonic prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections 4.5.4 and 4.5.10). Shearwaters are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 1. FMP 1 is therefore considered to have insignificant effects on shearwaters through availability of food.

Benthic Habitat

Shearwaters are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 1. FMP 1 is therefore considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 1

The past/present effects on both shearwater species are described in Section 3.7.6 (Table 3.7-14) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above (Table 4.5-54). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-54.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would not be expected to reduce the contribution of this fishery to the overall mortality of shearwaters. Expected incidental take of both species is considered insignificant at the population level.

- **Persistent Past Effects.** Both species of shearwaters have been subjected to various human-caused mortality factors in the past, including hunting on their nesting colonies and incidental take in net and longline fisheries. Sooty and short-tailed shearwaters are so abundant and so widespread in the Pacific Ocean that it is very difficult to estimate their populations and hence very difficult to determine if their populations are fluctuating in response to any set of conditions. Chicks of both species have been and are likely to continue to be harvested in massive numbers on their breeding grounds for both subsistence and commercial purposes. Many other fisheries throughout their huge range have taken them incidentally, although the total number of these mortalities is unknown. This situation is likely to continue in the future. The number of shearwaters taken in the BSAI/GOA groundfish fisheries has been relatively small (about 600 birds per year in the longline fisheries and about 800 birds per year in trawls). There is some evidence to suggest that both populations may be declining on their breeding grounds but the scope and mechanisms for these declines have not been established.

- **Reasonably Foreseeable Future Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets that are similar to those proposed for the Alaskan fisheries. These measures are not expected to reduce incidental take of shearwaters in those fisheries. The United Nations Committee on Fisheries established an international plan for reducing seabird bycatch in longline fisheries (FAO 1999) that calls on member states to voluntarily develop guidelines or regulations for their fisheries. However, these national plans are likely to be inconsistent in their efficacy and enforcement in the foreseeable future. It is therefore expected that incidental take of shearwaters in foreign longline and trawl fisheries will likely continue as in the past unless longline and trawl deterrence techniques are developed and applied that are effective for diving species.

- **Cumulative Effects.** Since the populations of shearwaters may be undergoing declines and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries under FMP 1, the cumulative effects on sooty and short-tailed shearwaters are considered to be conditionally significant adverse at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid as bycatch under FMP 1. This effect is considered insignificant at the population level for both shearwater species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on shearwater prey populations cannot be assessed at this time.

- **Persistent Past Effects.** Short-tailed and sooty shearwaters are susceptible to periodic widespread food shortages that have caused massive die-offs in Alaskan waters. Natural fluctuations in primary productivity and oceanographic factors are considered to be the driving forces that determine the abundance of their main prey (euphausiids) rather than competitive interactions with other predators. Since shearwaters can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources have potentially affected shearwater prey in the past. However, very little is known about the specific toxicological effects on prey species important to these species or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on shearwater prey availability. Pollution is likely to affect shearwater prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to shearwaters, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of shearwater prey is considered to be insignificant at the population level for all species.

<u>Benthic Habitat</u>

Since shearwaters feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.5.7.4 Northern Fulmar

Direct/Indirect Effects of FMP 1

<u>Incidental Take</u>

Northern fulmars make up a majority of all birds taken in all three gear sectors. The numbers of fulmars taken are reported in the Observer Program data under their own species listing plus an unknown number of the unidentified tubenoses and unidentified seabird groups (Tables 3.7-1 through 3.7-5). The number of fulmars taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated number of fulmars taken in this period averaged 10,689 birds per year in the BSAI longline sector, 406 birds per year on GOA longlines, 3,083 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, and 42 birds per year in BSAI and GOA pots, for an estimated average identified take of 14,220 birds per year in the groundfish fishery. This total does not include any portion of the "unidentified seabird" category in the data set or any estimate of birds killed by vessel strikes. Given the high proportion of fulmars in the identified categories, one could reasonably assume that a large number of the unidentified bird remains were actually fulmars. For this analysis, the portion of unidentified birds in the data that were actually fulmars will be approximated as an additional 1,000 birds per year, mostly from the BSAI longline sector. Vessel strike data have been collected in an *ad hoc* manner but existing records indicate that an average of at least 80 fulmars are killed each year by trawl third wires (NOAA Fisheries is currently researching the nature and extent of this mortality factor). Adding these approximations to the identified fulmar takes gives a total estimated average take of about

15,300 birds per year from all fisheries. The latest population estimate for fulmars in the BSAI and GOA is about 2 million birds, with 4 to 5 million in the North Pacific (Hatch and Nettleship 1998). Mortality from the groundfish fishery is thus equal to about 0.76 percent of the BSAI and GOA population.

This level of incidental take is considered to be insignificant at the overall population level. However, because fulmars only breed in a few large colonies in the BSAI/GOA, there is some concern that incidental take from the fisheries could have a colony level effect if a disproportionate amount of the overall take comes from only one colony, particularly the Pribilof Islands since it is the smallest colony. The USFWS has established permanent sample plots on the Pribilof Islands but the usefulness of those census plots to measure potential colony level changes of fulmars is questionable (see Section 3.7.5). The U.S. Geological Survey/Biological Resource Division (USGS/BRD) has recently begun to research the issue using satellite telemetry and genetic analysis to determine the movement patterns of fulmars and the colony of provenance of birds taken in the fishery. Other factors that may cause population levels to fluctuate, including variable environmental conditions, will be investigated as well.

The baseline seabird protection measures for longline vessels were developed in large part to protect short-tailed albatross but were based on the deterrence of northern fulmars and other albatross species since they behave in a similar manner around fishing vessels (see Appendix F-6 for a discussion of the effectiveness of the present seabird protection measures). Similarly, the new seabird protection measures that would be enacted under FMP 1 (68 FR 6386) were based in part on the substantial reduction of incidental take of fulmars and albatross using paired and single tori lines (Melvin *et al.* 2001). Although NOAA Fisheries is currently in the process of finalizing the new seabird deterrent regulations, many longline vessels have already adopted the paired and single tori line techniques on a voluntary basis and the numbers of birds taken per 1000 hooks has been decreasing since 2001. These new regulations are expected to result in a substantial overall reduction in take of fulmars, partly due to the effectiveness of the new techniques in deterring surface-feeding species and partly due to the inclusion of performance standards in the new regulations that were not included in the baseline. Since most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season, incidental take data from the 2002 season should give some indication of the potential effectiveness of the new regulations in reducing take of fulmars. Incidental take data are reported in the annual SAFE, Ecosystems Considerations Report. Data from the 2002 season will be available in the 2003 SAFE (NPFMC 2003b) (see Comment Analysis Report for updated statistics and analysis).

As described in the albatross section above, FMP 1 would incorporate any mitigation measures that arise from current research on incidental take from trawl third wires. Management actions under FMP 1 would therefore be expected to substantially reduce overall incidental take of fulmars relative to the baseline condition. Since the amount of incidental take for fulmars under the baseline conditions is considered to be insignificant at the population level, the reduced level of take under FMP 1 is therefore considered to be insignificant at the population level for fulmars.

<u>Changes in Food Availability</u>

Fulmars forage over vast areas of ocean on prey that are taken in very small amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections, 4.5.4 and 4.5.10). Fulmars are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 1. FMP 1 is therefore considered to have insignificant effects on fulmars.

Benthic Habitat

Fulmars are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 1. FMP 1 is therefore considered to have no effects on this species.

Cumulative Effects of FMP 1

The past/present effects on northern fulmars are described in Section 3.7.5 (Table 3.7-13) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above (Table 4.5-55). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-55.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the incidental take of fulmars in the groundfish fishery. Expected incidental take is considered insignificant at the population level.

- **Persistent Past Effects.** Fulmars have probably been taken incidentally in every net and longline fishery in the North Pacific but there are very little data on the magnitude of that overall mortality. Incidental take in the BSAI/GOA groundfish fisheries appears to be the largest source of human-caused mortality for fulmars in this area with an estimated average of over 15,000 birds per year from all gear sectors. Although fulmars are very abundant (estimated 2 million in the BSAI/GOA) and there is no indication of an area-wide population decline, there is some concern that particular colonies, especially on the Pribilof Islands, may be experiencing declines related to the groundfish fisheries. Other potential mortality factors that have been identified include acute and chronic effects of pollution, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation) due climatic and oceanographic fluctuations.

- **Reasonably Foreseeable Future Effects.** Incidental take of fulmars is expected to continue in all offshore fisheries in the BSAI/GOA. The IPHC fisheries will be subject to the same new seabird avoidance measures as the groundfish longline fleet so incidental take from the halibut and sablefish fleet is expected to decline substantially. Future oil spills and other incidents of pollution are likely but their effects on fulmars will depend on many factors that cannot be predicted.

- **Cumulative Effects.** Since the population of northern fulmars appears to be stable and the primary human-caused mortality factors, including contributions from the groundfish fisheries under FMP 1, are expected to decline in the future, the cumulative effects on fulmars are considered to be insignificant at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of forage fish and pelagic invertebrates as bycatch under FMP 1. This effect is considered insignificant at the population level for northern fulmars. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on fulmar prey populations cannot be assessed at this time.

- **Persistent Past Effects.** Fulmars prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since fulmars can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources have potentially affected fulmar prey in the past. However, very little is known about the specific toxicological effects on species important to fulmars or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on fulmar prey availability. Pollution is likely to affect fulmar prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to fulmars, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of fulmar prey is considered to be insignificant at the population level.

Benthic Habitat

Since fulmars feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernible effect on their prey. Therefore, no cumulative effect is identified for these species.

4.5.7.5 Species of Management Concern (Red-Legged Kittiwakes, Marbled and Kittlitz's Murrelets)

Direct/Indirect Effects of FMP 1

Incidental Take

The population of red-legged kittiwakes is estimated at around 150,000 birds, almost 80 percent of which nest on St. George Island in the Pribilofs. The combination of their restricted breeding area and substantial declines on permanent census plots led to their classification as a USFWS species of management concern. Red-legged kittiwakes have a separate species code in the Observer Program data on incidental take and may also be reported under the "gull" category and potentially under "unidentified seabirds" (Tables 3.7-1 through 3.7-5). Between 1993 and 2001, no specified red-legged kittiwakes were recorded as taken in the BSAI and GOA groundfish fisheries.

The proposed new seabird avoidance measures that would be adopted under FMP 1 are expected to substantially reduce the incidental take of surface-feeding seabirds such as red-legged kittiwakes. Since the incidental take of red-legged kittiwakes is apparently already very rare (if it occurs), a reduced level of take would be considered insignificant at the population level. The effects of FMP 1 on red-legged kittiwakes through incidental take are therefore considered insignificant.

Marbled and Kittlitz's murrelets are species of management concern in Alaska due to recent dramatic declines in their numbers in core habitats in southeast Alaska. Both of these species have separate species codes in the Observer Program data and may also be reported under the “alcids” and perhaps the “unidentified seabird” groups. No marbled or Kittlitz’s murrelets have been specifically reported taken in the observed groundfish fisheries between 1993 and 2001 Tables 3.7-1 through 3.7-5). Given their nearshore preferences and non-gregarious behavior, it is unlikely that murrelets are taken regularly in any of the BSAI/GOA groundfish fisheries. Since alcids are taken so infrequently on longlines, seabird avoidance measures for longlines would likely not affect the incidental take of murrelets. Therefore, the effects of FMP 1 on marbled and Kittlitz’s murrelets through incidental take are considered insignificant at the population level.

Changes in Food Availability

Red-legged kittiwakes consume several species of small schooling fish as well as zooplankton. Given the wide variety of foods used by kittiwakes and the extensive areas over which they forage, it seems unlikely that they are very susceptible to localized depletion of prey during the non-breeding season. However, while nesting, kittiwakes are more limited in their options and are more susceptible to localized depletions of prey around their colonies. The existing ban on the development of a commercial forage fish fishery would be maintained under FMP 1 and is considered to be beneficial to seabirds by preventing a potentially adverse fishery from developing. The species and size classes of forage fish and zooplankton that red-legged kittiwakes consume are taken only in negligible amounts by the groundfish fisheries. The abundance and distribution of these prey species do not appear to be affected on an ecosystem level by the groundfish harvest under the baseline conditions (see Sections 4.5.4 and 4.5.10). Since the structure and intensity of the fishery under FMP 1 would be very similar to the baseline condition, FMP 1 is considered to have insignificant effects on the availability of food for red-legged kittiwakes.

Marbled and Kittlitz’s murrelets forage in shallow waters within 5 kilometers (km) of shore and feed on small fish such as capelin and Pacific sandlance as well as zooplankton and other invertebrates. The groundfish fisheries have very little spatial overlap with murrelet foraging areas and, as described above for kittiwakes, appear to have insignificant effects on the abundance and distribution of these prey species. Overall, the effects of FMP 1 on the availability of prey for murrelets would be considered insignificant.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 1. Marbled and Kittlitz’s murrelets feed on species that depend on benthic habitats for at least part of their life cycles. However, benthic habitats in their nearshore foraging areas would not be affected directly by groundfish trawls under FMP 1 as these take place further offshore. FMP 1 is therefore considered to have insignificant effects on marbled and Kittlitz’s murrelets, and no effects on red-legged kittiwakes.

Cumulative Effects of FMP 1

The past/present effects on red-legged kittiwakes, marbled murrelets, and Kittlitz's murrelets are described in Sections 3.7.13 and 3.7.17 (Tables 3.7-22 and 3.7-26) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above (Table 4.5-56). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-56.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the incidental take of surface-feeding seabirds such as red-legged kittiwakes. Since the incidental take of red-legged kittiwakes is apparently already very rare (if it occurs), a reduced level of take would be considered insignificant at the population level. Murrelets would be much more likely to be taken in trawls than longlines but no takes of either species have been recorded by groundfish observers. Incidental take of murrelets is therefore considered insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging (red-legged kittiwakes), incidental take in coastal salmon gillnet and other net fisheries (murrelets), oil spills (murrelets), and logging of nest trees (marbled murrelets). Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed very little to the mortality of these species.

- **Reasonably Foreseeable Future Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. Conservation concerns for red-legged kittiwakes focus on potential impacts around the Pribilof Islands during the nesting season since 80 percent of the population is concentrated in time and space. For this reason, the introduction of nest predators or a large oil spill could have significant effects on mortality. While these potentially catastrophic events could happen at any time, several laws and programs are in place to mitigate the likelihood of them occurring.

  For the murrelet species, human impacts in nearshore habitats from the GOA to southeast Alaska will likely have a much greater effect on their populations than offshore fisheries. The largest sources of human-caused mortality from the past, oil spills and incidental take in salmon and other State net fisheries, are likely to remain the largest factors in the future. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality. If the Kittlitz's murrelet population continues to decline and the species is listed under the ESA, new regulations may be placed on the various nearshore net fisheries to monitor and reduce incidental take of the species. These measures would also benefit marbled murrelets.

- **Cumulative Effects.** The three species in this group have all experienced substantial population declines in the recent past and are all susceptible to future human-caused mortality factors, including potentially small contributions from the groundfish fishery. The decline of red-legged kittiwakes on the Pribilofs may have been reversed recently but it is not clear if their recovery will continue in the future. The cumulative effect for red-legged kittiwakes is therefore considered conditionally significant adverse at the population level. Both murrelet species continue to decline in their core areas and are thus considered to have significantly adverse cumulative effects at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch under FMP 1. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all three species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations cannot be assessed at this time.

- **Persistent Past Effects.** All three species prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources, including the EVOS, have likely affected the prey of these species in the past. Since murrelets are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded murrelets from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is also likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, cannot be made at this time.

- **Cumulative Effects.** While the groundfish fisheries are considered to have an insignificant effect on prey availability on their own, the dynamic interaction of natural and human-caused events, including fisheries and pollution, on the availability of forage fish and invertebrate prey to seabirds is only beginning to be explored with directed research. Since this dynamic could conceivably be adverse or beneficial depending on different circumstances, the cumulative effect on prey availability is considered to be unknown for these three species.

Benthic Habitat

No cumulative effect is identified for red-legged kittiwakes because they are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles but they forage in shallow waters that are inshore of the groundfish fishery. Since the groundfish fishery would not contribute to potential effects on benthic habitats important to murrelets the cumulative effect is considered insignificant.

4.5.7.6 Other Piscivorous Species (Most Alcids, Gulls, and Cormorants)

Direct/Indirect Effects of FMP 1

Incidental Take

The incidental take of species considered in this piscivorous group is reported in the Observer Program data under the gull, alcid, and "other" categories, as well as an unknown number of the "unidentified seabird" category (Tables 3.7-1 through 3.7-5). The number of piscivores taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001 data since these measures were implemented in 1997. The estimated number of gulls taken in this period averaged 3,268 birds per year in the BSAI longline sector, 147 birds per year on GOA longlines, and 274 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for an estimated average take of 3,689 birds per year in the groundfish fishery. Even if a large proportion of the unidentified seabirds are gulls, this level of mortality is considered insignificant at the population level given the combined estimated abundance (2.5 million birds) of the different gull species in the BSAI and GOA (Table 3.7-21).

For the alcids, mortality from the groundfish fishery comes almost entirely from the trawl sector and averaged 259 birds per year (mean of low and high estimates) in the BSAI/GOA trawls. Given the estimated abundance of large alcids in these waters (approaching 20 million, Table 3.7-21), this level of mortality is considered insignificant at the population level. Incidental take of cormorants would be included in the "other" category, which approaches zero and is therefore considered an insignificant level of mortality at the population level.

The new seabird protection measures for the longline fleet that would be instituted under FMP 1 (68 FR 6386) would be expected to result in a substantial overall reduction in take of surface-feeding species such as gulls. This is a substantial management and fishery action and is considered an improvement relative to the baseline level of mortality. Since the amount of incidental take for gulls under the baseline conditions is considered to be insignificant at the population level, the reduced level of take under FMP 1 is therefore considered to be insignificant at the population level for gulls.

Changes in Food Availability

Food consumption by seabirds depends not only on forage stocks in their feeding areas, but also on the availability of these stocks to the birds. The availability of prey to piscivorous seabirds is affected by a number of oceanographic and biological factors (see Section 3.7.1) that may vary substantially over short time periods and distances. The question of whether the intensity and structure of the groundfish fishery under the baseline condition has adverse or beneficial effects on the availability of forage fish for seabirds has not been addressed through directed research. Many of the data gaps identified in Section 5.1.2.8 address this issue. Although there are very little empirical data on how a fishery might affect the availability of forage fish to seabirds, it is assumed that fishing (with trawl gear at least) could disrupt the movements and structure of forage fish schools such that they would be less available to seabirds, at least for a short period of time. Localized depletion or disruption of prey species around seabird colonies could be particularly detrimental during the chick-rearing period for breeding seabirds. However, most species can forage up to 40 km from their colonies during chick-rearing with a few species ranging to 100 km so any localized and short term disruptions of forage fish would have negligible effects at the population level. The existing ban on the development of a commercial forage fish fishery (BSAI/GOA FMP Amendments 36/39) is considered to be beneficial to seabirds by preventing a potentially adverse fishery from developing. This ban would be maintained under FMP 1. The species and size classes of forage fish (and zooplankton) that piscivorous seabirds feed on are taken only in negligible amounts by the groundfish fisheries. The abundance and distribution of seabird prey does not appear to be affected on an ecosystem level by the groundfish harvest (see Sections 4.5.4 and 4.5.10). The baseline condition of groundfish harvest is therefore considered to have insignificant effects on the availability of food for piscivorous seabirds.

The fisheries provide an artificial yet nutritious supplement to seabird diets in the form of processing waste and offal. No studies have been conducted in Alaska on whether this food source provides a significant benefit to the survival rate or reproductive success of any species on the population or colony level. It is likely that the value of this supplemental food varies over time and space, fluctuating with the availability of natural food supplies and seasonal nutritional needs. Whereas some birds may benefit from the food supply provided by offal and processing waste, such waste also acts as an attractant that may lead to increased incidental take in fishing gear. In addition, some species, such as the large gulls, tend to be more successful at competing for fish scraps at vessels and processors and may thus receive a greater nutritional boost than the smaller species. Since the large gulls are also nest predators of other species, especially kittiwakes and murres, the supplemental food from fishery wastes may be beneficial to some species and detrimental to others within this species group. Thus, this indirect effect of the fishery potentially has both beneficial and adverse effects on seabirds and the net benefit or liability is unknown.

Under FMP 1, the structure and intensity of the fishery would be similar to the baseline condition, which is considered to have an insignificant effect on piscivorous seabird populations. FMP 1 would also maintain the ban on development of a directed forage fish fishery. For these reasons, FMP 1 is considered to have insignificant effects on food availability for piscivorous species.

Benthic Habitat

Cormorants and alcids have diverse diets that include both small schooling fishes (capelin and sand lance) as well as demersal fish species and crustaceans. These birds are capable of diving from 40 m to over 100 m deep and are thus able to reach the ocean floor in many areas. Some species, such as cormorants and guillemots, usually forage in coastal waters during the breeding season, but other species forage well away from land. Bottom trawl gear has the greatest potential to indirectly affect these diving seabirds via physical changes to benthic habitat but pelagic trawls (to various extents), pot gear, and longline gear also contact the ocean floor. Trawling (and to a lesser extent other fishing gear disturbance) can reduce habitat complexity and productivity (NRC 2002). Specific effects of trawling on seabird prey species in the BSAI/GOA (through habitat change rather than by direct take) are poorly known (see Sections 3.6 and 5.1.2.7 on EFH for a discussion of research needed to address data gaps in benthic habitat changes due to trawling). However, none of the species in this group appears to have experienced consistent or widespread population declines so there is no indication that the carrying capacity of the environment has been decreased through changes to benthic habitat (or any other mechanism). Overall trawl effort in the BSAI/GOA under FMP 1 will remain very similar to the baseline condition. The effect of FMP 1 on piscivorous seabirds through potential changes in benthic habitat is therefore considered insignificant at the population level.

Cumulative Effects of FMP 1

The past/present effects on the species in this group, including most alcids, gulls, and cormorants, are described in the species accounts of Section 3.7 (Tables 3.7-16 and 3.7-20) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above (Table 4.5-57). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-57.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the incidental take of surface-feeding seabirds such as gulls but not of diving species such as alcids. Incidental take of all species in this group is considered insignificant at the population level under FMP 1.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging, incidental take in a variety of foreign and U.S. coastal and pelagic fisheries, oil spills and other pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. Conservation concerns focus on preventing potential impacts around breeding colonies during the nesting season since populations are concentrated in time and space. For some species, human impacts in nearshore habitats will likely have a much greater effect on their populations than offshore fisheries. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of these species have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are therefore considered insignificant at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch under FMP 1. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations cannot be assessed at this time.

- **Persistent Past Effects.** All species in this group prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources, including the EVOS, have likely affected the prey of these species in the past. Since some of the alcids are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded them from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future foreign squid and forage fish fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is also likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, cannot be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute to the dynamic interaction of natural and human-caused events that affect the availability of forage fish and invertebrate prey to seabirds. While this dynamic is only beginning to be explored with directed research, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under FMP 1, the cumulative effect on prey availability is considered insignificant at the population level for these species.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, have the potential to modify benthic habitats and have indirect effects on the food web of diving piscivorous species. The overall effects of FMP 1 on piscivorous seabirds through potential changes in benthic habitat are considered insignificant.

- **Persistent Past Effects.** Benthic habitats important to the diving species in this group, including the alcids and cormorants, have been affected by various foreign and U.S. fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to seabirds. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may also have persistent effects in certain areas.

- **Reasonably Foreseeable Future External Effects.** All future fisheries in the BSAI/GOA that use bottom contact fishing gear are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will also continue.

- **Cumulative Effects.** The groundfish fisheries contribute to the many human-caused and natural factors that alter benthic habitats important to the food web of piscivorous seabirds. While there has been limited research on specific effects of benthic habitat disturbance on seabirds, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under FMP 1, the cumulative effect on benthic habitat is considered insignificant at the population level for these species.

4.5.7.7 Other Planktivorous Species (Storm-Petrels and Most Auklets)

Direct/Indirect Effects of FMP 1

Incidental Take

Leach's and fork-tailed storm-petrels are not identified to species in the Observer Program data but they do have an "unidentified storm-petrel" code and may be reported in the "unidentified tubenoses," "other," and "unidentified seabird" categories (Tables 3.7-1 through 3.7-5). The numbers of storm-petrels in these categories are unknown but likely to be small given their feeding behavior. Given the abundance of these species in the BSAI/GOA area, with a combined population estimate of over 10 million birds (Table 3.7-21), incidental take of storm-petrels under the baseline conditions is considered to be insignificant at the population level. Although some of the planktivorous auklets have individual species codes in the Observer Program data, they are reported in the "alcid" and "unidentified seabird" categories. It is unlikely that they are taken on longlines at all and probably constitute only a small fraction of the trawl take. Given their abundance in the BSAI/GOA, with a combined population of over 10 million birds (Table 3.7-21), incidental take of auklets under the baseline conditions is considered to be insignificant at the population level.

Another means of incidental take in the fishery is by birds striking the vessel or rigging. The Observer Program does not record vessel strikes on a systematic basis so data on the frequency or extent of such strikes are very limited (NPFMC 2003b). Crested auklets do not seem to strike fishing vessels very frequently but when they do, the incidents often involve large numbers of birds. According to preliminary analysis of the observer records of bird-strikes from 1993-2000, 1,305 crested auklets were involved in 7 recorded collisions. In one historical account, approximately 6,000 crested auklets were attracted to lights and collided with a fishing vessel near Kodiak Island during the winter of 1977 (Dick and Donaldson 1978). Storm-petrels are also prone to periodic collisions involving many birds (631 birds in 19 recorded incidents). Bird strikes are probably most numerous during the night and during storms or foggy conditions when bright deck lights are on, which can cause the birds to be disoriented. Given the sporadic nature of these collisions and the small numbers of birds involved relative to their overall populations, the effect of the fisheries on these species through vessel collisions is considered insignificant at the population level under the baseline conditions. Since fishing effort under FMP 1 would be similar to the baseline, the effect of FMP 1 on incidental take from vessel collisions is considered insignificant.

Changes in Food Availability

Storm-petrels are relatively small surface feeding seabirds that primarily target zooplankton and juvenile fish. The auklets feed on zooplankton (euphausiids), juvenile fish, and squid. The abundance and distribution of these prey species are affected by a number of oceanographic and biological factors (see Section 3.7.1) that may vary substantially over short time periods and distances. The groundfish fisheries could indirectly affect the availability of zooplankton and small schooling fish to seabirds through changes in the abundance and distribution of target fish species that also prey on small fish and zooplankton. For example, since young pollock are planktivores, large changes to pollock populations as a result of fishing could theoretically affect the carrying capacity for storm-petrels and auklets. However, zooplankton and juvenile fish abundance and distribution are thought to be influenced much more by primary productivity and oceanographic fluctuations (bottom-up factors) than predator/prey relationships (top-down factors) (see Section 4.5.10). Since the structure and intensity of the fisheries managed under FMP 1 would be similar to the baseline conditions, the effects of FMP 1 on the availability of prey are considered to be insignificant at the population level for planktivorous seabirds.

Benthic Habitat

Storm-petrel and auklets are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 1. FMP 1 is therefore considered to have no effects on these species.

Cumulative Effects of FMP 1

The past/present effects on the species in this group, including storm-petrels and most auklets, are described in Sections 3.7.7 and 3.7.18 (Tables 3.7-15 and 3.7-27) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above (Table 4.5-58). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-58.

Mortality

- **Direct/Indirect Effects.** Under FMP 1, new seabird protection measures for the BSAI/GOA longline fleet (Section 3.7.1) would be expected to substantially reduce the incidental take of surface-feeding seabirds such as storm-petrels but not of diving species such as auklets. However, it is likely that more birds of these species die from occasional vessel strikes than are taken in any groundfish fishing gear. Incidental take of all species in this group are considered insignificant at the population level under FMP 1.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in foreign and U.S. coastal and pelagic fisheries, oil spills and other marine pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. Conservation concerns focus on preventing potential impacts around breeding colonies during the nesting season since populations are concentrated in time and space. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are therefore considered insignificant at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The influence of the groundfish fisheries on the abundance and distribution of zooplankton and juvenile fish is limited to indirect effects on the abundance of target fish that prey on the same things the seabirds eat. This potential influence is considered minor compared to seasonal changes in primary productivity and oceanographic factors. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group under FMP 1.

- **Persistent Past Effects.** Zooplankton and juvenile fish have been taken in very small amounts as bycatch in squid and forage fish fisheries but their influence on abundance is probably negligible compared to natural fluctuations. Commercial whaling in the early 1900s decimated the populations of several planktivorous whales that competed with seabirds for prey. This release from competitive pressure may have had long-term beneficial effects on planktivorous seabird populations.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have minimal effects on prey availability for these species. Pollution is also likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, cannot be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute in an indirect way to human influences on planktonic prey availability, which are considered minimal compared to natural fluctuations. These cumulative effects are considered insignificant on the population level for all species in this group.

Benthic Habitat

Since these planktivorous seabirds feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.5.7.8 Spectacled Eiders and Steller's Eiders

Direct/Indirect Effects of FMP 1

Incidental Take

Spectacled eiders interact very little, if at all, with the groundfish fisheries because most of the habitat for this species is located in the northern Bering Sea or in inshore areas of northwest Alaska. Although spectacled eiders have an individual species code in the Observer Program manual, no spectacled eiders have been observed to be taken in any of the fisheries since data collection began in 1993. Thus the groundfish fisheries have no effect on spectacled eiders.

The winter distribution of Steller's eiders does include areas where groundfish fisheries occur although these birds prefer shallow, nearshore waters. There is some overlap between the fisheries and Steller's eider critical habitat in the northwestern portion of Kuskokwim Bay (Kuskokwim Shoals). Only two vessels fished this area in 2001, both over 200 ft LOA so there was 100 percent observer coverage. Steller's eiders have an individual species code in the Observer Program manual but no incidental takes have been documented since 1995 (Tables 3.7-1 through 3.7-5). Based on the very minimal overlap between the predicted fisheries under FMP 1 and these two eider species, FMP 1 is considered to have insignificant effects on the population level through incidental take.

Changes in Food Availability

The abundance of marine invertebrate species important to the spectacled and Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. The groundfish fisheries catch only negligible amounts of these species and are unlikely to affect their abundance or distribution through ecosystem level effects under the baseline conditions (see Section, 4.5.10). Since the fishery under FMP 1 is also predicted to have a minimal overlap with Steller's eider habitat, the effects of FMP 1 on prey abundance for Steller's eider species (separate from potential benthic habitat effects) are considered insignificant at the population level. As, discussed above, the groundfish fisheries do not overlap in space or time with spectacled eider critical habitat and therefore, have no effect on spectacled eider food availability.

Benthic Habitat

Gear impacts on benthic habitat used by spectacled and Steller's eiders would primarily be from bottom trawl gear although pelagic trawls and pot gear also make contact with the bottom and contribute to benthic disturbance. Trawling (and to a lesser extent other fishing gear disturbance) can reduce habitat complexity and productivity (NRC 2002). The effects of trawl gear on benthic habitat are discussed in the EFH sections of this document (Sections 3.6.4 and 4.5.6). Based on an analysis of the Observer Program data, no overlap occurred between spectacled eider critical habitat and the groundfish fishery under the baseline conditions. Since FMP 1 is predicted to have a similar structure and intensity as the baseline, there are no predicted effects on spectacled eider benthic habitat.

Since Steller's eiders forage almost exclusively in shallow waters inshore of the groundfish fisheries, their preferred winter habitats are not subject to groundfish fishing effort. During the breeding season, the overlap of bottom trawl fisheries and Steller's eider critical habitat is also very limited, involving only a few vessels in a limited area of Kuskokwim Bay (Kuskokwim Shoals, NPFMC 2003b). The effects of this small bottom trawl fishery on Steller's eider critical habitat have not been investigated but considering the limited fishing effort and large area of critical habitat that is not fished, it is unlikely that the changes in benthic habitat resulting from this fishery would affect Steller's eiders on a population level. During Section 7 consultations with NOAA Fisheries, USFWS also concluded that the fisheries were not likely to affect Steller's eiders (USFWS 1992). Under FMP 1, the Kuskokwim Bay fishery is expected to continue in approximately the same area and intensity as under the baseline conditions. The overall effect of FMP 1 on the benthic habitat of Steller's eider is therefore considered to be insignificant at the population level.

Cumulative Effects of FMP 1

The past/present effects on spectacled and Steller's eiders are described in Sections 3.7.9 and 3.7.10 (Tables 3.7-17 and 3.7-18) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above (Table 4.5-59). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-59.

<u>Mortality</u>

- **Direct/Indirect Effects.** Spectacled eiders do not overlap in time and space with the groundfish fisheries and are not expected to have any incidental take under FMP 1. Steller's eiders overlap with the fisheries to a limited extent but incidental take has been and is expected to continue to be very rare. Incidental take of Steller's eiders is therefore considered to be insignificant at the population level under FMP 1.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution, and lead shot poisoning on the nesting grounds. Incidental take in the BSAI/GOA groundfish fisheries appears to have been very rare for Steller's eider. Both species have been afforded protection through the ESA.

- **Reasonably Foreseeable Future Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. Conservation concerns focus on preventing potential impacts in critical habitat areas.

- **Cumulative Effects.** The groundfish fisheries do not contribute to direct mortality of spectacled eiders so no cumulative effect is identified for that species. Human-caused mortality of Steller's eider, including very rare incidental take in the groundfish fisheries, does not appear to account for the past population decline in Alaska. Since the population may have stabilized and known human-caused mortality is very low, the cumulative effects of mortality on Steller's eiders are considered insignificant at the population level.

<u>Changes in Food Availability</u>

The abundance of marine invertebrate species important to the spectacled and Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. Although other factors external to the fisheries may influence the abundance and distribution of Steller's eider prey, the groundfish fisheries have a minimal contribution to these potential effects. Therefore, an insignificant cumulative effect on prey availability is identified for Steller's eiders. There are no cumulative effects identified for spectacled eider food availability since there are no direct/indirect impacts from the groundfish fisheries.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, disrupt benthic habitats that support the prey of eiders. Under FMP1, the groundfish fishery is not expected to occur in spectacled eider critical habitat or any other area that they typically use. A limited amount of bottom trawling is expected to overlap with Steller's eider critical habitat. The overall effects of FMP 1 on Steller's eiders through potential changes in benthic habitat are considered insignificant at the population level.

- **Persistent Past Effects.** Benthic habitats important to spectacled and Steller's eiders have been affected by various trawl and pot fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to eiders. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may also have persistent effects in certain areas.

- **Reasonably Foreseeable Future Effects.** All future fisheries that use bottom contact fishing gear in areas used by eiders are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will also continue.

- **Cumulative Effects.** While the groundfish fisheries are predicted to have little spatial overlap with eider habitat under FMP 1, the interaction of human-caused and natural disturbances of benthic habitat important to Steller's eiders has not been examined with respect to their population declines in the past. The cumulative effects of benthic habitat disruptions over the years as they relate to the food web important to Steller's eiders are therefore considered to be unknown. There are no identified effects on spectacled eiders' benthic habitat because no direct/indirect impacts from the groundfish fisheries have been identified.

4.5.8 Marine Mammals Alternative 1 Analysis

4.5.8.1 Western Distinct Population Segment of Steller Sea Lions

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 1 is not likely to result in significant changes to the population trajectory of the western distinct population segment (western population) of Steller sea lions. An average of 8.4 Steller sea lions from the western population was estimated to have been taken incidental to groundfish fisheries from 1995 to1999 (Angliss *et al.* 2001) (Table 4.5-60). In this context, incidental take refers to animals which are deceased or have injuries that are expected to result in the death of the animal. The ratio of observed takes of Steller sea lions to observed groundfish catch (from 1995 to 1999) was multiplied by the new projected groundfish catch (all fisheries combined) to estimate incidental takes expected to occur over the next six years under this alternative management regime. The estimated annual incidental take level of Steller sea lions under FMP 1 in all areas combined is expected to be less than ten based on expected catch in this alternative, or about one sea lion per 220,000 mt of groundfish harvested. Incidental bycatch frequencies in the BSAI, which are typically low, reflect locations where fishing effort was highest. In the Aleutian Islands and GOA, incidental takes are often within critical habitat, though in the Bering Sea such bycatch is farther off shore and along the continental shelf. Otherwise there seems to be no apparent “hot spot” of incidental catch disproportionate with fishing effort. Therefore, it is appropriate to estimate take ratios based on estimated catch. However, if these take rates differ between observed and unobserved vessels then these take estimates would be biased accordingly. These rates also reflect a prohibition of trawling within ten or 20 nm of 37 rookeries which likely reduces the potential for incidental take, particularly during the breeding season when females are on feeding trips within the critical habitat area.

Entanglement of Steller sea lions in derelict fishing gear or other materials seems to occur at frequencies that do not have significant effects on the population. From a sample of rookeries and haul-out sites in the Aleutian Islands in which 15,957 adults were observed, Loughlin *et al.* (1986) found only 11 (0.07 percent) entangled in marine debris, some of which was derelict fishing gear. Observations of sea lions at Marmot Island for several months during the same year observed two out of 2,200 adults (0.09 percent) entangled in marine debris. Between 1993 and1997, only one fishery-related stranding was reported from the range of the western population: a sea lion observed in August 1997 with troll gear in its mouth and down its throat (Angliss *et al.* 2001). Entanglement of sea lions in derelict fishing gear or other marine debris does not appear to present a significant threat to the population.

The Marine Mammal Protection Act (MMPA) requires NOAA Fisheries (NMFS Office of Protected Resources) to assess whether human-caused mortality threatens the stability or recovery of any species of marine mammal. The MMPA defines a measurement tool for this purpose, the potential biological removal (PBR), that is a calculated value of the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. This calculation takes into consideration the most recent population estimates, historic population trends, status of the stock in relation to historic levels (i.e. whether it is depressed or not), and potential rates of recovery. According to the most recent stock assessment, PBR for the western population of Steller sea lions is 208 animals per year (Angliss and Lodge 2002). Mortality from incidental take and entanglement in marine debris is likely to continue under FMP 1 at levels that are small (less than ten percent) relative to PBR and is therefore considered insignificant according to the criteria set for significance (Table 4.1-6).

<u>Fisheries Harvest of Prey Species</u>

Changes in the fishing mortality rates for Steller sea lion prey species were calculated using output from the multi-species management model which projected catch rates for the various alternatives. The estimated fishing mortality rates expected to occur under each alternative management regime were compared to the baseline fishing mortality rate in order to apply the significance criteria established in Table 4.1-6 for determining effects of the FMPs on marine mammal populations. The baseline fishing mortality rates for the individual BSAI and GOA groundfish fisheries, the fishing mortality rates projected to occur under each FMP, and the relative difference between the baseline and FMP fishing mortality rates are shown in Table 4.5-61.

Under FMP 1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 22 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in the harvest of this key Steller sea lion prey species is rated as significant. It is worth noting that the harvest rate of pollock in the EBS was abnormally low in 2002. This low harvest rate was due to the high abundance of commercially sized pollock in the EBS which resulted in a large recommended ABC for this population. By definition, ABC is set annually at a level deemed to be biologically acceptable based on the status and dynamics of the population, environmental conditions, and other ecological factors (e.g., natural mortality). The baseline groundfish FMPs contain catch provisions referred to as OYs that limit the total amount of BSAI and GOA groundfish harvest. Unlike the ABC, which is applied to individual species or species groups, the OY limit applies to the entire complex of commercially important species as well as other species with lesser or no commercial importance in each management region. In 1981, the OY for total BSAI groundfish catch was set as a range from 1.4 to 2.0 million mt. In 2002, the recommended ABC for pollock in the EBS was greater than the OY and was therefore capped to stay within the OY range. Because the 2002 EBS pollock TAC was capped by the OY ceiling, F was lower than that deemed to be biologically acceptable. Therefore, in relative terms, subsequent increases in F expected to occur under FMP 1 for EBS pollock may not result in significantly adverse effects to predators in terms of the biomass of prey available, despite being categorized as such under the established significance criteria.

The fishing mortality rate of GOA pollock is expected to increase by an average of one percent relative to the comparative baseline over the next five years under FMP 1. This change in F is insignificant at the population level for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline condition. There is no change in the projected catch of Aleutian Islands pollock between the baseline and FMP 1 and therefore effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level.

Under FMP 1, BSAI and GOA Pacific cod fishing mortality rates are expected to increase by 20 percent and decrease by 17 percent, respectively. These combined changes are insignificant to Steller sea lions according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to Steller sea lions with a 60 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline for harvest of other non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under FMP 1 were determined to be insignificant to Steller sea lions.

The comparative baseline conditions include all Steller sea lion protection measures that were adopted in 2001 (NMFS 2001a). These include provisions to protect prey resources such as area closures, critical habitat harvest limits on prey species, gear and TAC restrictions, and a modified global harvest control rule to prohibit fishing when spawning biomass per recruit is reduced to 20% of the unfished level. With these controls, the combined harvest of prey was found to not jeopardize the continued existence of the western populations of Steller sea lions (NMFS 2001a). Harvest levels under FMP 1 would be similar to the 2002 baseline conditions and are thus considered insignificant to the western population of Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The criterion used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations is that the alternative FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. The spatial/temporal measures in FMP 1 were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods that are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures, but where sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as "global controls." Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, so that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to jeopardize the continued existence of the western population of Steller sea lions or appreciably reduce the likelihood of their survival and recovery in the wild (NMFS 2001b). Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under FMP 1 are determined to be insignificant to Steller sea lions according to the criteria established in Table 4.1-6.

Disturbance

With regard to disturbance are existing management measures minimize nearshore disturbance of Steller sea lions. In particular, the prohibition of vessel entry within 3 nm of major rookeries avoids intentional and unintentional hazing of hauled out sea lions or those aggregated near shore. A total of 3,250 square kilometer (km^2) around 36 sites is offered this protection.

What is not clear, however, is what circumstances might constitute disturbance elsewhere, such as in pelagic foraging areas. Vessel traffic, nets moving through the water column, or underwater sound production may all represent perturbations, which could affect foraging behavior, but few data exist to determine their relevance to Steller sea lions. The influence of trawl activities on Steller sea lion foraging success cannot be addressed directly with existing data. Foraging could potentially be affected not only by interactions between vessels and sea lions, but also as a function of changes in fish schooling behavior, distributions or densities in response to harvesting activities. In other words, disturbance to the prey base may be as relevant a consideration as disturbance to the predator itself.

For the purposes of this analysis, it is recognized that some level of prey disturbance may occur as a fisheries effect. The impact on marine mammals who prey on fish schools is a function of both the amount of fishing activity and its concentration in space and time, neither of which may be extreme enough under the status quo to represent population-level concerns. To the extent that the baseline condition imposes limits on fishing activities inside critical habitat, it is assumed some protection from these disturbance effects is currently provided. These protections occur as byproducts of other actions that either reduce fishing effort or create buffer zones to limit impacts on foraging. Also, they occur directly in the case of the 3 nm no entry zones around rookeries. With these measures in place, the baseline is consistent with the underlying goal of reducing disturbance effects. Whether the residual levels of disturbance represent significant effects on Steller sea lions cannot be determined with the data that are currently available.

However, anecdotal evidence suggests that fisheries/disturbance related events are unlikely to be of consequence to the Steller's population as a whole. For instance, vessel traffic and underwater sound production have long been features of the Bering Sea and GOA, at least over much of the twentieth century. Such circumstances have prevailed before, as well as after the decline of Steller sea lions, suggesting no obvious causal link. Steller sea lions also appear to be tolerant of at least some anthropogenic effects, recognizing their attraction to fish processing facilities and gillnets as well as their distributions in proximity to ports. Further, the eastern population of Steller sea lions is increasing, despite anthropogenic activities throughout their range on the west coast of North America and particularly in southeast Alaska. Levels of disturbance to Steller sea lions similar to those occurred in 2002 are expected under FMP 1. The effects of disturbance on Steller sea lions under FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

The past/present effects on the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. This analysis seeks to provide an overall assessment of the species' population-level response to its environment as it is influenced by the groundfish fishery. The effects considered in this analysis are listed in Table 4.5-62. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Mortalities from incidental take and entanglement in derelict fishing gear occur at frequencies that do not have population-level effects on the western population of Steller sea lions and are therefore considered insignificant.

- **Persistent Past Effects.** Substantial mortality of Steller sea lions did not occur in the fisheries until after the 1950s. The take of Steller sea lions was substantial after this time with over 20,000 animals believed to have been incidentally killed in the foreign and JV groundfish fisheries from 1966 to 1988, although data from this period are not complete (Perez and Loughlin 1991). In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 per year in the early 1990s to an average of 7.8 sea lions per year from 1996 to 2000. The number of Steller sea lions incidentally taken in state-managed nearshore salmon gillnet fisheries and halibut longline fisheries is estimated at 14.5 sea lions per year in the PWS drift gillnet fisheries (Wynne *et al.* 1992). It is thought that shooting used to be a significant source of mortality prior to listing the Steller sea lion as endangered under the ESA. Two cases of illegal shooting were prosecuted in the Kodiak area in 1998 involving two Steller sea lions from the western population (Angliss *et al.* 2001). The subsistence harvest of the western population has decreased over the last ten years from 547 to 171 animals per year (1992 to1998) (Angliss and Lodge 2002). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). Predation by transient killer whales and sharks has always contributed to the natural mortality of Steller sea lions. The numbers of sea lions taken and the relative contribution of this factor to the recent population decline and lack of recovery is currently under investigation (Matkin *et al.* 2001, Matkin *et al.* 2003, Springer *et al.* 2003).

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillnet fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely be relatively low (fewer than 10 per year). Entanglement in fishing gear and intentional shootings would also be expected to continue at a level similar to the baseline condition. Predation will continue to contribute to natural mortality but climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** The cumulative effect of mortality based on the contribution of internal effects of the groundfish fishery and external mortality factors is considered significantly adverse for the western population of Steller sea lions. The western population of Steller sea lions has declined approximately 80 percent since the 1970s and was listed as endangered under the ESA in 1997. A number of human-caused mortality factors have been identified as potentially contributing to this decline and lack of recovery. According to current estimates, incidental take from the BSAI and GOA groundfish fisheries and other fisheries (29) and subsistence harvest (198) exceeds the PBR (208) for the western population of Steller sea lions (Angliss and Lodge 2002). In addition, natural mortality factors, such as predation by transient killer whales and sharks, may be relatively more important for a depressed population and may be inhibiting the recovery of the Steller sea lion population. Because the population is still depressed from historic levels, has not recovered to the point that a recovery rate can be reliably calculated, and overall human-caused mortality exceeds the PBR for this population, the cumulative effect of all mortality factors is considered significantly adverse for the western population of Steller sea lions. The contribution of the groundfish fisheries to mortality is small compared to total human-caused mortality, and as such, has been determined not to jeopardize the continued existence or recovery of the western population under the ESA (NMFS 2001b).

Prey Availability

- **Direct/Indirect Effects.** The combined harvest of Steller sea lion prey species under FMP 1 is not expected to result in population-level effects and is rated as insignificant.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that were targeted or taken as bycatch by the foreign, JV, and domestic groundfish fisheries and parallel fisheries in state waters, and partial overlap with other state-managed fisheries. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s. One hypothesis is that the combined fisheries, perhaps in conjunction with climate and oceanographic fluctuations, greatly reduced the availability of forage fish to Steller sea lions. NMFS issued a number of Biological Opinions (BiOps) since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of the western population of Steller sea lions or causing adverse impacts to their critical habitat. A recent Steller sea lion BiOp and EIS (NMFS 2001b and 2001c) explores this subject in great depth.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a generally similar manner to the baseline conditions. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects of availability of prey but the direction or magnitude of these changes are difficult to predict. Climate induced change has been suspected in the decline of the western stock Steller sea lion.

- **Cumulative Effects.** The cumulative effect on prey availability for Steller sea lions is based on direct, indirect, and external effects on prey and is considered conditionally significant adverse. This rating is based on the adverse effects on prey availability in the past from foreign, JV, and domestic groundfish fisheries, the state-managed salmon and herring fisheries, and indications that prey availability has been a key factor in the decline of the western population over the last several decades. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine with natural fluctuations to affect prey availability such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under FMP 1 are determined to be insignificant to Steller sea lions.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, as well as state-managed fisheries for salmon and herring have all attempted to maximize their catch per unit effort by concentrating their fishing at times and places where fish are most concentrated. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s, and one hypothesis is that the combined fisheries caused localized depletion of forage fish. Past changes in the domestic groundfish harvest regulations have dispersed the fishing effort in time and space in order to minimize the potential for localized depletion of Steller sea lion prey. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of sea lion protective measures, which constitute the baseline condition.

- **Reasonably Foreseeable Future External Effects.** The only reasonably foreseeable future factors external to the groundfish fisheries that affect the spatial/temporal harvest of Steller sea lion prey would be the state-managed salmon and herring fisheries, which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to continue to be managed as they have been in recent years. No new state or federal fisheries are anticipated at this time.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey is based on past and future effects of the groundfish fisheries and state-managed fisheries and is considered conditionally significant adverse. Although there are several hypotheses regarding the decline and lack of recovery of Steller sea lions, localized depletion of prey due to commercial fishing is a plausible mechanism for population-level effects. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine to cause localized depletion of prey in key areas such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance on Steller sea lions under FMP 1 are considered to be insignificant.

- **Persistent Past Effects.** Past effects of disturbance were identified from foreign, JV, and domestic groundfish fisheries in the BSAI and GOA and state-managed fisheries. Past disturbances were also identified from commercial harvest, intentional shooting and subsistence harvest. General vessel traffic and disturbance to prey fields from fishing gear have also regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects.** Future sources of disturbance were identified for state-managed salmon and herring fisheries as well as general fishing and non-fishing vessel traffic in Steller Sea lion foraging areas. Subsistence harvest was also identified as a continuing source of low level disturbance to Steller sea lions. The level of disturbance is expected to be similar to baseline conditions.

- **Cumulative Effects.** The cumulative effect of disturbance to Steller sea lions is based on contributions from both internal and external events. This effect is considered insignificant, because the level of disturbance is similar to the baseline condition and population-level effects are unlikely.

4.5.8.2 Eastern Distinct Population Segment of Steller Sea Lions

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 1 is not likely to result in significant changes to the population trajectory of the eastern distinct population segment (eastern population) of Steller sea lions. No Steller sea lions from the eastern population have been taken incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al.* 2001) (Table 4.5-60). In this context, incidental take refers to animals that are either killed or sustain injuries that are expected to result in death. Because no animals from the eastern population have been taken incidental to groundfish fisheries, changes in catch resulting from the FMP 1 are not expected to result in an increase in the level of incidental takes.

Entanglement of Steller sea lions from the eastern population in derelict fishing gear or other marine debris seems to occur at frequencies that do not have significant effects upon the population. Entanglement of sea lions in derelict fishing gear or other marine debris does not appear to represent a significant threat to the population. In conclusion, incidental take and entanglement in marine debris under the FMP 1 are insignificant according to the criteria set for significance (Table 4.1-6).

Fisheries Harvest of Prey Species

BSAI groundfish fisheries are not likely to have large impacts on the prey availability of the eastern population of Steller sea lions as there is little overlap with this population and fisheries that harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to have an effect on the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock and Pacific cod are expected to increase by one percent and decrease by 17 percent, respectively, relative to the comparative baseline over the next 5 years under FMP 1. The changes in the fishing mortality rates expected to occur under FMP 1 are insignificant at the population level for Steller sea lions.

Little difference is expected relative to the baseline for harvest of other, non-target species that are prey for Steller sea lions (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of prey species for the eastern population of Steller sea lions under FMP 1 is not expected to result in population-level effects and was determined to be insignificant overall.

Spatial/Temporal Concentration of the Fishery

The criterion used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations is that the alternative FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. The spatial/temporal measures in FMP 1 (and retained throughout all of the alternative FMPs) were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods that are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, e.g., surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as "global controls." Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the eastern population of Steller sea lions in the wild. Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to the eastern population of Steller sea lions according to the criteria established in Table 4.1-6.

Disturbance

Levels of disturbance similar to those that occurred to the eastern population of Steller sea lions in 2002 are expected under the FMP 1 management regime. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on the eastern population of Steller sea lions under the FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

The past/present effects on the eastern population of the Steller sea lion in southeast Alaska are described in Section 3.8.1 (Table 3.8-1) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above. The effects considered in this analysis are listed in Table 4.5-63. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With regard to incidental take, FMP 1 is expected to have insignificant changes to the population trajectory of the eastern population of Steller sea lions (see Direct and Indirect Effect above).

- **Persistent Past Effects.** It is thought that shooting used to be a significant source of mortality prior to listing the Steller sea lion as threatened under the ESA. NMFS Alaska Enforcement Division has successfully prosecuted two cases involving illegal shooting of four sea lions from the eastern population (Angliss *et al.* 2001). It is not known to what extent illegal shooting continues in the eastern population but stranding of sea lions with bullet holes still occurs. Predator control programs associated with mariculture facilities in British Columbia account for a mean of 44 animals killed per year from the eastern population (Angliss and Lodge 2002). The subsistence harvest from the eastern population is very small and is subject to an average of only two sea lions taken per year from southeast Alaska (1992-1997) (Angliss and Lodge 2002). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine-year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). The proportion of these from the eastern population is unknown. Intentional shooting of Steller sea lions, other than in subsistence hunts, became illegal after the species was listed as threatened under the ESA in 1990. It is thought that shooting was a significant source of mortality prior to that time. Steller sea lions are incidentally taken in low numbers by commercial fisheries other than groundfish fisheries, including some state-managed salmon drift and set gillnet fisheries, and the salmon troll fishery in southeast Alaska (mean of 1.25 and 0.2, respectively) (Angliss and Lodge 2002). Small numbers of sea lions from the eastern population are also taken outside of southeast Alaska in groundfish fisheries (0.45 per year in Washington, Oregon, and California) and set gillnet fisheries in Northern Washington State (0.2 per year) (Angliss and Lodge 2002). The PBR for this population is 1,396 and current human caused mortality is 45.5, substantially less than 10 percent of the PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillnet and troll fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely be relatively low (<10 per year). Groundfish fisheries in Washington, Oregon, and California and salmon set gillnets fisheries will continue to take small numbers from this population. Entanglement and intentional shootings would also be expected to continue. Pollution is likely more of a factor for this population due to the closer association with human population centers. Climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** The cumulative effect of mortality based on the contribution of internal effects of the groundfish fishery and external mortality effects is considered insignificant because the overall human-caused mortality does not approach the PBR for this population. Although this population is listed as threatened under the ESA, the population has been increasing over the last 20 years. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and has been determined not to cause jeopardy under the ESA (NMFS 2001b).

<u>Effects of Prey Availability</u>

- **Direct/Indirect Effects.** The combined harvest of the eastern population of Steller sea lion prey species under FMP 1 is not expected to result in population-level effects and is therefore determined to be insignificant.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in state waters, and partial overlap with other state-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries. NMFS issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of Steller sea lion populations or causing adverse impacts to their critical habitat but most of the focus was on the western population. A recent Steller sea lion BiOp and EIS (NMFS 2001b and 2001c) explore this subject in great depth.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a generally similar manner to the baseline condition. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects of availability of prey but the direction or magnitude of these changes are difficult to predict. Climate induced change has been suspected in the decline of the western population Steller sea lion, but effects of climate change or regime shifts on the eastern population of the Steller sea lion are largely unknown.

- **Cumulative Effects.** The cumulative effects of prey availability on the eastern population of the Steller sea lion are considered to be insignificant at the population level. The eastern population of Steller sea lions has been increasing steadily over the last 20 years so prey availability is not considered to be limiting the recovery of the population.

<u>Spatial/Temporal Concentration of the Fishery</u>

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in the FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under FMP 1 are determined to be insignificant to the eastern population of Steller sea lions.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries, and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of sea lion protective measures, which remain in effect under FMP 1.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon drift and set gillnet fisheries, salmon troll fisheries, and herring fisheries are expected to continue in future years in a generally similar manner to the baseline conditions.

- **Cumulative Effects.** The cumulative effect of spatial and temporal harvest of prey based on both internal and external sources is considered to be insignificant. This is because the effect is likely to remain similar to the baseline condition, under which the population has steadily increased.

<u>Disturbance</u>

- **Direct/Indirect Effects.** The effects of disturbance on Steller sea lions under the FMP 1 are expected to be similar to the baseline, and population-level effects are unlikely; therefore, internal effects are considered insignificant. Protection measures around rookeries and haulouts that limit the potential for disturbance will continue under FMP 1.

- **Persistent Past Effects.** Past disturbance was identified for foreign, JV, and domestic groundfish fisheries as well as state-managed salmon and herring fisheries. General vessel traffic has also contributed to the disturbance level for this population. Intentional shooting has likely been a factor in disturbance in past years.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and vessel traffic will likely continue in the future at a level similar to the baseline condition. Disturbance from subsistence harvest is not an issue for this population.

- **Cumulative Effects.** The cumulative effect of disturbance of prey based on both internal and external sources is considered to be insignificant. This is because the effect is likely to remain similar to the baseline condition, under which the population has increased steadily.

4.5.8.3 Northern Fur Seals

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, the FMP 1 is not likely to result in significant changes to the population trajectory of northern fur seals. The incidental take of northern fur seals is uncommon in the groundfish fisheries. The last recorded mortality in any Alaskan groundfish fishery occurred in 1996, when the take rate was one animal per 1,862,573 mt of groundfish harvested. Observer records from 1990 to 1999 indicate that direct interactions with groundfish vessels occurred only in the BSAI trawl fishery, despite observer placement in pot, longline and trawl fisheries in both the BSAI and GOA. In the BSAI trawl fishery, the average annual take rate (1995 to 1999) was 0.6. Since PBR for this population is 17,138 animals per year (Angliss and Lodge 2002), this level of take is inconsequential to population trends.

Northern fur seal entanglement in marine debris is more common than any other species of marine mammal in Alaskan waters (Laist 1987, 1997, Fowler 1987). Fowler (1987) concluded that mortality of northern fur seals from entanglement in marine debris contributed significantly to declining trends in the Pribilof Islands during mid to late 1970s and early 1980s. The contribution of intentional discard of net debris from Alaskan groundfish fisheries vessels is thought to have declined over the past decade. However, consistent numbers of seals entangled in packing bands on St. Paul Island may reflect disposal of these materials in proximity to the islands. Recent data from satellite-tracked drifters deployed in the Bering Sea suggests a "trapped" circulation pattern around the Pribilof Islands (Stabeno *et al.* 1999) which may retain marine debris in the nearshore environment. An increase in the number of Antarctic fur seals (*Arctocephalus gazella*) entangled in polypropylene packing bands was observed at Bird Island, South Georgia, in the late 1980s as these materials came into common usage by at-sea processing vessels (Croxall *et al.* 1990). Involuntary sources of marine debris, as in loss of gear, are diminishing as fishery cooperative systems develop (such as in the BSAI offshore pollock allocation). That is, as the pace of fisheries is slowed, there is less incentive to risk capital equipment. Data do not yet exist to assess the rates at which various gear types are lost or discarded to result in risk to fur seals, especially in regard to fishery or nation of origin. In consideration of progress in stemming the loss and discard of net fragments and other plastic debris by domestic commercial fisheries, the extent to which the current FMP could change the rate of fur seal entanglement in marine debris is considered to be low. There seem to be few options, given the likelihood that sources beyond the control of fisheries managers (i.e., foreign fisheries, international shipping, and shoreside refuse) constitute significant sources of discard. In view of these factors, the effects on northern fur seals under the FMP 1 are rated insignificant, with respect to incidental take and entanglement in marine debris.

Fisheries Harvest of Prey Species

The diet of northern fur seals includes a wide range of fish species, with less apparent dependence on Pacific cod and Atka mackerel compared to Steller sea lions. However, both adult and juvenile pollock occur in the diet of northern fur seals and consumption rates vary according to the abundance of different age classes of pollock in the foraging environment (Swartzman and Haar 1983; Sinclair *et al.* 1996). Because fur seals are opportunistic foragers, the presence of strong year-classes results in a disproportionately high percentage of that age class of pollock in the fur seal diet. Evaluation of the effects of harvest of prey species on northern fur seals, focuses less on removals of Pacific cod and Atka mackerel and more broadly on removals of pollock and small schooling fishes. Northern fur seals forage at shallow to mid-water depths of 0 to 820 ft (0-250 m), both near shore and in pelagic regions of their migratory range. Female and young male fur seals generally consume both juvenile and adult small-sized (2 to 8 inches) schooling fishes and squids although diet varies across oceanographic subregions along their migration routes and around breeding locations in the Pribilof Islands. In the eastern Bering Sea, primary prey species include pollock and Pacific cod, but deep sea smelts, lanternfish, and squids are also major components. Studies based on scat analysis have indicated that the pollock and Pacific cod consumed by fur seals tend to be smaller than those selected by the target fisheries, however data from stomach collections from the 1960s through the 1980s indicate that fur seals often consume adult pollock. Recent studies using bio-chemical methods to study the diet of northern fur seals suggests that the diet of deep diving fur seals in waters over the continental shelf includes adult pollock (Kurle and Worthy 2000, Goebel 2002).

Under the FMP 1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 22 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of adult pollock , which is a key prey species of northern fur seals in the EBS, is rated significantly adverse. However, overall harvest of northern fur seal prey species is considered insignificant under the FMP 1 due to the factors explained below.

Catches of squid and small schooling fish (e.g., fish designated in the forage fish assemblage) in the groundfish fisheries of the BSAI and GOA are low, generally less than 1,000 mt per year. While precise biomass estimates for these groups do not exist, the exploitation rate on these groups in the groundfish fisheries is thought to be very low. For instance, squid biomass in the Bering Sea may be as large as 4 million mt, based on marine mammal food habits, daily ration, and abundance data (Sobolevsky 1996). Similarly, with respect to small schooling fishes, consumption of capelin in the GOA by arrowtooth flounder alone may be as large as 300,000 mt per year (Livingston 1994). Assuming that these crude projections of squid and capelin biomass at least approximate the order of magnitude of the true population levels, then the fisheries removals would amount to only a fraction of one percent of those populations. Fisheries for pollock and Pacific cod do not target fish younger than 3 years of age (Ianelli *et al.* 1999, Dorn *et al.* 1999, Thompson and Dorn 1999, Thompson and Zenger 1994, Fritz 1996). Catches of pollock smaller than 30 centimeters (cm) are small, and thought to be only 1 to 4 percent of the number of one- and two-year olds each year in the EBS and GOA (Fritz 1996).

Therefore, while fisheries do harvest prey of northern fur seals (i.e. pollock and Pacific cod), competition due to the harvest rates of those species may vary depending on the size range consumed by northern fur seals. The overall catch of juvenile pollock has tended to be low in recent years and the degree to which adult pollock occur in the northern fur seal diet is not certain. While the potential overlap with fisheries may be moderated by these factors, effects on northern fur seals may yet exist, the relevance of which is not reflected by estimates of biomass removals over large geographical areas.

The potential for competitive overlap between northern fur seals and groundfish fisheries may be tempered by the spatial and temporal distribution of the harvest. These effects are analyzed under the "Spatial/Temporal" heading. Fisheries may also trigger trophic level effects which may affect the availability of northern fur seal prey and these effects are discussed in the ecosystem section.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures in the FMP 1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to northern fur seals according to the criteria established in Table 4.1-6. However, effects to northern fur seals from spatial/temporal concentration of the fisheries under the strategy defined as the baseline for this environmental analysis were rated conditionally significant adverse in the Steller sea lion SEIS (NMFS 2001b). Therefore, while changes in the spatial/temporal effects of FMP 1 are insignificant relative to the baseline, the baseline has been described as having potential adverse effects on northern fur seals based on past concentration of the fisheries.

In recent years, fishing effort for pollock has increased in nearshore areas around the Pribilof Islands (NMFS 2003) where northern fur seals are known to forage. The greatest potential for temporal overlap between northern fur seals and the pollock fishery in the eastern Bering sea is July through November. Under the baseline, pollock fisheries were extended in order to slow the pace of the fishery and now occur from June through October. This disperses the harvest over a longer time period than in previous seasons, thereby reducing temporal concentration of the fisheries. However, this change also extends the fisheries into the summer months when fur seals are concentrated near the Pribilof Island rookeries and may thus increase the likelihood of localized effects in foraging areas near the Pribilofs (NMFS 2001b). Seasonally, the highest bycatch of small pollock occurs during the summer (May-July) when spawning aggregations have dispersed and pollock are generally less segregated by size (Fritz 1996). However, given the expected temporal dispersal of the fisheries under FMP 1 and the steadily increasing biomass trends for pollock, the magnitude of harvest and bycatch of species/size classes important to fur seals during the breeding season is not expected to cause localized depletion of prey to the point that the fur seal population as a whole will be affected. Therefore, the spatial/temporal concentration of the fishery under FMP 1 is determined to be insignificant to northern fur seals.

Disturbance

Disturbance from the baseline level of fishing activities has not been implicated as a potential cause for the population decline of northern fur seals. FMP 1 is expected to produce similar levels of disturbance as the baseline which are unlikely to have population-level effects and are therefore considered insignificant according to the significance criteria established in Table 4.1-6.

Cumulative Effects

A summary of the past/present effects on the northern fur seal are described in Section 3.8.2 (Table 3.8-2), and the predicted direct and indirect effects of the groundfish fishery under FMP1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. This analysis seeks to provide an overall assessment of the species' population-level response to its environment as it is influenced by the groundfish fishery. The effects considered in this analysis are listed in Table 4.5-64. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With respect to mortality and entanglement in marine debris, the effects on the northern fur seal under the FMP 1are rated as insignificant.

- **Persistent Past Effects.** Effects of past mortality on fur seal population include commercial harvest of young males up to 1985, harvest of females between 1956 and 1968, incidental take in the JV fisheries, foreign fisheries, and annual subsistence harvest on the Pribilof Islands. Commercial harvest of fur seals peaked in 1961 with over 126,000 animals but was halted in 1985. The harvest of female fur seal on the Pribilof Islands, as many as 300,000 between 1956 and 1968, likely contributed to the decline of the population in the late 1970s and early 1980s (York and Kozloff 1987). This precipitous decline resulted in its depleted status under the MMPA. Entanglements may have contributed significantly to declining trends of the population during the late 1970's (Fowler 1987). Since the cessation of commercial harvest in 1985, fur seal number have steadily declined (NMFS 1993, Angliss and Lodge 2002). The contribution of the earlier harvest of fur seal to the subsequent declines is uncertain since it has been nearly 20 years since commercial harvest was ended. Subsistence harvests have been one of the major contributors to fur seal mortality in recent years. From 1986 to 1996, the average annual subsistence take was 1,605 from St. Paul and St. George Islands. From 1995 to 2000 this average take dropped to 1,340 seals per year, which represents about 8 percent of the PBR for this species.

- **Reasonably Foreseeable Future External Effects.** These effects include incidental take from foreign fisheries outside the U.S. EEZ where fur seal are widely dispersed. State-managed fisheries take small numbers of fur seal including PWS drift gillnet fishery, Alaska Peninsula and Aleutian Island salmon gillnet fisheries, and the Bristol Bay salmon fisheries (Angliss and Lodge 2002). Subsistence will continue to be a major source of mortality in the future but is limited to the Pribilof Islands. Levels of take are expected to be well below 10 percent of the PBR for this species. Short-term and long-term climate change is not considered a major mortality factor for this species.

- **Cumulative Effects.** The cumulative effect of mortality from internal and external factors is considered insignificant. The contribution of the groundfish fisheries is very small and approaches zero. The cumulative effect is considered insignificant because of the size of the fur seal population in relation to existing levels of take, which are well below the PBR of this species; therefore, population-level effects are not anticipated.

Availability of Prey

- **Direct/Indirect Effects.** The effect of the groundfish fisheries under the FMP 1 is not expected to have population-level effects, therefore, is rated as insignificant to northern fur seal (see Direct and Indirect Effect above.

- **Persistent Past Effects.** Effect of groundfish harvest in the past has likely occurred from overlap of prey species and fish targeted by the foreign and JV fisheries in the BSAI as well as by the state and federal fisheries. Climate and oceanic fluctuations are also suspected in past changes in the abundance and distribution of prey.

- **Reasonably Foreseeable Future External Effects.** Effect on prey availability for northern fur seal in the futures is considered to come from a small overlap in prey species with the state-managed salmon and herring fisheries in nearshore areas and effect of climate change/regime shifts on prey species abundance and distribution. Climate effects are largely unknown but could potentially have adverse effects on the availability of prey.

- **Cumulative Effects.** The cumulative effect of prey availability from both the internal contribution of the groundfish fisheries and external effects on prey such as other fisheries and possibly long-term climate change is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Spatial/Temporal Concentration of Harvest

- **Direct/Indirect Effects.** The effects of groundfish fisheries under FMP 1 on the spatial/temporal concentration of fisheries harvest are very similar to the baseline conditions; thus, the effects of the spatial/temporal concentration under FMP 1 are determined to be insignificant to northern fur seals.

- **Persistent Past Effect.** Effect of past fisheries harvest of prey are primarily from the foreign and JV fisheries and the state and domestic fisheries in the BSAI. There has been concern with regard to displaced/increased fishing effort that is encroaching into nearshore areas of the Pribilofs resulting in increased overlap with fur seal foraging areas. The proportion of the total June-October pollock catch in fur seal foraging habitat increased from an average of 40 percent in 1995-1998 to 69 percent in 1999-2000 (NMFS 2001b). There is particular concern that this increased fishing pressure could have impacted lactating females from St. George Island where catch rates were consistently higher than in areas used by females from St. Paul (Robson *et al.* 2004).

- **Reasonably Foreseeable Future External Effects.** Effects of the spatial/temporal harvest of prey species are primarily from the foreign and domestic fisheries outside the EEZ, due to the extensive range of the fur seal when they are away from their breeding rookeries. state-managed fisheries have very limited overlap with fur seal prey. Climate change was also identified as a potential factor in spatial/temporal effects on prey.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey based on the presence of internal and external factors is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. The potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional because the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established.

Disturbance

- **Direct/Indirect Effects.** FMP 1 is expected to produce similar levels of disturbance as the baseline, and as such, these effects are unlikely to have population-level effects and are therefore considered insignificant at the population level.

- **Persistent Past Effects.** Past disturbance of fur seals includes commercial groundfish fisheries harvest by foreign, JV, and domestic groundfish fisheries, state-managed fisheries, and, to a lesser extent, the subsistence harvest of fur seal on the Pribilof Islands. It is unlikely that disturbance persists as a result of these past activities but the ongoing fisheries do continue to result in some level of disturbance to fur seal while they are in the BSAI region.

- **Reasonably Foreseeable Future External Effects.** Future external disturbance effects on fur seal were identified for state-managed fisheries and subsistence activities on the Pribilof Islands. No new fisheries are expected within the range of the northern fur seal.

- **Cumulative Effects.** The cumulative effect of disturbance from internal and external factors is considered insignificant because there is little evidence to indicate an adverse effect at the population level for this degree of disturbance.

4.5.8.4 Harbor Seals

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

In both the GOA and BSAI, groundfish fisheries takes of harbor seals are at levels approaching zero and are insignificant factors in population trends. Reported cases of harbor seal entanglement in marine debris are less prevalent than for northern fur seals or Steller sea lions (Laist 1987, 1997). Given their inshore distribution and the high frequency with which they are observed, the low incidence of entanglement is unlikely to be a result of few opportunities to document such events. Thus, the effect of direct take and entanglement in marine debris under FMP 1 on harbor seal populations is rated insignificant.

Fisheries Harvest of Prey Species

The major prey of harbor seals in Alaskan waters include fish from the following families: Gadidae, Clupeidae, Cottidae, Pleuronectidae, Salmonidae, Osmeridae, Hexagrammidae, and Trichodontidae. Octopus and gonatid squid are also important. However, overlaps with commercial groundfish fisheries occur primarily with reference to pollock, Atka mackerel, and Pacific cod, which may constitute grounds for indirect interactions, particularly in the GOA and Aleutian Islands. However, the basis for concern is less pronounced than those noted for Steller sea lions, or even for northern fur seals, so that the overall effects are likely to be lower as well. Pollock, Atka mackerel, and Pacific cod constitute approximately 12, 9, and 8 percent, respectively, of harbor seal diet in the Aleutian Islands and Bering Sea (Perez 1990). In the GOA, pollock, octopus and capelin were reported by Pitcher and Calkins (1979) as the most important prey, while Pacific cod was less important and Atka mackerel were absent in the sample. Ashwell-Erickson and Elsner (1981) estimated that harbor seals and spotted seals combined consume approximately 81,600 mt of pollock per year, compared to current Bering Sea pollock biomass estimates (1998) of over 9 million mt. Pollock removals by fisheries are less than 10 percent of the biomass estimate, suggesting that in terms of volume, the unharvested fraction is sufficient to satisfy harbor seal foraging needs. Under FMP 1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 22 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key harbor seal prey species is rated significantly adverse. See the discussion regarding the aberrant fishing mortality rate for EBS pollock in 2002 (which served as the comparative baseline) in Section 4.5.9.1.

The fishing mortality rate of GOA pollock is expected to increase by an average of one percent relative to the comparative baseline over the next 5 years under the FMP 1. This change in F is insignificant at the population level for harbor seals. Under the FMP 1, the BSAI Pacific cod fishing mortality rates is expected to increase by 20 percent which was determined to be insignificant to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to harbor seals with a 60 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for harbor seals (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under FMP 1 was determined to be insignificant to harbor seals. Although there is overlap in species/size classes taken by the groundfish fisheries and harbor seal prey, harbor seals also consume a large amount of other prey species. The combined harvest of harbor seal prey species under FMP 1 is not expected to increase substantially from the baseline condition or to result in population-level effects and was determined to be insignificant overall.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to harbor seals according to the criteria established in Table 4.1-6.

Disturbance

The potential for disturbance effects caused by vessel traffic, fishing gear, or noise appears limited for harbor seals. These animals are common in nearshore waters and are subjected to considerable levels of anthropogenic disturbances, typical of ports and shipping lanes. Interactions with groundfish fishing gear, such as trawl nets, also appears limited, based on the rare incidence of takes in groundfish fisheries. Finally, given the nearshore distribution of harbor seals, their overlap with fishing activities is more limited than in the case of either Steller sea lion or northern fur seals. FMP 1 is expected to produce similar levels of disturbance as the baseline which are unlikely to have population-level effects and are therefore considered insignificant according to the significance criteria established in Table 4.1-6.

Cumulative Effects

A summary of the past and present effects with regards to harbor seals is presented in Section 3.8.4. (Table 3.8-4). The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case (Table 4.5-65). Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** In both the GOA and BSAI, groundfish fisheries' takes of harbor seals are at levels approaching zero and do not likely affect population trends. Thus, the effect of incidental take and entanglement in marine debris under FMP 1 is rated as insignificant at the population level.

- **Persistent Past Effects.** Residual effect on local populations of state predator control programs (1950s to 1972) and commercial hunts (1963 to 1972) may still occur in some areas although there is no data on these factors. Foreign and JV groundfish fisheries in the 1960s and 1970s have likely contributed to some level of direct harbor seal mortality from entanglement in gear but based on the near shore distribution of harbor seals, there was likely minimal direct interaction and mortality is believed to have been very low. From 1990 to 1996, minimum estimates of harbor seals taken incidentally in groundfish gear in the Bering Sea were 4 per year and less than 1 per year in the GOA. In southeast Alaska, 4 harbor seals are estimated to be killed each year on longlines. Harvest of harbor seals for subsistence purposes is likely the highest cause of anthropogenic mortality for this species since the cessation of commercial harvests in the early 1970s. Between 1992 and 1998, the state-wide harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which are taken in southeast Alaska (Wolfe and Hutchinson-Scarbrough 1999). Harvest of Bering Sea stock of harbor seals is approximately 161 animals, 42 percent of PBR for this species. For the GOA stock, the harvest is at approximately 91 percent of the PBR for this stock. For the southeast stock, harvest is at approximately 83 percent of PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take of harbor seals in state-managed fisheries such as salmon set and drift gillnet fisheries would be expected to continue at its present low rate. Subsistence take is expected to continue to be the greatest source of human-controlled mortality with a relatively high percentage of the PBR in both the GOA and southeast Alaska stock and a lower take in the BSAI region. Climate change is likely not a factor in the direct mortality of harbor seals although there would likely be indirect effects.

- **Cumulative Effects.** The cumulative effect of mortality from both the internal contribution of the groundfish fisheries and external factors is considered insignificant. The human-caused mortality for all harbor seals is below the PBR for each stock and, therefore, population-level effects are unlikely.

Availability of Prey

- **Direct/Indirect Effects.** The combined harvest of harbor seal prey species under FMP1 is not expected to result in population-level effects and was determined to be insignificant overall.

- **Persistent Past Effects.** Availability of prey for harbor seals in the past has likely been affected by foreign, JV, and domestic groundfish fisheries, and state-managed salmon and herring fisheries since the fish targeted by these fisheries are also prey of the harbor seal. Climate change/regime shift could possibly have been a factor in fluctuations in prey availability in the past.

- **Reasonably Foreseeable Future External Effects.** state-managed salmon and herring fisheries are identified as potential adverse effects on harbor seal prey availability, especially in preferred nearshore foraging areas. Climate change/regime shift will continue to be a contributing factor although the effects can be either beneficial or adverse, depending on direction and magnitude of the change.

- **Cumulative Effects.** The cumulative effect of prey availability from internal effects of the groundfish fisheries and external factors is considered conditionally significant adverse. This rating is based on the fact that the population has declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on harbor seals through this mechanism are considered conditional.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to harbor seals.

- **Persistent Past Effects.** Effects of prey harvest in the past has likely occurred from overlap of harbor seal prey species and fish targeted and areas fished by the foreign and JV fisheries in the BSAI, as well as the state and federal fisheries. Climate and oceanic fluctuations are not considered factors in past changes in the spatial/temporal harvest of harbor seal prey.

- **Reasonably Foreseeable Future External Effects.** Future effects on spatial/temporal harvest is considered for the state-managed fisheries in nearshore areas such as salmon and herring. Since these fisheries generally occur in the nearshore areas in comparison to groundfish fisheries, overlap is more pronounced than with the groundfish fisheries. Effects of climate change/regime shifts on prey species abundance and distribution are also likely in the foreseeable future.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey from internal effects of the groundfish fisheries and external effects of other fisheries is considered to be conditionally significant adverse. This rating is based on the fact that the population has declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. The potentially adverse cumulative effects on harbor seals through this mechanism are considered conditional because the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance similar to those that occurred to harbor seals under the baseline conditions are expected under the FMP 1. The effects of disturbance on harbor seals are considered to be insignificant at the population level.

- **Persistent Past Effects.** Disturbance of harbor seals in the past include commercial groundfish fisheries harvest by foreign, JV, and domestic fisheries, commercial harvest, state predator control programs, and to a lesser extent the subsistence harvest of harbor seals. It is unknown whether these past activities have persistent effects in the present but the ongoing fisheries activities and subsistence continue to result in some level of disturbance to harbor seals.

- **Reasonably Foreseeable Future Effects.** State-managed fisheries, general vessel traffic, and subsistence activities would be expected to continue to create some level of disturbance to harbor seals in the foreseeable future.

- **Cumulative Effects.** The cumulative effect of disturbance from internal and external sources is considered to be insignificant. Harbor seals have been exposed to similar levels of disturbance for many years and there is little to indicate an adverse effect of this level of disturbance on the population-level.

4.5.8.5 Other Pinnipeds

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

The incidental take rates in commercial fisheries for ice seals, walrus and northern elephant seals are very low. Mean annual mortality of all ice seals combined from 1995 - 1999 was estimated to be 1.8 animals based on NMFS observers on board BSAI groundfish trawl, longline, and pot fishing vessels (Angliss *et al.* 2001) (Table 4.5-60). These rates constitute levels approaching zero according to NMFS standards (Angliss *et al.* 2001) and are not expected to affect the population trajectories of the species included in this category. The take rate of walrus and elephant seal qualifies as an insignificant level, approaching zero by NMFS standards (Forney *et al.* 2000) and is not expected to affect population trajectory of these species. Entanglement in marine debris is likewise rare for these species and is considered to have insignificant effects. Of the federally-managed fisheries in Alaska, only the EBS and Aleutian Islands pollock fishery would be likely to have an impact on ice seals and walrus, because of their northern distribution in the Bering Sea. Because of their distribution in the GOA and south of the Aleutian Islands (Stewart and DeLong 1994, LeBoeuf *et al.* 2000), northern elephant seals would be likely to be affected only by the GOA and Aleutian Islands pollock and cod fisheries. Population-level effects are not expected to result from incidental take and entanglement under FMP 1. Therefore, incidental take and entanglement of other pinnipeds under FMP 1 is rated insignificant.

Fisheries Harvest of Prey Species

With the exception of spotted seals, the food habits of the ice seals do not overlap with commercial fisheries targets. Bearded seals consume primarily benthic prey including crabs and clams as well as shrimps and Arctic cod (Kosygin 1966, 1971, Lowry 1981a, 1981b). Ringed seals eat Arctic cod, saffron cod, smelt, herring, shrimps, amphipods and euphausiids (Fedoseev 1984, Johnson *et al.* 1966, Lowry *et al.* 1980, McLaren 1958). Ribbon seal diet has been characterized as intermediate between ringed and bearded seals (Shustov 1965). Spotted seals include pollock in their diet when feeding in the central Bering Sea (Bukhtiyarov *et al.* 1984), but their use of that resource in the EBS and Aleutian Islands is unknown. Spotted seal diet in Bristol Bay, the Priblof Islands and the eastern Aleutian Islands is likewise unknown, but if similar to harbor seals in those areas, it is likely to be diverse and may include a small percentage of commercially important species. Thus, no effects on ice seals are assumed to occur under the baseline, nor are they likely to occur under FMP 1.

With regard to Pacific walrus, their diet is composed almost exclusively of benthic invertebrates (97 percent), particularly bivalve molluscs. Fish ingestion has been considered incidental to their normal feeding behavior (Fay and Stoker 1982). Groundfish removals under FMP 1 would have insignificant effects on walrus populations.

The diet of northern elephant seals in the GOA is unknown, however, the species is known to be a deep diver. This behavior suggests that their foraging may be partitioned by depth from most groundfish fishing activities. The effects of groundfish harvests on prey species for northern elephant seals is determined to be unknown under FMP 1.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures in the FMP 1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under the FMP 1 are determined to be insignificant to other pinnipeds according to the criteria established in Table 4.1-6.

Disturbance

Levels of disturbance similar to those that occurred to other pinnipeds under the baseline are expected under the FMP 1 management regime. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on other pinnipeds under FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

A summary of the past/present effects on other pinnipeds is presented in Section 3.8.2 and Section 3.8.5 to Section 3.8.9. (Tables 3.8-3 through 3.8-9). The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above. Cumulative effects are summarized in Table 4.5-66.

Mortality

- **Direct/Indirect Effects.** Population-level effects are not expected to result from incidental take and entanglement under FMP 1 and are rated as insignificant.

- **Persistent Past Effects.** Past external effects on the populations of pinnipeds include low levels of incidental take in the foreign, JV, and domestic groundfish fisheries, and low levels of take in the state-managed fisheries. Spotted seal incidental mortality in groundfish fisheries is one per year between 1995 and 1999 (Angliss and Lodge 2002). For bearded seal, the BSAI groundfish fisheries take an average of 0.6 per year. The Bristol Bay salmon drift gillnet fishery from 1990-1993 reported 14 mortalities and 31 injuries of bearded seal. No mortalities of ringed seal have been observed in the last ten years in the BSAI groundfish (Angliss *et al.* 2001). For ribbon seal incidental take, the Bering Sea trawl fishery with one reported taken in 1990, one in 1991, and one in 1997. An average of 86 elephant seals are taken each year in various gillnet fisheries from California to Washington.

Incidental take included one in the Bering Sea trawl fishery in 1990, two in the GOA trawl fishery in 1990, and three in the GOA longline fishery in 1990. One juvenile elephant seal, originally misidentified as a bearded seal, was taken in the Bering Sea trawl fishery in 1991 (Angliss *et al.* 2001). Of the 17 Pacific walrus that were caught each year in groundfish trawl fisheries in the eastern Bering Sea between 1990 and 1997, over 80 percent were already decomposed (Gorbics *et al.* 1998). Subsistence is the major human-caused external factor for mortality. Annual subsistence harvest rates include 5,265 spotted seal, 6,788 bearded seal, 100 ribbon seal, 9,567 ringed seal, 1,000 walrus, and zero elephant seal.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries will likely continue to take very small numbers of seals in this group. Subsistence take of these marine mammals will likely continue at a similar rate to the baseline conditions.

- **Cumulative Effects.** The cumulative effect of mortality within the other pinniped group from both internal effects of the groundfish fisheries and external effects such as subsistence harvest is considered insignificant. For spotted, ringed, bearded, and ribbon seals, PBRs cannot be calculated. Walrus take is below PBR and population-level effects are unlikely. Elephant seal populations are expanding so overall mortality is considered insignificant. Contributions of the groundfish fisheries to overall mortality is very small.

Availability of Prey

- **Direct/Indirect Effects.** Except for elephant seals, where the amount of prey overlap is unknown, there is very little overlap of species taken in the groundfish fisheries with prey of the pinnipeds in this group and the effects of fisheries harvest on prey species are determined to be insignificant under the FMP 1.

- **Persistent Past Effects.** Past effects on spotted seal prey include foreign, JV, and domestic groundfish fisheries, as well as state-managed fisheries for salmon and herring. For the other ice seals, elephant seals and walrus, no persistent past effects were identified, due to minimal overlap with commercial fisheries.

- **Reasonably Foreseeable Future External Effects.** Future effects were identified for state-managed fisheries for the spotted seal. Climate change may be either a beneficial or adverse factor for pinnipeds due to the potential effects of ice cover on their foraging strategies and the abundance and distribution of prey in the Bering Sea.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance of prey for pinnipeds is considered insignificant for all species. Spotted seals have some overlap of prey with the groundfish fisheries but the harvest of prey by the fisheries is not expected to have population-level effects. The amount of groundfish fishery overlap with elephant seals is unknown but, since the elephant seal population is expanding, food does not appear to be limiting so cumulative effects on prey availability are considered insignificant. The amount of prey overlap with the other pinniped species is very limited and is considered insignificant for all species in this group.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in the FMP 1 do not deviate from the baseline, and therefore have an insignificant effect on pinniped species.

- **Persistent Past Effects.** Persistent past effects on spotted seal include foreign, JV, and domestic groundfish fisheries, as well as state-managed fisheries. For other species, none are identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries within the range of spotted seals would be expected to be conducted in the future in a manner similar to the baseline conditions. Future effects of spatial/temporal concentration of fisheries on other species in this group would not be expected.

- **Cumulative Effects.** The spatial/temporal concentration of the groundfish fishery and all other fisheries is considered to have an insignificant cumulative effect on pinniped prey due to limited seasonal overlap. Population-level effects are unlikely for any of the species in this group.

Disturbance

- **Direct/Indirect Effects.** Similar levels of disturbance as the baseline are expected under the FMP 1 and are considered insignificant.

- **Persistent Past Effects.** Past sources of disturbance of spotted seals have been identified from the foreign, JV, and the domestic groundfish fisheries in the BSAI and state-managed fisheries for salmon. Overlap of fisheries is minimal for most species in this group. The primary source of external disturbance to the other pinniped category would be related to subsistence harvest.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries could be expected to continue at a level similar to the baseline condition. Disturbance from subsistence harvest activities in future years would be expected to be similar to the baseline conditions.

- **Cumulative Effects.** The cumulative effect of disturbance from internal and external effects is found to be insignificant for all species based on very limited overlap with the fisheries and the lack of evidence that disturbance has a population-level effect for any of these species.

4.5.8.6 Transient Killer Whales

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 1 is not likely to result in significant changes to the population trajectory of killer whales. Six commercial fisheries in Alaska that could have interacted with transient killer whales from the western and GOA stock were monitored for incidental take by fishery observers from 1990 to 1999. Of the observed fisheries (BSAI and GOA groundfish trawl, pot, and longline), killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Angliss *et al.* 2001) (Table 4.5-60).

In addition to mortalities caused by entanglement, killer whales are susceptible to injury or mortality through vessel strikes. One killer whale was reported to be killed when it struck the propeller of a BSAI groundfish trawl vessel in 1998 (Angliss and Lodge 2002). The mean annual mortality of killer whales incidental to groundfish fisheries from 1995 to 1999 was estimated to be 1.4 whales (Angliss *et al.* 2001). It is not known what proportion of these whales were transients versus residents. Interactions which result in the entanglement of killer whales in fishing gear are rare and are not expected to have population-level effects. The effects of entanglement and take of killer whales incidental to groundfish fisheries are rated insignificant.

<u>Fisheries Harvest of Prey Species</u>

The diet of transient killer whales consists of marine mammals. Because the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant under FMP 1.

<u>Spatial/Temporal Concentration of the Fishery</u>

The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant under FMP 1.

<u>Disturbance</u>

Similar levels of disturbance as that which occurred to killer whales under the baseline are expected under FMP 1. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on killer whales under FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

The past/present effects on the transient killer whales are described in Section 3.8.22 (Table 3.8-22) and the predicted direct and indirect effects of the groundfish fishery under the FMP 1 are described above. This analysis seeks to provide an overall assessment of the species' population-level response to its environment as it is influenced by the groundfish fishery. The effects considered in this analysis are listed in Table 4.5-67. Representative direct effects used in this analysis include mortality and disturbance, with the major indirect effects of prey availability and spatial/temporal concentration of the fisheries (Table 4.1-6).

<u>Mortality</u>

- **Direct/Indirect Effects.** With regard to incidental take, FMP 1 is not likely to result in significant changes to the population trajectory of transient killer whales.

- **Persistent Past Effects.** Mortality has been documented in the JV fisheries, domestic groundfish fisheries, state-managed fisheries, as well as reported intentional shootings. Past incidental take in the groundfish fisheries is less than 2 animals per year but it is not known if these animals were transients or residents. In addition to mortalities caused by entanglement, killer whales are also susceptible to injury or mortality through vessel strikes. The EVOS resulted in the loss of half of the individual killer whales from the AT1 transient group in PWS (Matkin *et al.* 1999). This distinct group of whales is being evaluated for recognition as a separate stock and protection as a depleted stock under the MMPA. Contaminant levels in whales in this group were found to be many times higher than in other killer whales (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Future mortality is expected from external factors such as state-managed fisheries, intentional shooting, and marine pollution, particularly bio-accumulating compounds such as *para*-dichlorodephenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs) (Matkin *et al.* 2001).

- **Cumulative Effects.** The cumulative effect of mortality from internal effects of the groundfish fisheries and other external factors is unlikely to have population-level effects on transient killer whales and is therefore determined to be insignificant. The exception to this finding is the AT1 transient group in PWS. The cumulative effect of mortality was determined to be significant adverse on the AT1 group due to the past external effects of the EVOS and subsequent population decline.

Prey Availability

- **Direct/Indirect Effects.** Because the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant.

- **Persistent Past Effects.** Because marine mammals are the primary prey of transient killer whales, all of the factors that have been identified as affecting the abundance or distribution of cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include commercial and subsistence harvest, intentional shootings, incidental take in all fisheries, marine pollution, climate change, and regime shifts. In addition, there is the potential for past indirect effects due to fisheries on the abundance of Steller sea lions, fur seals, and harbor seals, all of which are important prey species for transient killer whales. Declines in harbor seals in PWS after the EVOS could have affected the AT1 group of transient killer whales through their food supply (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey species important to transient killer whales, primarily marine mammals, would likely include foreign and state-managed fisheries, subsistence harvest, marine pollution, climate change, and regime shifts.

- **Cumulative Effects.** The cumulative effects of prey availability on different marine mammal species are varied, with some populations declining substantially while others increase. Although some individual whales may focus on particular prey species, the ability of these top predators to vary their prey and forage over vast areas is believed to decrease the importance of any one species or stock of marine mammal prey in the diet of these mammals. The overall availability of prey does not appear to currently have population-level effects on transient killer whales and therefore the cumulative effect is considered insignificant.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant.

- **Persistent Past Effects.** All persistent past effects that have been identified for cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include the potential contribution of the spatial/temporal concentration of past fisheries to have caused localized depletion of prey for Steller sea lions, harbor seals, and northern fur seals with consequent population-level effects on those species.

- **Reasonably Foreseeable Future External Effects.** The future spatial/temporal concentration of external fisheries could have indirect effects on the abundance and distribution of marine mammals that are important prey for transient killer whales.

- **Cumulative Effects.** The cumulative effects of the spatial/temporal concentration of fisheries on different marine mammal species result in changes to the abundance and distribution of prey to transient killer whales. Because transient killer whales are able to vary prey and forage over vast areas, the potential localized depletion of any one species or stock of marine mammal prey is unlikely to have population-level effects on the killer whales. The cumulative effect of the spatial and temporal harvest of fish from all fisheries does not appear to be having population-level effects on transient killer whales and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance to transient killer whales are expected to be similar to baseline conditions and are therefore expected to be insignificant.

- **Persistent Past Effects.** Some levels of disturbance have likely occurred from foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Vessel traffic external to the fisheries has also contributed to overall disturbance of these animals. Effects of the level of disturbance on transient killer whales is largely unknown.

- **Reasonably Foreseeable Future External Effects.** External effects of state-managed fisheries and other vessel traffic on disturbance will likely occur in future years at a level similar to the baseline.

- **Cumulative Effects.** The cumulative effect of internal and external disturbance factors is unlikely to have any population-level effect on transient killer whales and is therefore considered insignificant.

4.5.8.7 Other Toothed Whales

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 1 is not likely to result in significant changes to the population trajectories of toothed whales. Incidental takes attributed to the fisheries and entanglement in fishing gear and marine debris occur at low levels thought to be insignificant to toothed whale populations. The highest incidental take rate for any cetacean is that of Dall's porpoise. From 1995 to 1999 an average of 8.8 Dall's porpoise were estimated to have been taken incidental to groundfish fishing activities. The majority of these were taken in BSAI trawl fisheries while an average of 1.6 and 1.2 animals were taken in BSAI longline and

GOA trawl fisheries, respectively. Three harbor porpoise moralities were observed incidental to BSAI groundfish trawl fisheries from 1995 to 1998. The mean annual mortality of Pacific white-sided dolphins incidental to groundfish fisheries from 1995 to 1999 was estimated to be less than one animal with reported takes occurring only in the BSAI longline fishery (Angliss *et al.* 2001) (Table 4.5-60). The estimated mean annual mortality of beluga whales, endangered sperm whales, and beaked whales incidental to groundfish fisheries was zero from 1995 to 1999.

Ten non-lethal interactions with endangered sperm whales have been documented in the GOA longline fishery targeting sablefish in management zones 640 and 650 (Hill *et al.* 1999). Two of the three entanglements reported between 1997 and 2000 resulted in release of the animal without serious injury. The extent of the injuries to the third animal was not known though it was alive at the time of release. No sperm whale mortalities have been observed or reported in the BSAI/GOA groundfish fisheries since observers began collecting data in 1990 (Angliss and Lodge 2002).

In the observed fisheries (BSAI and GOA groundfish trawl, pot, and longline), killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Angliss *et al.* 2001). The mean annual mortality of killer whales incidental to groundfish fisheries from 1995 to 1999 was estimated to be 1.4 whales (Angliss *et al.* 2001). It is not known what proportion of these whales were transients versus residents. Interactions which result in the entanglement of killer whales in fishing gear are rare and are not expected to have population-level effects.

The level of incidental takes and entanglement of these toothed whale species related to groundfish fishing activities is rare and is not expected to affect the population trajectories of any species, and is therefore insignificant at the population level.

<u>Fisheries Harvest of Prey Species</u>

The effects of the fisheries on toothed whale prey are largely constrained by differences between their prey and the fisheries harvest targets. FMP 1 is not expected to increase the level of competitive interactions for prey from the baseline condition and are therefore determined to be insignificant.

The beluga whale stocks along the western coast of Alaska from Bristol Bay north, and in Cook Inlet are generally restricted to shallow coastal and estuarian habitats not used by commercial groundfish fisheries. Their diet is predominantly salmonids and small schooling fishes such as eulachon and capelin. These species are taken only in small quantities as bycatch in the groundfish fisheries. Thus, it is unlikely that fishery interactions exist between beluga whales and Alaskan groundfish fisheries.

Similarly, Pacific white-sided dolphins are not commonly observed north of the Aleutian Islands, and appear to be seasonal visitors in parts of the GOA and southeast Alaska. The main body of their population is more commonly found in the central North Pacific Ocean (Ferrero and Walker 1996). With regard to diet, Pacific white-sided dolphins and Dall's porpoise feed mainly on cephalopods and small schooling fishes such as myctophids. These species are taken only in small quantities as bycatch in the groundfish fisheries.

The remaining species consume a wide variety of both fish and invertebrate species, but overlap with commercially important species is limited in most cases. Beaked whales, a diverse group unto itself, are poorly known, but available information suggests that they prey on benthic and epibenthic species including squid, skates, rattails, rockfish, and octopus. The diet of harbor porpoises in Alaskan waters is also poorly understood, although forage consumed by stocks in the Pacific Northwest and their tendency toward near shore distribution suggest that they probably consume a variety of coastal species. None of these species are taken in significant quantities in the groundfish fisheries.

Sperm whale diet overlaps with commercial fisheries targets more than any other species in this group, but the degree of overlap is at least partly due to direct interactions with longline gear. In addition to consuming primarily medium to large sized squids, they also consume salmonids, rockfish, lingcod and skates, and in the GOA they have been observed feeding off longline gear targeting sablefish and halibut. The interaction with commercial longline gear does not appear to have an adverse impact on sperm whales since no mortalities have been observed. However, the whales appear to have become more attracted to these vessels in recent years as reliable and easy sources of food.

Most information regarding resident killer whale's consumption of commercially important groundfish results from observations of whales depredating longlines as they are retrieved in locations ranging from the southeastern Bering Sea to PWS. In the waters between Unimak Pass and the Priblof Islands, killer whales regularly strip sablefish and Greenland turbot from longlines. Consumption of other groundfish species by resident killer whales not interacting with gear is largely unknown. In general, they are opportunistic feeders with diets that differ both regionally and seasonally. Nishiwaki and Handa (1958) examined killer whale stomach contents from the North Pacific and found squid, fish, and marine mammals. The importance of these prey items in the BSAI or GOA groundfish management areas is uncertain, but there is no evidence to suggest exclusive reliance on commercially important groundfish species.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures under FMP 1 do not deviate from the baseline, which do not appear to be causing localized depletion of prey for any species of toothed whale, and are thus determined to be insignificant to other toothed whales according to the criteria established in Table 4.1-6.

Disturbance

Similar levels of disturbance to toothed whales are expected under the FMP 1 as occurred under baseline conditions, which do not appear to have population-level effects on any species. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on toothed whales under the FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

The past/present effects on the other toothed whale species are described in Section 3.8.19 through 3.8-21 and Sections 3.8-23 through 3.8.25 (Tables 3.8-19 through 3.8-21 and Tables 3.8-23 through 3.8-25) and the predicted direct and indirect effects of the groundfish fishery under the FMP 1 are described above. The effects considered in this analysis are listed in Table 4.5-68. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The level of mortality for toothed whale species related to groundfish fishing activities is rare and is not expected to affect the population trajectories of any of these species, and is therefore insignificant at the population level.

- **Persistent Past Effects.** Persistent past effects on species within the other toothed whale group include incidental take and entanglement in foreign, JV, and domestic groundfish fisheries and state-managed fisheries, and subsistence hunting on beluga whales. The decline of the Cook Inlet beluga population is thought to have been the result of subsistence harvests, which ranged from 21 to 123 animals per year between 1993 and 1998. Only one beluga was harvested in 2001 by hunters from the Native Village of Tyonek and one beluga was harvested in 2002 by the Cook Inlet community hunters. Belugas are incidentally taken in the state-managed salmon gillnet fisheries in Bristol Bay and Cook Inlet. One beluga was reported to be taken from the eastern Bering stock in 1996 and 7 were reported taken in Bristol Bay in 2000. In the BSAI and GOA groundfish fisheries, no mortality or serious injuries to belugas have been observed. Harbor porpoise have not been taken in the observed groundfish fisheries over a ten year period between 1990 to 1998 (Angliss and Lodge 2002). Salmon gillnet fisheries in southeast Alaska take approximately 3 individuals per year. Dall porpoise mean annual mortality was 6.0 for the Bering Sea groundfish trawl fishery, 1.2 for the GOA groundfish trawl fishery, and 1.6 for the Bering Sea groundfish longline fishery. The Alaska Peninsula/Aleutian Island salmon drift gillnet fishery has a higher take of Dall's Porpoise with an estimated 28 porpoises in one year (1990). Thousands of Pacific white-sided dolphins were killed annually between 1978 and 1991 in the high seas driftnet fisheries, which no longer occurs (Angliss *et al.* 2001). One Pacific white-sided dolphin was taken in the BSAI trawl fishery and one in the BSAI longline fishery during the same time span (Angliss *et al.* 2001). State-managed salmon gillnet fisheries take approximately 2 dolphins per year.

  Approximately 258,000 sperm whales were harvested in the North Pacific by commercial whalers between 1947 and 1987, with the highest mortality occurring in 1968 when 16,357 sperm whales were harvested, after which time the population was severely depleted. Sperm whale interactions with longline fisheries operating in the GOA are known to occur and may be increasing in frequency. Sperm whales have been known to prey on sablefish caught on commercial longline gear in the GOA. Only three entanglements have been reported in the GOA longline fishery.

  For killer whales, the combined average mortality from the observed groundfish fisheries was 1.4 whales per year (Angliss *et al.* 2001). While it is most likely that whales interacting with fisheries are from resident pods (since they eat fish), no genetic testing has been done on whales incidentally taken in the groundfish fisheries to ascertain whether they were from resident or transient stocks.

  For beaked whales (Baird’s, Cuvier’s, or Stejneger’s), no incidental take or entanglement in BSAI and GOA groundfish trawl, longline, and pot fisheries has been documented (Angliss and Lodge 2002).

- **Reasonably Foreseeable Future External Effects.** Several of the toothed whale species range outside of the BSAI and GOA during the winter months. Therefore, foreign fisheries outside the EEZ and state-managed fisheries were identified as potential sources of mortality in the future.

Subsistence take of some stocks of beluga whales would be expected to occur in the future. Other species are not taken for subsistence purposes.

- **Cumulative Effects.** The cumulative effect of mortality from both internal and external mortality factors is considered insignificant for all non ESA-listed species due to the low level of incidental take in the groundfish fisheries and limited external human-caused mortality.

  For the endangered sperm whale, the cumulative effect was also considered insignificant because the very low level of incidental take in the groundfish fisheries or other fisheries and very limited human-caused mortality from external sources is not expected to delay the recovery of sperm whale populations.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 1 on the toothed whales are largely constrained by differences between their prey and the fisheries harvest targets. FMP 1 is not expected to increase the level of competitive interactions for prey from the baseline condition and is therefore considered to have insignificant effects on toothed whale prey.

- **Persistent Past Effects.** Past effects on the availability of prey for this group are identified for fisheries in general and include the foreign, JV, and domestic groundfish fisheries, as well as the state-managed fisheries for salmon and herring. The diversity of diet in this whale group results in limited overlap for most species, with the possible exception of sperm whales and resident killer whales.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries were identified as an external factor having a potential effect on prey for these species in the future. Climate and regime shifts are also identified but the direction and magnitude of these effects could be either beneficial or adverse.

- **Cumulative Effects.** The ability of these whale species to forage over wide areas and on a variety of prey species moderates any potential impacts from fisheries competition. Cumulative effects on prey availability were identified for this group, including a very limited contribution from the groundfish fishery, but the degree of fishery harvest and bycatch of prey important to these whale species is not expected to have population-level effects on any species, including the endangered sperm whale, and is therefore considered insignificant.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Spatial and temporal fishing measures under FMP 1 do not deviate from the baseline, which do not appear to be causing localized depletion of prey for any species of toothed whale, and are thus determined to be insignificant.

- **Persistent Past Effects.** The spatial/temporal concentration of foreign, JV, and domestic groundfish fisheries and the state-managed fisheries are believed to have had minimal effects on the abundance and distribution of toothed whale prey.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue in similar manner as the under the baseline conditions. Effects of future fishing activities on toothed whale prey are expected to be minimal.

- **Cumulative Effects.** The ability of toothed whales to forage over wide areas and on a variety of prey species moderates any potential impacts from localized depletion of prey from the spatial/temporal concentration of fisheries. Cumulative effects on prey abundance and distribution, including a very limited contribution from the groundfish fishery, are not expected to have population-level effects on any species, including the endangered sperm whale, and are therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Disturbance effects of on toothed whales from the groundfish fishery under FMP 1 are determined to be insignificant at the population level.

- **Persistent Past Effects.** Past potential disturbance effects on species in this group were identified for foreign, JV, and domestic groundfish fisheries, however, there is little indication of an adverse effect. General vessel traffic likely also contributes to disturbance of these species.

- **Reasonably Foreseeable Future External Effects.** Increases in the general marine vessel traffic and continued fishing activity in the state-managed fisheries were identified as potential sources of disturbance to these marine mammals.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external effects is found to be insignificant for endangered sperm whales and other toothed whale species, based on the lack of evidence that disturbance has a population-level effect for any of these species. For sperm whales, there is growing evidence that the whales are attracted to fishing vessels as reliable and easy sources of food.

4.5.8.8 Baleen Whales

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

Incidental take of baleen whales from groundfish fishing activities is rare. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Humpback whales are occasionally taken in the Bering Sea pollock trawl fishery through entanglement in fishing gear. The extent of interactions between bowhead whales and the groundfish fishery is not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. The extent of interactions between gray whales and the groundfish fishery are not known but some entanglement in gear does occur. Since 1989, no incidental takes of right whales are known to have occurred in the North Pacific. The low level of take of baleen whales projected to occur under FMP 1 will not affect the population trajectories of these baleen whale species, does not conflict with goals of any recovery plan for endangered whales, and is thus insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Most baleen whale species such as blue, fin, sei, and northern right whales feed primarily on copepods, euphausiids, and amphipods. Gray whales feed mostly on epibenthic and benthic invertebrates, while humpbacks and minke whales have a more diverse diet including euphausiids, Atka mackerel, sand lance, herring and capelin. The BSAI and GOA groundfish fisheries do not target these prey items (with the exception of Atka mackerel) and take very small amounts of these prey species as bycatch. Neither the abundance or distribution of zooplankton are influenced by commercial fishing operations. While a few species of baleen whales do consume herring and juvenile pollock (e.g., humpback and fin whales), changes in removal patterns of these prey species under FMP 1 would not be expected to impact their availability to whales, which can forage over vast areas and throughout the water column. The groundfish fisheries under FMP 1 are therefore unlikely to impact baleen whales through competition for prey, including the endangered blue, fin, bowhead, humpback, sei, and northern right whales.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures under FMP 1 do not deviate from the baseline, which does not cause localized depletion of prey for whales, and are therefore determined to be insignificant to both the endangered and non-ESA listed baleen whales according to the criteria established in Table 4.1-6.

Disturbance

The effects of disturbance caused by vessel traffic, fishing operations, or sound production on baleen whales in the GOA and BSAI are largely unknown. With regard to vessel traffic, most baleen whales appear tolerant, at least as suggested by their reactions at the surface. Observed behavior ranges from attraction to course modification or maintenance of distance from the vessel. Reaction to gear such as pelagic trawls is unknown, although the rarity of incidental takes suggests either partitioning or avoidance. Given their distribution throughout the fishing grounds, at least some individuals may be expected to occasionally avoid contact with vessels or fishing gear, which would constitute a reaction to a disturbance. Assuming these instances occur, the effects are likely to be temporary.

Coincident to fishing activity, as well as vessel transit, is the routine use of various sonar devices. The sounds produced by these devices may be audible to baleen whales and suggest disturbance sources. For instance, wintering humpback whales have been observed reacting to sonar pulses by moving away (Maybaum 1990, 1993), although few other cases of reaction have been documented. Given the continued occupation of the fishing grounds by these animals, and their generally positive population trends, disturbance from sonar, if it occurs in the BSAI/GOA, does not appear to have population-level effects.

Levels of disturbance to baleen whales under FMP 1 are expected to be similar to those that occurred under baseline conditions. These disturbance levels do not appear to have population-level effects on any species. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on both endangered baleen whale species and other non ESA-listed baleen whales under FMP 1 are expected to be insignificant relative to the baseline.

Cumulative Effects

The past/present effects on the other baleen whale group are described in Section 3.8.11 to Section 3.8.18 (Tables 3.8-11 through 3.8-18) and the predicted direct and indirect effects of the groundfish fishery under the FMP 1 are described above. The effects considered in this analysis are listed in Table 4.5-69. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

<u>Mortality</u>

- **Direct/Indirect Effects.** The low level of take of baleen whales projected to occur under the FMP 1 is considered insignificant.

- **Persistent Past Effects.** Commercial whaling in the last century has had lingering effects on most of the baleen whales in this group, with the possible exception of minke whales. These include the endangered blue whales, fin whales, sei whales, humpback whales, northern right whales and the non-ESA- listed gray whale. A full discussion of the effects of commercial whaling on baleen whales is presented in Sections 3.8.11 through 3.8.18. Subsistence whaling has also affected several of the baleen whales in the past. Gray whales are harvested both in Alaska and in Russia and have a 5-year quota of 620 whales. The 1968-1993 average take for Russian and Alaska Natives combined was 159 whales per year. Bowhead whales are harvested under International Whaling Commission quotas, which allow up to 67 strikes per year, although actual strikes have been less than the quota since 1978. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Fin whales were reported in this region year-round, most often in the summer and autumn (POP 1997). Humpback whales are present year-round in Alaska waters but are most frequently reported during the summer and autumn. In 1997, a dead humpback was found entangled in netting and trailing orange buoys near the Bering Strait. It is often difficult to determine if the entanglement occurred with active or derelict gear, or to identify the fishery the derelict gear originated from. Two mortalities (October 1998 and February 1999) were reported by observers in the Bering Sea pollock trawl fishery operating near Unimak Pass. The extent of interactions between bowhead whales and the groundfish fishery is not known. Bowhead whales are present in the Bering Sea during winter and early spring but are usually associated with ice-covered regions. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Of 236 bowhead whales examined from the Alaskan subsistence harvest (from 1976 to 1992), three had visible ship-strike injuries from unknown sources and six had ropes attached or scars from fishing gear (primarily pot gear), one found dead was entangled in ropes similar to those used with fishing gear in the Bering Sea (Philo *et al.* 1992). Since 1992, additional bowhead whales have been observed entangled in pot gear or with scars from ropes. The extent of interactions between gray whales and the groundfish fishery is not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Since 1997, five entanglements (mostly in pot gear) and one ship strike mortality have been reported in Alaska waters. Since 1989, no incidental takes of right whales are known to have occurred in the North Pacific. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. Because the right whale population is believed to be very small, any mortality incidental to commercial fisheries would be considered to be significant. Based on the lack of reported mortalities of endangered right whales, the estimated annual mortality rate incidental to commercial fisheries is zero whales per year from this stock.

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and state-managed fisheries are expected to continue to take small numbers of baleen whales in the coming years. Entanglement in fishing gear will also continue to effect baleen whales throughout their ranges. Subsistence for gray whales and bowhead will continue to be the largest source of human-caused mortality.

- **Cumulative Effects.** Mortality is considered cumulative, based on internal effects of the fishery and contributions from external factors. The effect is considered conditionally significant adverse for endangered fin, humpback, and northern right whales based on past effects on their populations and their endangered status. This is conditional on whether take or entanglement and other human-caused mortality affects recovery or the current population trajectory. The cumulative effect is found to be insignificant for the endangered blue, bowhead, and sei whales, based on very limited interaction with fisheries and lack of adverse external factors.

  Mortality is also considered insignificant for non ESA-listed minke whales and gray whales. Population-level effects are not anticipated for any of these species.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 1 are determined to have an insignificant effect on baleen whale species in regards to harvest of prey species due to minimal competitive overlap in species targeted by each.

- **Persistent Past Effects.** Persistent past effects on availability of prey were not identified due to the lack of competitive overlap in prey species targeted.

- **Reasonably Foreseeable Future External Effects.** Future effects were identified as state-managed fisheries such as herring, which are preyed on by humpback whales and fin whales. Other species would not be expected to be directly affected through their prey.

- **Cumulative Effects.** The cumulative effect of prey availability based on internal effects of the fishery and contributions from external factors is considered unlikely to result in population-level effects for all species in this group due to the limited overlap of prey species with the fisheries. These effects, therefore, are considered insignificant.

Temporal/Spatial Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under FMP 1 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects of temporal and spatial concentrations of the fisheries were not identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries would be expected to continue to contribute some degree of effect on several species with the baleen whales group.

- **Cumulative Effects.** The effects of spatial and temporal concentration of harvest are considered cumulative based on internal and external factors. This effect is not likely to have population-level effects due to the very low overlap in prey species for this group. The contribution of the groundfish fisheries is very slight. Cumulative effects are therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Similar levels of disturbance as that which occurred to other baleen whales under baseline conditions is expected under FMP 1 and is considered insignificant.

- **Persistent Past Effects.** Some level of disturbance has likely occurred from foreign, JV, and domestic groundfish fishing, as well as state-managed fisheries along with general vessel traffic. For some species such as the gray whale and bowhead whale, subsistence activities have contributed to disturbance of these marine mammals.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and general vessel traffic from recreational boating and whale watching to commercial vessels would be expected to continue in future years and well as subsistence activities.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external sources is determined to be similar to the baseline condition and would not likely to result in a population-level effect for any of the species in this group. Therefore, the cumulative effect is considered to be insignificant.

4.5.8.9 Sea Otters

Direct and Indirect Effects

Incidental Take/Entanglement in Marine Debris

Sea otter interactions with fishing gear, either passive or active are infrequent. Laist (1997) reported that sea otter entanglement in marine debris is rare. Likewise, incidental takes in fishing gear occur at a rate too low to cause population-level effects. While the PBRs for the three sea otter stocks in Alaska were 871 (southeast), 2,095 (southcentral) and 5,699 (southwest), mortalities incidental to commercial fishing were 0, less than 1, and less than 2 per year, respectively (Angliss and Lodge 2002).

In southwest Alaska, the NOAA fisheries observer program reported eight kills in the Aleutian Islands black cod pot fishery in 1992 (USFWS 2002a). No other sea otter kills were reported by observers in the region from 1993 to 2000 (USFWS 2002a). USFWS petitioned NMFS to add sea otters to their annual *List of Fisheries*, (NMFS 2000b) and in 2000, sea otters appeared a "species recorded as taken in this fishery" in the BSAI groundfish trawl (Angliss *et al.* 2001). The USFWS is currently pursuing information regarding the extent of that possible interaction. The total fishery mortality and serious injury for the Alaska sea otter is considered to be insignificant (i.e., will not affect population trajectories). The effects on sea otters under the FMP 1 are considered insignificant, with respect to incidental catch and entanglement in marine debris.

Fisheries Harvest of Prey Species

The effects of the groundfish fisheries on sea otters is limited by differences between their prey and the species targeted and taken as bycatch by the fisheries. Sea otters consume a wide variety of prey species, including annelid worms, crabs, shrimp, mollusks (e.g., chitons, limpets, snails, clams, mussels, and octopus), sea urchins, and tunicates. Occasionally, groundfish (e.g., sablefish, rock greenling, and Atka mackerel) may also be consumed but invertebrates are considered the predominant elements of their diet (Kenyon 1969, USFWS 1994). Given the minor importance of groundfish in their diet, fisheries removals under FMP 1 are not expected to have significant effects on the abundance of sea otter prey and are therefore determined to be insignificant for sea otters.

Spatial/Temporal Concentration of the Fishery

The grounds for suggesting competition for forage between sea otters and commercial fisheries is weak despite the species' broad geographical distribution in the GOA and the Aleutian Islands. Sea otters inhabit waters of the open coast, as well as the bays and inside passages of southeastern Alaska. Since their primary prey items are found on the bottom in the littoral zone, to depths of 50 m, the majority of otters feed within one km of the shore (Kenyon 1969). In areas where shallow waters extend far offshore (e.g., Unimak Island), sea otters have been reported as far as 16 km offshore. They are often seen resting and diving for food in and near kelp beds (Kenyon 1969). Because of this habitat preference for shallow areas, they do not overlap spatially with groundfish fisheries. Therefore, the effects of the spatial/temporal concentrations of the fisheries are insignificant for sea otters for all of the alternative management regimes.

Disturbance

As noted for many of the other marine mammals, the effects of disturbance caused by vessel traffic, fishing operations or sound production on sea otters in the BSAI/GOA are expected to be insignificant. Sea otters exhibit considerable tolerance for vessel traffic and in some cases are attracted to small boats passing by (Richardson *et al.* 1995). Sea otters may be more tolerant of underwater sound relative to other species, owing to the greater amount of time they spend at the surface. Similar levels of disturbance as that which occurred to sea otters under the baseline conditions is expected under the FMP 1 management regime. Therefore, according to the significance criteria established in Table 4.1-6, the effects of disturbance on sea otters under FMP 1 are considered insignificant.

Cumulative Effects

The past/present effects on the sea otter are described in Section 3.8.10 (Table 3.8-10) and the predicted direct and indirect effects of the groundfish fishery under FMP 1 are described above. The effects considered in this analysis are listed in Table 4.5-70. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The effects of incidental take and entanglement on sea otters under FMP 1 are considered insignificant.

- **Persistent Past Effects.** Commercial exploitation for pelts had a great impact on sea otters dating from the mid-1700s to the late 1800s, causing them to become nearly extinct (Bancroft 1959, Lensink 1962). Protective measures instituted in 1911 have allowed remnant groups to increase and reoccupy much of the historic sea otter range in Alaska (Kenyon 1969, Estes 1980). Residual effects from this early harvest likely persist in several areas. Alaska Natives have hunted sea otters for pelts and meat throughout history. Current harvest levels represent 9 percent of PBR for the southwestern stock, 15 percent of PBR for the southcental stock, and 35 percent of PBR for southeast stock. (USFWS 2002a, 2002b, and 2002c). In 1992, fisheries observers reported 8 sea otters taken incidentally by the Aleutian Island black cod pot fishery. During that year, only a third of the fisheries were observed, yielding an estimate of 24 otters killed in cod pot gear. No other sea otter takes were reported from observed fisheries in the range of the southwest stock from 1993 through 2000. In 1997, one sea otter was self-reported to be taken in the BSAI groundfish trawl fishery (USFWS 2002a, 2002b, and 2002c). Oils spills, such as the EVOS, can result in substantial mortality of sea otters. Sea otter numbers have declined dramatically from the Alaska Peninsula to the Bering Sea and this stock is being considered for listing under the ESA.

- **Reasonably Foreseeable Future External Effects.** Low levels of incidental take in commercial and subsistence fisheries, subsistence hunting, and periodic mortalities from oil spills are likely to continue in the future. Population-level effects from killer whale predation may continue in the southwest Alaska stock, depending on the recovery of alternate prey and behavior of whales.

- **Cumulative Effects.** The cumulative effects of mortality from all sources are different for different stocks of sea otters. The populations of the southeast and southcentral stocks of sea otters appear to be stable or increasing and are not expected to have additional mortality pressures in the future. These stocks are therefore considered to have insignificant cumulative effects from mortality. The rapid decline of the southwest Alaska stock does not appear to be the result of food shortages, disease, or toxic contamination and is likely the result of increased predation by killer whales following the collapse of their preferred sea lion prey population in the 1980s (Estes *et al.* 1998). Since the mechanism(s) of the population decline is still under investigation, the cumulative effect on the southwest stock is considered to be conditionally significant adverse.

Prey Availability

- **Direct/Indirect Effects.** The effects of the FMP 1 on sea otters are limited by differences between their prey and the fisheries harvest targets. As such, the effects of harvest of key prey species in groundfish fisheries are determined to be insignificant for sea otters.

- **Persistent Past Effects.** Groundfish fisheries have had little effect on the availability of prey in the past due to the limited overlap in prey species of the sea otter and the fish targeted by the groundfish fisheries. There is some minor overlap in state-managed crab fisheries and sea otter prey.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries that take crab from shallow waters were identified as external effects. The overlap primarily occurs in inshore areas or offshore areas with relatively shallow water.

- **Cumulative Effects.** The cumulative effect of prey availability is determined to be insignificant, based on both internal effects of the groundfish fisheries and external factors, such as the crab fisheries. This rating is due to the very limited overlap of these fisheries and the sea otter forage species, which is not likely to result in population-level effects.

Spatial/Temporal Concentration of the Fisheries

- **Direct/Indirect Effects.** The effects of the spatial/temporal concentrations of the fisheries are insignificant for sea otters for all of the alternative management regimes.

- **Persistent Past Effect.** The limited spatial overlap of groundfish fisheries and other fisheries in the past have limited their interaction with sea otter prey. Past effects of spatial/temporal concentration have likely been in very specific areas and associated with state-managed crab fisheries.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries are likely to continue into the future at a level similar to the baseline conditions.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey from the internal and external effects of fisheries is considered to be insignificant, due their limited spatial overlap with sea otter habitat. These fisheries are unlikely to have population-level effects.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance under FMP 1 are expected to be similar to the baseline, which do not appear to have population-level effects on sea otters, and are therefore expected to be insignificant.

- **Persistent Past Effects.** Past effects of disturbance are primarily related to fishing and other vessel traffic as well as from disturbance associated with subsistence harvest of sea otters.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue at a level similar to the baseline. Vessel traffic within sea otter habitat in future years would also be expected to be similar to the baseline.

- **Cumulative Effects.** Effects of disturbance of sea otters from internal and external sources is considered insignificant and unlikely to result in any population-level effects. The contribution of the groundfish fishery to the overall cumulative effect is minimal.

4.5.9 Socioeconomic Alternative 1 Analysis

4.5.9.1 Harvesting and Processing Sector

In general, the description of FMP 1 is a 5-year (2003-2007) projection of the Alaska groundfish fisheries under the management measures approved by the NPFMC through the June 2002 Council meeting. The model and analytical framework used in the analysis of the effects of FMP 1 on the harvesting and processing sectors are described in Section 4.1.7.

Model projections of ex-vessel value and product value for this FMP are based on 2001 prices and product mixes. Actual prices may rise or decline with levels of catch, changes in market conditions, or other factors. The use of 2001 product prices and product mixes may underestimate product value for the pollock fishery (particularly the inshore component) since average product value per unit of pollock catch is expected to rise as a result of continued increases in product quality and value made possible by the AFA cooperatives. Cooperatives were in place in the catcher processor sector by 1999 but were not implemented until 2000 for the inshore and mothership sectors.

Table 4.5-71 summarizes projected impacts of FMP 1 on harvesting and processing sectors. The numbers in the table reflect the 5-year average of outcomes projected for 2003 to 2007. Primarily as a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA compared to the baseline, harvests of this species are estimated to increase by about 30 percent, from 218 thousand mt to 285 thousand mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment and groundfish payments to labor.

4.5.9.1.1 Catcher Vessels

Direct/Indirect Effects of FMP 1

<u>Groundfish Landings by Species Group</u>

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 catcher vessel conditions reveals that under FMP 1 there would be few significant changes in overall retained harvests of groundfish relative to the comparative baseline (Table 4.5-71). As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, retained catches of this species are expected to increase by about 31 percent. In addition, an increase in the TAC for sablefish and rockfish (components of the Atka mackerel, rockfish, sablefish, other groundfish species [A-R-S-O] group) will result in a significant increase in the retained harvests of these species. These increases would result in a significantly beneficial effect in comparison to the baseline condition. Retained harvests of pollock and flatfish are not expected to change significantly.

<u>Ex-Vessel Value</u>

The total ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline but not significantly. Increased Pacific cod harvests by the smaller trawl catcher vessels and pot catcher vessels account for much of the increase in groundfish ex-vessel value. Longline vessels are expected to benefit from the increased catches of sablefish and rockfish.

<u>Employment and Payments to Labor</u>

Total groundfish employment and payments to labor by catcher vessels are expected to increase under FMP 1, but not significantly.

<u>Impacts on Excess Capacity</u>

No significant change in excess capacity is expected to occur under FMP 1 relative to the comparative baseline. This FMP would maintain current measures to reduce excess capacity and the race for fish in the

Alaska groundfish fisheries. Current measures that address overcapacity include the LLP, the sablefish longline fishery IFQ program, which includes provisions for community purchase of quota shares; the cooperatives established in the BSAI pollock fishery under the AFA, and the western Alaska CDQ program. These measures have been successful in limiting harvesting and processing capacity in Alaska groundfish fisheries, and further decreases in capacity in the BSAI pollock fishery and sablefish longline fishery are expected. However, no additional overcapacity measures would be implemented under this FMP. A recent report by Felthoven *et al.* (2002) indicates that significant excess capacity remains in several groundfish fisheries. This excess capacity and the use of the race for fish to allocate TAC and PSC limits among competing fishermen are expected to decrease the net benefits to the Nation from these fisheries. They are expected to do so by decreasing 1) retention rates; 2) product utilization rates; 3) product quality; and 4) the ability of harvesters and processors to take fuller advantage of seasonal demand for some seafood products, prevent seasonal market gluts, or take advantage of seasonal differences in product quality.

Average Costs

No significant change in average costs is expected to occur under FMP 1 relative to the comparative baseline. It can be assumed that the use of the race for fish to allocate TAC and PSC limits among competing fishermen in some fisheries will continue to lead to excessive fixed and variable harvesting costs in those fisheries. In addition, the existing area closures will continue to require smaller catcher vessels based out of the Alaska Peninsula, Aleutian Islands, and Kodiak communities to travel far to fish, thereby increasing transit time and operating costs. Existing bycatch reduction measures will continue to have some level of success in decreasing overall bycatch mortality but not without cost to some participants in the groundfish fisheries. Because of halibut PSC limits, portions of the annual TAC specified for most flatfish species have remained unharvested. Pacific herring PSC limits have repeatedly closed Herring Savings Areas 2 and 3 to trawl fisheries directed at pollock and rock sole, yellowfin sole, and other flatfish. Area closures for salmon and crab have also had adverse economic effects on some groundfish fisheries participants.

Fishing Vessel Safety

No significant change in fishing vessel safety is expected to occur under FMP 1 relative to the comparative baseline. The risk to fishermen is expected to remain high under this FMP. This is in part due to regulations that require fishermen to operate farther from shore or in areas and seasons with more hazardous weather conditions. In particular, the existing area closures will continue to require smaller catcher vessels based out of the Alaska Peninsula, Aleutian Islands, and Kodiak communities to travel far to fish, exposing the vessels to additional safety risks. The continued use of the race for fish to allocate TAC and PSC limits among competing fishermen in some fisheries is also expected to have an adverse effect on fishing vessel safety.

Cumulative Effects of FMP 1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety. Table 4.5-72 summarizes the cumulative effects for catcher vessels.

Groundfish Landings by Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are not expected to change significantly compared to the baseline except for Pacific cod which is expected to increase by about 31 percent with a significantly beneficial effect in comparison to the baseline condition.

- **Persistent Past Effects.** Foreign fisheries were the first to exploit specific fish stocks and develop commercial fisheries and markets for the products; in the course of doing so, many fisheries were over-harvested, with long-term effects on stocks and the sustainable yield of specific fisheries. Foreign vessels also began using Alaska ports for services, which led to the expansion or development of commercial services and marine infrastructure in many coastal communities. Development of joint venture fisheries led to the development of domestic fish harvesting and processing capacity, through foreign and domestic investment in harvesting and processing infrastructure. Increased global demand for seafood, especially whitefish, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. For more detail on persistent past effects, please see the Catcher Vessels Past/Present Effects Table 3.9-125.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail below.

  Many of the harvesters and processors that participate in the groundfish fishery also participate in other fisheries such as the salmon, halibut, crab, and halibut fisheries. These other fisheries provide opportunities for harvesters and processors to intercept or otherwise affect groundfish stocks and harvest quotas, and provide other sources of employment and tax revenue for local communities. Activities with these fisheries may offset or exacerbate the effects from groundfish management alternatives, in both the harvesting and processing sectors. The fisheries that have the greatest potential for cumulative effects are crab (tanner and king), salmon, halibut, and state groundfish fisheries. Several classes of catcher vessels and inshore processors currently participate in these fisheries to a certain degree, and rely on the combined harvest from these fisheries. In several communities, the processing sector handles a range of products (e.g., groundfish, crab, and salmon); in other communities they are more specialized, focusing on one or two products. Where groundfish is a primary or secondary product line, a significant, long-term decrease (as compared to cyclical) in groundfish availability could jeopardize the economic viability of harvesting and processing other fish. Given projected closures and reductions in commercial crab fisheries, and the likely continuation (or further reductions) of salmon caps, some participants in these fisheries are likely to experience adverse cumulative effects. These other fisheries also affect consumer values; their product availability provides net benefits to domestic seafood consumers. However, the extent and intensity of these other fisheries can adversely affect non-consumptive and non-use values by contributing to the actual and perceived level of fishing activities in the BSAI and GOA.

  Other economic development activities may interfere with or compete for labor, services, and facilities; or provide additional employment and revenue opportunities for local communities. Direct and indirect employment opportunities associated with economic developments may offset or exacerbate the effects from groundfish management alternatives. In addition, employment opportunities directly affect the population of a community or region, and increase demand for municipal services and population based revenue sharing (such as education). The economic development activities that have the greatest potential for cumulative effects are state and federal oil and gas exploration/production (primarily potential exploration activities in Cook Inlet and potentially Dutch Harbor), military projects (contaminated site clean-up and missile defense projects in the Alaska Peninsula and Aleutian Islands), Kodiak rocket launch complex, tourism, and construction and operation of marine or air-related transportation projects. Such economic activities may offset short-term declines in fisheries, but are not likely to substitute for long-term declines, particularly where regional and community economies depend on fishing. In addition, economic development in coastal Alaskan communities, particularly in the Aleutian Islands and Alaska Peninsula, may be adversely affected by the designation of critical habitat for Steller's eider and Steller sea lions. This issue is already affecting construction of marine infrastructure projects and may affect other coastal activities.

Other sources of municipal and state revenue help fund local facilities and services. Within Alaska, regions and communities participating in the fishing industry generate revenue or receive revenue sharing from taxes on fishing (in some cases over 99 percent), and from non-fishing sources. Changes in these revenue streams may offset or exacerbate the effects from groundfish management alternatives. Changes in revenue streams also may affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt. The programs that have the greatest potential for cumulative effects are landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut), power cost equalization subsidies, and municipal revenue sharing programs from the State of Alaska (including shared education funding). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing.

Other factors could affect price and demand for groundfish, such as the rising U.S. dollar relative to currencies of countries with high levels of groundfish imports, and adverse effect on ex-vessel values of all vessels and processors, or higher or lower global harvests of fish/seafood and fish inventories that could serve as substitutes for groundfish. Similarly, there is a link between availability of seafood industry jobs and population levels in Alaska coastal communities. These factors are difficult to predict and are not considered in this analysis.

- **Cumulative Effects.** Given the current downward trends in the commercial salmon and crab fisheries, catcher vessels that rely on a mix of groundfish, salmon and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under FMP 1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (49 percent), as well as for sablefish and rockfish. Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under FMP 1. Area closures and harvest limits in other fisheries can have an impact on the groundfish fisheries; however, under FMP 1 this impact is not likely to be significant. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline but not significantly. It is expected to increase 9 percent to approximately $317 million.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings by Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings by Species Group.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in ex-vessel value (10 percent) that are predicted for FMP 1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from FMP 1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Overall, the change in employment is not significant. A slight increase in employment is predicted (14 percent) and is likely the result of the increase in Pacific cod harvests and ex-vessel value. Similarly, a slight increase in payments to labor is expected (10 percent), but is not significant.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings by Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (14 percent) under FMP 1, is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (10 percent) under FMP 1 thereby mitigating some of the reductions in other fisheries. Employment and payments to labor in the salmon fisheries have been in decline in recent years and have had serious adverse effects on the fishing industry. Any reductions in the groundfish fisheries may further exacerbate this effect. However, as employment and payments to labor are not expected to change significantly under FMP 1 from the baseline, insignificant effects are likely.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** No significant changes in excess capacity are expected under FMP 1 relative to the baseline. Current measures to reduce excess capacity and the race for fish would be maintained. For further details, please refer to the direct/indirect section at the beginning of Section 4.5.9.1.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings by Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings by Species Group.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under FMP 1, no significant cumulative effects are expected for excess capacity as conditions are not expected to change substantially from the baseline.

Average Costs

- **Direct/Indirect Effects.** No significant change in average costs are expected under FMP 1 relative to the comparative baseline. It is assumed that the continued race for fish to allocate TAC and PSC limits among competing fishermen will lead to fixed and variable harvesting costs. FMP 1 measures are not expected to alter the effects of closure areas, bycatch restrictions, and PSC limits significantly from baseline conditions. More detail on average costs can be found at the beginning of this section.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings by Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings by Species Group.

- **Cumulative Effects.** Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Area closures also affect average costs through increases or decreases in transit time to fishing areas. Increases in closure areas increase costs, whereas decreases in closures usually decrease costs. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with average costs in the groundfish fishery, significant cumulative effects may result. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. As FMP 1 closures do not change substantially from the baseline condition, cumulative effects on average costs in the groundfish fisheries are expected to be insignificant.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Risks to fishermen are expected to remain high under FMP 1 though this is not a significant change from the baseline condition. Regulations that require fishermen to operate farther from shore and in areas or seasons with severe weather conditions continue to have an adverse effect on vessel safety.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings by Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings by Species Group.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, distance to fishing areas, and sea conditions, relative to vessel size. Additional closures that may result from other fisheries management measures may increase the risk to fishermen, however, these effects are not expected to be significant under FMP 1. As there are no predicted increases in area closures under FMP 1, cumulative effects on vessel safety are insignificant compared to the baseline condition.

4.5.9.1.2 Catcher Processors

Direct/Indirect Effects of FMP 1

Groundfish Landings by Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 catcher processor conditions reveals that under FMP 1 there would be few significant changes in overall groundfish catches relative to the comparative baseline (Table 4.5-71). As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 24 percent and could have a significantly beneficial effect in comparison to the baseline condition. Catches of pollock, flatfish, and Atka mackerel, rockfish, sablefish, and other groundfish (A-R-S-O) species are not expected to change significantly.

Groundfish Gross Product Value

The total wholesale product value of groundfish outputs of catcher processors is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by head-and-gut trawl catcher processors, longline catcher processors and pot catcher processors account for much of the increase in product value. The harvest of Pacific cod by surimi trawl catcher processors and fillet trawl catcher processors is limited by AFA sideboard measures that restrict the participation of AFA-eligible vessels in other groundfish fisheries to some level of historic participation.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under FMP 1, but not significantly.

Product Quality and Product Utilization Rate

No significant change in overall product quality or product utilization rate is expected to occur under FMP 1 relative to the comparative baseline. The product value for the BSAI pollock fishery is expected to continue to increase with the predicted rise in average product value per unit of pollock catch resulting from increases in product quality made possible by the AFA cooperatives and the end of the race for fish. The end of the race for fish is also expected to lead to further increases in product utilization rate, leading to more product per unit of fish caught. Processors that are able to generate more product from a given amount of pollock are likely increase to their gross revenue. However, the continued use of the race for fish to allocate TAC and PSC limits among competing fishermen in other groundfish fisheries is expected to result in unnecessarily low product values by decreasing product quality and utilization rates.

Excess Capacity

As with catcher vessels, no significant change in excess capacity is expected to occur under FMP 1 relative to the comparative baseline.

Average Costs

As with catcher vessels, no significant change in average costs is expected to occur under FMP 1 relative to the comparative baseline.

Fishing Vessel Safety

As with catcher vessels, no significant change in fishing vessel safety is expected to occur under FMP 1 relative to the comparative baseline.

Cumulative Effects of FMP 1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety. See Table 4.5-73 for a summary of the cumulative effects.

Groundfish Landings by Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are not expected to change significantly compared to the baseline, except for Pacific cod, which is expected to increase by about 24 percent with a significantly beneficial effect in comparison to the baseline condition.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1 above.

- **Cumulative Effects.** Similar to the effects experienced by catcher vessels, catcher processors that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under FMP 1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (24 percent), though it is not significant. Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under FMP 1. Area closures and harvest limits in other fisheries can have an impact on the groundfish fisheries; however, under FMP 1 this impact is not likely to be significant. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase from the baseline, but not significantly.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1 Groundfish Landings by Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on wholesale product value and landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (4 percent) that are predicted for FMP 1 may mitigate some of the declines in other fisheries. Overall, insignificant cumulative effects on ex-vessel value are expected to result from FMP 1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Insignificant effects are predicted for catcher processors under FMP 1.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1 Groundfish Landings by Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Employment and payments to labor in the salmon fisheries have been in decline in recent years and have had serious adverse effects on the fishing industry. Any reductions in the groundfish fisheries may further exacerbate this effect. The increase, although slight, in groundfish employment (5 percent) under FMP 1, may mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (5 percent) under FMP 1. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under FMP 1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** No significant changes in product quality or utilization rate are expected under FMP 1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, the continuation of this harvest strategy may hinder some of these improvements. Overall, increases in product quality and utilization are likely in the long-term though these improvements are not likely to result in significant cumulative effects under FMP 1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** No significant changes in excess capacity are expected under FMP 1 relative to the baseline. Current measures to reduce excess capacity and the race for fish would be maintained.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** As with catcher vessels, excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under FMP 1, insignificant cumulative effects are expected for excess capacity as conditions are not expected to change significantly from the baseline.

Average Costs

- **Direct/Indirect Effects.** No significant change in average costs are expected under FMP 1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** Average costs in the groundfish fisheries are often associated or shared with other fisheries. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. Recent decreases in government subsidies, educational loan programs, and power cost sharing have indirectly increased pressure to implement or increase fish taxes as communities look for other sources of revenue. Although this can increase average costs, this effect is not expected to be significant under FMP 1. As FMP 1 closures do not change significantly from the baseline condition, cumulative effects on average costs in the groundfish fisheries are expected to be insignificant. For more details on this discussion please refer to Section 4.5.9.1.

Fishing Vessel Safety

- **Direct/Indirect Effects.** No significant change in fishing vessel safety is expected under FMP 1.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings by Species Group.

- **Cumulative Effects.** As described under the catcher vessel section above, vessel safety is primarily a function of the race for fish, distance to fishing areas, and sea conditions, relative to vessel size. As there are no predicted increases in area closures under FMP 1, cumulative effects on vessel safety are insignificant compared to the baseline condition.

4.5.9.1.3 Inshore Processors and Motherships

Groundfish Landings by Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 inshore processor and mothership conditions reveals that under FMP 1 there would be few significant changes in overall groundfish catches relative to the comparative baseline (Table 4.5-71). As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 45 percent. In addition, an increase in the TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant increase in the retained harvests of these species. These increases have significantly beneficial effects when compared to the baseline condition. Retained harvests of pollock and flatfish are not expected to change significantly.

Groundfish Gross Product Value

The wholesale product value of groundfish processed by inshore processors and motherships is expected to increase relative to the comparative baseline, but not significantly. Increased deliveries of Pacific cod to Bering Sea pollock shore plants, Alaska Peninsula and Aleutian Islands shore plants, Kodiak shore plants, and floating inshore processors account for much of the increase in groundfish product value. Southeast Alaska shore plants and southcentral Alaska shore plants are expected to benefit from the increased catches of sablefish and rockfish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore processors and motherships are expected to increase under FMP 1, but not significantly.

Product Quality and Product Utilization Rate

As with catcher processors, no significant change in overall product quality or product utilization rate is expected to occur under FMP 1 relative to the comparative baseline.

Excess Capacity

As with catcher vessels and catcher processors, no significant change in excess capacity is expected to occur under FMP 1 relative to the comparative baseline.

Average Costs

As with catcher vessels and catcher processors, no significant change in average costs is expected to occur under FMP 1 relative to the comparative baseline.

Cumulative Effects of FMP 1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety. See Table 4.5-74 for a summary of the cumulative effects.

Groundfish Landings by Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are not expected to change significantly compared to the baseline, except for Pacific cod, which is expected to increase by about 45 percent with a significantly beneficial effect in comparison to the baseline condition.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Processors that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. However, as with catcher vessels, and with catcher processors, this cumulative effect may not result in significant changes in groundfish landings under FMP 1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (45 percent), as well as minor increases for flatfish and certain species in the A-R-S-O complex. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under FMP 1. Area closures and harvest limits in other fisheries can have an impact on the groundfish fisheries; however, under FMP 1 this impact is not likely to be significant. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations or diversity, as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase from the baseline but not significantly.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in wholesale value that are predicted for FMP 1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on gross product value are expected to result from FMP 1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Insignificant effects are predicted for catcher processors under FMP 1.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Employment and payments to labor in the salmon fisheries have been in decline in recent years and have had serious adverse effects on the fishing industry. Any reductions in the groundfish fisheries may further exacerbate this effect. The increase, although slight, in groundfish employment (8 percent) under FMP 1, is likely to mitigate some of the current reductions in other fisheries as described in Section 4.5.9.1. Similarly, payments to labor are also projected to increase slightly (8 percent) under FMP 1. Cumulative effects on employment and payments to labor are expected to be insignificant under FMP 1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** No significant changes in product quality or utilization rate are expected under FMP 1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, the continuation of this harvest strategy may hinder some of these improvements. Overall, increases in product quality and utilization are likely in the long-term, though these improvements are not likely to result in significant cumulative effects under FMP 1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** No significant changes in excess capacity are expected under FMP 1 relative to the baseline. Current measures to reduce excess capacity and the race for fish would be maintained.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** As with catcher vessels and catcher processors, excess capacity still remains in other fisheries as well as the groundfish fishery. Measures such as the LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under FMP 1, insignificant cumulative effects are expected for excess capacity.

Average Costs

- **Direct/Indirect Effects.** Insignificant changes in average costs are expected under FMP 1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects, please refer to the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section, Groundfish Landings by Species Group.

- **Cumulative Effects.** As described in more detail in Section 4.5.9.1, average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Area closures also affect average costs through increases or decreases in transit time to fishing areas. As FMP 1 closures do not change significantly from the baseline condition, cumulative effects on average costs in the groundfish fisheries are expected to be insignificant.

4.5.9.2 Regional Socioeconomic Effects

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past and present effects on regions that participate in the groundfish fishery are described in Section 3.9 (and summarized in Table 3.9-126) and below; these regions (illustrated in Figures 3.9-9 through 3.9-13) include the Aleutian Islands/Alaska Peninsula (comprised of the Aleutians East Borough and the Aleutians West Census Area, which includes the communities of Unalaska, Nikolski, Atka, Adak and the Pribilof Islands), Kodiak Island (Kodiak Island Borough, which includes the City of Kodiak) southcentral Alaska (the Kenai Peninsula Borough, Matanuska-Susitna Borough, Municipality of Anchorage, and the Valdez-Cordova Census Area, which includes the PWS region), southeast Alaska (all of the southeastern part of the state, from Yakutat Borough to Dixon Entrance), Washington inland waters (all counties bordering Puget Sound and the Strait of Juan de Fuca), and Oregon coast (Lincoln, Tillamook, and Clatsop counties, the three northernmost Oregon coastal counties). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case.

Changes in the management of the groundfish fisheries can affect regions and the communities within the BSAI and GOA in two major ways. The first category of effects, which drives the second category, are direct/indirect/cumulative impacts on segments of the fishing industry within a specific region. Potential effects of management changes on industry segments (processors, catcher processors, catcher vessels) have been analyzed in the previous section for FMP 1. Depending on where these industry segments are owned and operated, a variety of revenue (ex-vessel value, product value) and expenditure (wages, purchase of goods and services, taxes and fees) effects occur and accrue to specific regions. Because many of the segments participate in multi-species fisheries (such as salmon, crab, and halibut), the combination of potential effects from groundfish combines with effects in other fisheries, resulting in cumulative effects. Regional activities and accrual of revenues and expenditures drives effects on regional economies (including direct/indirect/induced employment and income), public revenue (local and state taxes and service charges), and to a certain degree, population and other socioeconomic characteristics.

Due to the linkages of potential effects on regions that participate in the groundfish fishery, to changes in harvest and processing levels under each of the policy alternatives and illustrative bookends, the direct and indirect effects of each alternative are based on an economic model that distributes potential effects to each of the participating regions. The representative indicators used in this analysis are based on types data that can be collected and modeled in a manner that assigns potential effects to each of the six regions. In turn, these indicators have implications and, in many cases are indicative of effects on other community characteristics that are more difficult to model, such as municipal revenue, generation and support of secondary employment and economic activity, and potential effects on population. Potential effects are assigned by the predictive model to the region where processors and catcher vessels are located. Indicators used to assess potential effects of the alternatives and their implications are briefly described below:

In-Region Processing and Related Effects. Shore-based processors are closely tied to the region in which they are located. Much of the tax revenue generated through fish landed and processed accrues locally. While much of the processing employment is non-resident, processing activity generates demand for goods and services and stimulates secondary employment and economic development activity.

Regionally Owned At-Sea Processors. At-sea processors are tied to the region in which they are based. It is assumed that the majority of employment and tax revenue benefits also accrue to the region in which they are based, along with secondary economic activity. However, while not captured in the model, at-sea processors generate revenue and secondary economic development activity when purchasing goods and services in Alaskan ports such as Unalaska and Kodiak.

Extra-Regional Deliveries of Regionally Owned Catcher Vessels. When catcher vessels deliver their catch outside their region, they bring their earnings back into the region where they are located. These earnings translate into secondary employment and economic activities in the communities where catcher vessels are located, and are captured under the direct/indirect/induced labor and income projections.

In-Region Deliveries of Regionally Owned Catcher Vessels. When catcher vessels deliver within the region they are located, their earnings are counted as expenditures to the processors to which they deliver. While these earnings are not additive, catcher vessels delivering in-region generate secondary employment and economic activities in the communities where catcher vessels are located, and are captured under the direct/indirect/ induced labor and income projections.

Total Direct, Indirect, and Induced Labor Income and FTE Employment. This indicator measures the amount of employment by region, generated by the groundfish fishery.

For more information on the economic model used to assess direct and indirect regional effects, please refer to the economic model methodology described in Section 4.1.7 of the document.

Direct/Indirect Effects of FMP 1

FMP 1 extends the management practices and trends associated with current management of the groundfish fishery. Under FMP 1, in general there is a net overall increase in fishery socioeconomic indicator values over baseline conditions for all regions, although there is a good deal of variation the degree of increase between regions (and both increases and decreases in individual indicators within specific regions). The change in total value of processing sales (combining in-region shore processors and regionally owned at-sea processors) was beneficial, although not significant in comparison to baseline conditions. Similarly, changes in total income and total employment (combining values for in-region shore processors, regionally owned at-sea processors, and regionally owned catcher vessels) were also beneficial, but not significant under FMP 1. For the more western Alaska regions, these overall changes result from increases in Pacific cod take in both the GOA (to a lesser extent) and BSAI (to a greater extent). Within the Alaska Peninsula and Aleutian Islands region, the largest gains from the Pacific cod increases are seen in the larger shore processors. (Some decreases in variables associated with catcher vessels were seen in this region, but those are assumed to primarily be associated with a model attribution difficulty for western GOA fisheries.) For the Kodiak Island region, the change from the baseline is largely explained by changes in Pacific cod numbers, but floating processors also benefit from sablefish associated gains. For the southcentral and southeast Alaska regions, changes in A-R-S-O, driven primarily by rockfish and sablefish, account for a good deal of the change from the baseline. These benefits are concentrated among the smaller vessel sectors, while vessels in the medium size classes also benefit from gains associated with cod. Net regional gains in the Washington inland waters region are largely associated with increases in cod as well. The following subsections provide a region-by-region summary of change under FMP 1 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 1, total in-region groundfish processing value would increase, but not by a significant amount (with increases in the BSAI portion somewhat offset by decreases in the much smaller GOA portion of the total). In-region processing associated labor income and FTE jobs would also increase, but by less than a significant amount. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would increase in percentage terms, but this is a very small sector in this region, with a negligible impact on a regional basis. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease, with relatively large decreases seen for in-region deliveries, but again this is understood to be in large part an artifact of the modeling output, so these decreases are considered less than significant. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would decrease but by a less than significant amount. For in-region deliveries, catcher vessel payments to labor and FTEs would both appear to decrease by a significant amount, but as with delivery data, this is considered to be an apparent rather than a real decrease. For both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. (Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes.) The total regional direct, indirect, and induced labor income and FTE employment would increase under this FMP, but by less than a significant amount (from a base of $226 million in labor income and 4,796 FTEs). FMP 1 is considered to result in largely beneficial, but less than significant impacts for the region as a whole.

Kodiak Island. Total in-region groundfish processing value would increase by about 23 percent under this FMP (with higher values for both BSAI and GOA, but BSAI values are not a significant portion of the regional total). Associated labor income and FTE jobs would also increase by 23 percent. Regionally owned at-sea processing value would increase, but by less than a significant amount (with the vast majority of the increase attributable to changes in BSAI values), and associated labor income and FTEs would both increase to about the same degree. (In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total; labor income and FTEs distribution between these processing sectors follow a similar pattern.) The value of extra-regional deliveries would increase, but not significantly, while in-region deliveries by regionally owned catcher vessels would increase by about 30 percent. Catcher vessel payments to labor increases would be beneficial, but less than significant, while FTE jobs associated with extra-regional deliveries would increase by about 25 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 30 and 23 percent, respectively, but over a smaller base than seen for extra-regional deliveries. On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income and FTE employment would both increase by about 21 percent under this FMP (from a base of $66 million in labor income and 1,600 FTEs). FMP 1 has consistently beneficial impacts for the Kodiak Island region, with some significantly beneficial impacts on both a local sector and regional (or community) basis.

Southcentral Alaska. Total in-region groundfish processing value would increase by 35 percent (all attributable to GOA increases). Associated labor income and FTE jobs would also increase by 35 percent. Regionally owned at-sea processing value would increase, but by a less than significant amount (with both BSAI and GOA values increasing), and associated labor income and FTEs both increasing by a similar amount. (In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by 30 and 58 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would increase by about 30 and 32 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 58 and 68 percent, respectively. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase by about 31 percent and FTE employment would increase by about 33 percent (from a base of $23 million in labor income and 567 FTEs). FMP 1 has consistently beneficial impacts for the southcentral Alaska region, with some significantly beneficial impacts on both a local sector and regional (or community) basis, although a relatively low level of groundfish dependency in local economies within this region tends to lessen what would otherwise appear to be a relatively large overall impact.

Southeast Alaska. Total in-region groundfish processing value would increase marginally (all attributable to GOA increases), as would associated labor income and FTE jobs (but both remain relatively small values). Regionally owned at-sea processing value would increase (with increases in BSAI values offset to a degree by declines in GOA values) as would associated labor income and FTEs, but none of these increases would rise to the level of significance. (In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would increase somewhat (but by less than a significant amount), and in-region deliveries by regionally owned catcher vessels would remain about the same. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would increase; for in-region deliveries, catcher vessel payments to labor would remain the same and FTEs would also increase but while all of these changes are beneficial, none are large enough to be considered significant. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income and FTE employment would increase, but not by amounts considered significant (from a base of $34 million in labor income and 879 FTEs). FMP 1 has consistently beneficial impacts for the southeast Alaska region, but none of these impacts are considered significant on a local sector or regional basis.

Washington Inland Waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase (with increases in BSAI offset somewhat by decreases in GOA values, although GOA values are comparatively very small), and associated labor income and FTEs would increase as well, but none of these changes rise to the level of significance. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase, but by relatively small amounts. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would also increase, but by less than significant amounts. Similarly, for in-region deliveries, catcher vessel payments to labor and FTEs would both increase, but by less than significant amounts. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase, as would FTE employment (from a base of $557 million in labor income and 10,316 FTEs), but these increases are not large enough to be considered significant. FMP 1 has consistently beneficial impacts for the Washington inland waters region, but none of these impacts are considered significant on a local sector or regional basis.

Oregon Coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase, as would associated labor income and FTE jobs, but the amounts of these increases are considered less than significant. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this FMP. The total regional direct, indirect, and induced labor income would increase, as would FTE employment (from a base of $15 million in labor income and 318 FTEs), but none of these increases are considered significant. FMP 1 has consistently beneficial impacts for the Oregon coast region, but none of these impacts are considered significant on a local sector or regional basis.

Cumulative Effects of FMP 1

See Table 4.5-75 for a summary of the cumulative effects on regions and communities under FMP 1.

In-Region Processing and Related Effects

- **Direct/Indirect Effects.** Direct/indirect effects are considered insignificant for the Alaska Peninsula/ Aleutian Islands, southeast Alaska, Washington inland waters, and Oregon coast regions; effects on Kodiak Island and southcentral Alaska are considered significantly beneficial. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These effects are summarized below:

  Fishing trends and developments such as allocation of groundfish between inshore and offshore processors, establishment of the CDQ program, and passage of the American Fisheries Act have established the current involvement of regions and communities in the fishery. The domestic groundfish fisheries have matured to provide significant contributions to regional economies. The economies of the Alaska Peninsula/Aleutian Islands and Kodiak Island regions are heavily dependent on fishing and groundfish in particular; the economies of the other Alaskan, Washington, and Oregon regions are more diversified, and fishing provides a significantly smaller contribution to these regions.

Municipal and State Revenues: Taxes on groundfish landed and processed have become a significant source of shared revenue to local municipalities and the State of Alaska, and have contributed to municipal revenue amounts ranging from $1.3 million in the Kodiak Island region to over $7 million in the Alaska Peninsula and Aleutian Islands. Several municipalities also have fuel transfer taxes where vessels participating in the groundfish fishery generate local revenue. Furthermore, real and personal property tax on both onshore processing facilities and fishing vessels generate additional revenues for specific municipalities. Revenues directly resulting from local landings or groundfish processing are not the primary basis for local taxation in the southcentral and southeast Alaskan regions, although both received shared fish tax revenue from the state. Communities also rely on fish tax from the halibut, salmon, and crab fisheries. Downturns and closures in the latter two fisheries have resulted in loss of revenue for many communities in the three years. Revenue sharing from the State of Alaska to municipal government, through programs such as Power Cost Equalization and capital facility construction funds, have also been decreasing in recent years, forcing communities to rely more on local sources of revenue. The availability of state and local revenue has funded public services, and construction of public facility and infrastructure projects, generating local income and employment.

- **Reasonably Foreseeable Future Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are summarized below:

  Other state and federal fisheries, which may provide other fishing opportunities to vessels and processors participating in the groundfish fishery, intercept or otherwise affect groundfish stocks and harvest quotas, and provide other sources of employment and tax revenue for local communities. Activities associated with these fisheries may offset or exacerbate the effects from groundfish management alternatives, in both the harvesting and processing sector. The fisheries that have the greatest potential for cumulative effects are crab (tanner and king), salmon, halibut, and state groundfish fisheries; herring and scallops interact to a lesser degree. Several classes of catcher vessels and inshore processors currently participate in these fisheries to a certain degree, and rely on the combined harvest from these fisheries. However, entry of additional vessels into the salmon and halibut fisheries is currently limited by permit; participation in the crab fisheries is limited by vessel size, gear requirements, and license to participate in the fishery. In several communities, the processing sector handles a range of product (groundfish, crab and salmon); in other communities they are more specialized, focusing on one or two products. Where groundfish is a primary or secondary product line, a significant decrease in groundfish availability could jeopardize the economic viability of processing other fish.

  Projected closures and/or rationalization of quota for commercial crab fisheries may adversely affect fishery participants in specific communities, particularly depending on what years of fishery participation are chosen as the qualifying years to determine eligibility and quota. It may also adversely effect service suppliers in the short-term that are currently geared for meeting peak demands created by the race for fish. Given the projected continuation in reduced demand and prices for Alaskan salmon, some participants in these fisheries are experiencing significantly adverse effects, as are communities that rely on the salmon fishery for employment and income, secondary economic activity, and municipal revenue. The halibut fishery has been relatively stable in terms of stock size and price; this stability is expected to continue. Changes in state groundfish quotas could have beneficial or adverse effects on vessels and processors, depending on the alternative.

Other economic development activities may interfere with or compete for labor, services, and facilities; or provide additional employment and revenue opportunities for local communities. Direct and indirect employment opportunities associated with economic developments may offset or exacerbate the effects from groundfish management alternatives. In addition, employment opportunities directly affect the population of a community or region, and increase demand for municipal services and population based revenue sharing (such as education). The economic development activities that have the greatest potential for cumulative effects are oil and gas exploration and production (primarily potential exploration activities in Cook Inlet, and potentially out of Dutch Harbor), military projects (contaminated site clean-up and missile defense projects in the Alaska Peninsula and Aleutian Islands), tourism, and construction of public marine or air-related transportation projects. Reduced levels of state and municipal funding is having an adverse effect on employment and support activities that are typically created by public projects, particularly in Alaska.

Other sources of municipal and state revenue may help fund construction and operation of local facilities, and provide services. Within Alaska, regions and communities participating in the fishing industry generate revenue or receive revenue sharing from taxes on fishing (in some cases over 99 percent), and from non-fishing sources. The level of income differs depending whether or not municipal governments levy a raw fish tax on ex-vessel value landings, or tax fuel transfer or other fisheries related services. Changes in these revenue streams may offset or exacerbate the effects from groundfish management alternatives. Changes in revenue streams may affect the communities' ability to provide municipal services, fund capital projects, borrow money, and retire debt service. The programs that have the greatest potential for cumulative effects are revenues from landing taxes on non-groundfish fisheries (such as salmon, crab, and halibut), power cost equalization, and municipal revenue sharing programs from the State of Alaska (including shared education funding). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. The dramatic downturn in the salmon industry, coupled with state budget cuts to address a deficit are likely to continue to adversely affect many Alaskan coastal communities.

Other natural factors may affect the productivity of groundfish and other fisheries upon which regions and communities depend. These factors would include short-term cyclic changes and long-term climate changes.

- **Cumulative Effects.** Cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. The influence of external factors is adverse for the most part, which offset increases in in-region processing. The exception occurs in portions of the Alaska Peninsula, where increases in processing due to gains in Pacific cod are overshadowed by external factors. Trends in multi-species fisheries and other sources of municipal and state revenue, primarily due to the downturn in salmon and reductions in state and municipal revenue, result in conditionally significant adverse effects on in-region processing and municipal revenue. The Kodiak and southeast Alaska region is experiencing similar declines in the salmon industry and municipal revenues; however, with a more diversified economy and larger population base, adverse effects are not as severe, and are considered insignificant.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** Direct /indirect effects are considered insignificant for all six regions. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. At-sea processors are affected by changes that have occurred in the groundfish industry related to allocation, and by their participation in multi-species fisheries. However, participation in multi-species fisheries is low compared most Alaskan at-sea processors. As the majority of at-sea processors are owned by Washington State residents, tax revenue generated is not as significant a factor on a local or regional basis.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. Given the limited participation in multi-species fisheries and the relatively diversified economy in Washington, where the majority of at-sea processors are based, external reasonably foreseeable future affects are not likely to have much of a contribution to cumulative effects.

- **Cumulative Effects.** Cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. Direct/indirect effects are insignificant for all regions. Reasonably foreseeable external effects will not contribute much to cumulative effects, except in Kodiak, where most of the Alaska at-sea processor fleet is based. As indicated previously, with a more diversified economy and population base, cumulative effects will be insignificant.

Extra-Regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Direct/indirect effects are insignificant for the Alaska Peninsula/ Aleutian Islands, Kodiak Island, southeast Alaska, Washington inland waters, and Oregon coast regions; effects on southcentral Alaska are considered significantly beneficial. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under In-Region Processing.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail, see the discussion of persistent past effects under In-Region Processing.

- **Cumulative Effects.** Extra-regional deliveries of regionally owned catcher vessels decrease but are considered to be cumulatively insignificant; vessels that participate in multi-species fisheries such as crab and salmon, may experience conditionally significant adverse cumulative effects, and are primarily based out of the Alaska Peninsula/Aleutian Islands and Kodiak. Reductions in state and municipal revenue, and limits on other economic development activity besides fishing are likely to further contribute to cumulative adverse effects in the Alaska Peninsula and Aleutian Islands.

<u>In-Region Deliveries of Regionally Owned Catcher Vessels</u>

- **Direct/Indirect Effects.** Direct indirect effects are insignificant for the Alaska Peninsula/Aleutian Islands, southeast Alaska, Washington inland waters, and Oregon coast regions; effects on southcentral Alaska and Kodiak Island are considered significantly beneficial. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under In-Region Processing.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities., other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators, for all alternatives.

- **Cumulative Effects.** In-region deliveries of regionally owned catcher vessels are likely to decrease, but are considered to be cumulatively insignificant; vessels that participate in multi-species fisheries such as crab and salmon may experience conditionally significant adverse cumulative effects, and are primarily based out of the Alaska Peninsula/Aleutian Islands and Kodiak. Reductions in state and municipal revenue and limits on other economic development activity besides fishing are likely to further contribute to cumulative adverse effects in the Alaska Peninsula and Aleutian Islands.

<u>Total Direct, Indirect, and Induced Labor Income and FTE's</u>

- **Direct/Indirect Effects.** Direct, indirect, and induced labor income and employment is likely to increase for all regions. Significant increases are expected for Kodiak Island and southcentral Alaska. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under In-Region Processing.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators, for all alternatives.

- **Cumulative Effects.** Direct, indirect, and induced labor income and employment is likely to increase in all regions, including a significant increase for Kodiak Island and southcentral Alaska. Within Washington and Oregon, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Trends in other fisheries (particularly salmon) and reductions in municipal revenue decrease labor income and employment, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects are insignificant in most regions, except in the Alaska Peninsula and Aleutian Islands, where cumulative effects are conditionally significant adverse.

4.5.9.3 Community Development Quota Program

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past and present effects on CDQ are described in Section 3.9 (Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case (Table 4.5-76). The representative indicator used in this analysis is the allocation of catch to CDQ groups. It should be noted that the allocation reflects potential revenue to CDQ groups, and indirectly the potential funds that are available for approved economic development activities in CDQ communities.

Direct/Indirect Effects of FMP 1

Under this FMP, 7.5 to 10 percent of all BSAI groundfish quotas would continue to be apportioned under the CDQ program to the 65 eligible western Alaska communities through the established CDQ groups. It is assumed that the multi-species CDQ program and quotas would continue as well. Under this FMP, TAC increases, so no adverse impacts to the CDQ program or regions are anticipated.

Cumulative Effects of FMP 1

Cumulative effects on CDQ for FMP 1 are summarized in Table 4.5-76.

<u>CDQ Allocations</u>

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 1 on the CDQ program are insignificant.

- **Persistent Past Effects.** The past/present effects on the CDQ program for groundfish fisheries occur within the BSAI coastal region. Management actions taken include: persistent limitations on economic development and associated employment activities; 1992 CDQ program established during inshore/offshore pollock fishery allocation process; 1995 BSAI halibut and sablefish CDQ implemented (7.5 percent of TAC); 1996 program incorporated into MSA; 1998 AFA increased

CDQ pollock allocation to 10 percent of TAC, initial pollock allocation set at 7.5 percent of TAC; and 1998 multi-species groundfish CDQ program implemented (7.5 percent of TAC). The comparative baseline statement for CDQ includes the 65 ANCSA communities in 6 CDQ regions that participate in the program. Program benefits include flow of royalties, employment, and income to areas typically characterized by limited commercial economic opportunities. CDQ investment has resulted in increased participation in both regional and local fisheries. Past/present effects for CDQ groups include the effects of stock levels and fishery closures in other fisheries where CDQ groups have quota share, primarily in crab and halibut. Natural fluctuations in these stocks drive fishery opening and closures. As species and percent for which share has been allocated to CDQs increases, the involvement in multi-species fisheries increases.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and other sources of municipal and state revenue all have the potential to affect the CDQ program adversely or beneficially. Many harvesters and processors participate in salmon, crab, federal groundfish, and halibut. Crab CDQ groups will likely benefit due to rationalization of that fishery as CDQ shares are projected to rise. CDQ groups participating in salmon fisheries will be adversely effected because price is down and runs vary. Halibut share of CDQ groups will hold stable. Other economic development activities will be effected by community infrastructure projects creating employment and income opportunities. Currently the trends in funding available to CDQ communities are somewhat offsetting. There are funds available for infrastructure improvement through the Denali Commission, but state revenue sharing and related projects are generally decreasing. Changes in federal and state fiscal policies are likely to occur and effect CDQ communities. Long-term climate change and regime shifts will continue to influence the openings and closures of groundfish and other fisheries where CDQ groups are participants.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for the CDQ Program, and the effect is judged to be insignificant. With guaranteed CDQ shares through the CDQ program, no significantly adverse cumulative impacts to the CDQ program are expected.

4.5.9.4 Subsistence

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past/present effects on subsistence are described in Section 3.9 (Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case (Table 4.5-77). The representative indicators used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, sport and personal use, and long-term climate change and regime shift.

Direct/Indirect Effects of FMP 1

Potential impacts to subsistence fall into four main categories: subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon in western Alaska and bycatch in the groundfish fisheries, and indirect impacts on other subsistence activities, specifically the loss of income that would be otherwise directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. Under this FMP, no changes in the commercial fishery are anticipated that would result in impacts to baseline subsistence groundfish fishing conditions. There is also no indication that this FMP would have an adverse impact on Steller sea lion subsistence activities. Salmon bycatch would essentially remain the same as under baseline conditions and is determined to have no significantly adverse effects on the return of salmon to western Alaska rivers; therefore no significantly adverse impacts to subsistence salmon fisheries are expected to result. Catcher vessel activity and labor income are anticipated to be neutral or increase under this FMP; therefore no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

Cumulative Effects of FMP 1

The predicted direct and indirect effects of the groundfish fishery under the FMP 1 are described above. The past/present effects on subsistence are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. Representative indicators used in this analysis are the same as those used in the direct and indirect analysis, and include subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon, and indirect impacts on other subsistence activities such as income and joint production opportunities (Table 4.5-77).

Subsistence Use of Groundfish

- **Direct/Indirect Effects.** Under this FMP, no changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline subsistence groundfish fishing conditions.

- **Persistent Past Effects.** Foreign, JV, domestic, and state-managed fisheries have decreased populations of some species of groundfish used for subsistence. The comparative baseline indicates that groundfish makes a relatively modest contribution to the total subsistence resource base, but comprises up to 9 percent of the base in some commercial groundfish communities.

- **Reasonably Foreseeable Future External Effects.** Other fisheries have a potential to adversely contribute to the groundfish fisheries. The state-managed groundfish fishery activity could impact subsistence groundfish fishing. Other economic development activities and sport and personal use of subsistence use of groundfish do not significantly contribute potential effects on the subsistence use of groundfish. There are relatively low levels of subsistence use of groundfish in comparison to other fish resources. Infrastructure development, and sport use, and personal use are unlikely to cause a decline in groundfish stocks. Long-term climate change and regime shift have the potential to adversely affect groundfish stocks due to the natural fluctuations in groundfish stocks.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for subsistence use of groundfish, but is judged to be insignificant. The external impacts of economic development activities, sport use, and personal use of subsistence groundfish are not likely to contribute to significantly adverse cumulative effects on the groundfish fisheries. However, other state-managed fisheries could have adverse impacts on the subsistence use of groundfish due to the direct competition for the same species, but are not considered to be significant. The long-term climate change could adversely affect groundfish stocks.

Subsistence Use of Steller Sea Lions

- **Direct/Indirect Effects.** There is no indication that this FMP would have an adverse impact on Steller sea lion subsistence activities or take over baseline conditions.

- **Persistent Past Effects.** The past/present effects on subsistence use of Steller sea lions include the following: a long-term decline in population of Steller sea lions due to a number of factors; while sea lions have been used for subsistence since pre-contact times, there has been a long-term decline in relative importance of marine mammals in local diets; and commercial groundfish fishing takes prey species utilized by Steller sea lions, although the relative impact of this interaction is the subject of continuing research. With regard to past and present management actions, the MMPA (1972) limits subsistence take to Alaska Natives. The Steller sea lion population west of 144 degrees west longitude was declared endangered in 1990 (and populations east of line were declared threatened). The subsistence use of Steller sea lions reduces the number of Steller sea lions as does any other activity that results in Steller mortality, but by definition, but Steller subsistence use may not be directly related to overall Steller population decline. Most activity occurs in communities in the southwest portion of the state, although a significant number of Steller sea lions are harvested in a handful of other communities.

- **Reasonably Foreseeable Future External Effects.** Other commercial federal and state fisheries compete for sea lion prey and are likely to adversely contribute to the state of the sea lion population. Subsistence uses of Steller sea lions are not likely to adversely contribute to the groundfish fisheries. Other economic development activities and long-term climate change and regime shifts could adversely contribute to Steller sea lion subsistence activities. Community marine port and harbor development could potentially impact habitat and increase Steller sea lion disturbance. Long-term climate change could potentially effect recovery of Steller populations.

- **Cumulative Effects.** Under FMP 1, while an adverse cumulative effect is identified for subsistence use of Steller sea lions, the effect is judged to be insignificant. However, the cumulative effects of take, the continuing endangered status, and long-term decline in abundance are likely having population-level effects, but not enough to have significant indirect impacts to subsistence. The external impacts of other fisheries, other economic development activities, and subsistence uses of Steller sea lions are not likely to contribute adversely to the groundfish fisheries.

<u>Subsistence Use of Western Alaskan Salmon and Bycatch in the Groundfish Fishery</u>

- **Direct/Indirect Effects.** Under this FMP, salmon bycatch would essentially remain the same as under baseline conditions, therefore adverse direct/indirect impacts to subsistence salmon fisheries are expected to be insignificant.

- **Persistent Past Effects.** Salmon has been utilized for subsistence since pre-contact times; salmon bycatch in the groundfish fishery raises concerns especially during years of poor runs in western Alaska, but current data does not allow for a clear demonstration of the significance of adverse impact. Other past and present management actions include the adverse contribution of commercial salmon fishing on subsistence use of salmon; Area M salmon fishing closures were implemented to decrease intercept of salmon returning to areas further west and north. The comparative baseline statement for subsistence use of salmon indicated that it is part of the household economic base and sociocultural institutions in dozens of communities in western and interior Alaska.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts could all adversely contribute to effects on salmon subsistence activities. Salmon intercept from other commercial fisheries has the potential to contribute to poor salmon returns in western Alaska. Other economic development activities and community infrastructure development could potentially effect salmon spawning and rearing habitat. Long-term climate change could potentially effect at-sea salmon survival and reduce salmon runs. Sport and personal use or subsistence use of salmon is not likely to contribute to adverse effects on the salmon population.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for subsistence use of salmon, and is judged to be adverse but insignificant. However, given the depressed stock status of salmon runs in western Alaska, adverse contributions from external factors, and the salmon bycatch in the BSAI and GOA, sustainability of depressed salmon stocks could be adversely impacted, but are considered insignificant.

Indirect Impacts on Other Subsistence Activities (Income and Joint Production Opportunities)

- **Direct/Indirect Effects.** Under this FMP, catcher vessel activity and labor income are anticipated to be neutral or increase, therefore no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

- **Persistent Past Effects.** The past/present effects on the indirect impacts on other subsistence activities include a history of joint production as a part of local groundfish and other commercial fishery activities; and income from fishing used for investment in subsistence similar to use of income from other activities. The comparative baseline statement for indirect impacts on other subsistence activities indicates that joint production activity has been largely undocumented; activity that does occur is primarily associated with the smaller vessel classes within the fleet; vessels used as a platform or to access a number of subsistence activities in addition to fishing (e.g., hunting and berry picking).

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts could all adversely or beneficially contribute to indirect subsistence activities. Other fisheries and other economic development activities could potentially effect income available for pursuit of subsistence activities. For example, current reductions in salmon fishing due to lower prices is likely to reduce joint production opportunities. Long-term climate change could potentially effect groundfish stocks and opportunity for joint production and income. Effects of sport and personal use on indirect subsistence activities is minimal.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for indirect subsistence use, and the effect is judged to be insignificant. Catcher vessel activity, and joint production opportunities are not expected to be affected adversely. However, the external impacts of other fisheries, other economic development activities, and long-term climate change and regime shifts could potentially contribute adversely to the indirect subsistence use.

4.5.9.5 Environmental Justice

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past and present effects on Environmental Justice are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The external effects used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, other sources of municipal and state revenue, and long-term climate change and regime shift (Table 4.5-78).

Direct/Indirect Effects of FMP 1

Potential impacts that drive Environmental Justice issues include employment/municipal revenue in communities with significant percentages of special populations (Alaska Native and minority processing workforce); revenue to Alaska Native-owned catcher vessels; revenue to Alaska Native-owned catcher processors; subsistence activities associated with groundfish, Steller sea lion, and salmon; and the loss of income from fishing that would be otherwise directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. The regions that could experience potential impacts include the Alaska Peninsula and Aleutian Islands, Kodiak Island, southcentral Alaska, southeast Alaska, Washington inland waters, Oregon coast, the CDQ regions, and western Alaska communities that harvest salmon for subsistence purposes.

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominately Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 204 jobs; therefore, no Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $492 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities and therefore no associated environmental justice impacts would occur. In this region the ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of adult male populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under this FMP, the total value of catcher vessel operations would appear to decrease as would corresponding labor income and employment; therefore, a potential environmental justice impact would result, but this is likely to be at least in part an artifact of the output model distribution rather than an impact that would be high and adverse.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 134 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $100 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the City and the Kodiak Island Borough, but given local and regional demographics, this is not likely to be an environmental justice issue. Ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of the adult male population of the City of Kodiak itself, and therefore the local fleet associated population is not likely to be predominately Alaska Native (or comprised of other identified minority populations). Under this FMP, the total value of catcher vessel operations would increase as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be of any consequence as an environmental justice issue.

Southcentral Alaska. As described in existing conditions, environmental justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and thus it is unlikely that environmental justice issues will be associated with any employment change. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns. Similarly, processing value increases; however catcher vessel associated values decrease, but these changes are not tied to environmental justice concerns.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall environmental justice concerns appear not to apply in this region. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns. Similarly, processing value increases as do analogous catcher vessel associated values, but this change is not associated with environmental justice concerns.

Washington Inland Waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, environmental justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under this FMP, at-sea processing labor income and FTEs increase (if by less than significant amounts), so there are no environmental justice impacts associated with this change.

Oregon Coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are not linked to environmental justice concerns.

CDQ Region. The CDQ region is predominately comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve environmental justice concerns. As described above, the CDQ program and region would not experience adverse impacts under this FMP, therefore no associated environmental justice impacts are likely to result.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve environmental justice concerns. Subsistence activities where there are potential environmental justice issues include the following:

- Harvest of groundfish (which occurs to some extent in all four Alaska regions), Steller sea lion (primarily and activity in the Alaska Peninsula/Aleutian Islands region), and salmon (primarily an issue in western Alaska, where poor runs have adversely affected subsistence harvests).

- The loss of income from fishing that would otherwise be directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production (which occurs to some extent in all four Alaska regions).

While there are some concerns about the effect of the groundfish fishery on Steller sea lions and salmon bycatch, it has been determined that fishing under FMP 1 is not having a significantly adverse contribution to Steller Sea lion and salmon populations and their availability for subsistence harvest. Significantly adverse direct/indirect impacts to subsistence activities are not foreseen under this FMP, therefore no associated Environmental Justice impacts are anticipated.

Cumulative Effects of FMP 1

The predicted direct and indirect effects of the groundfish fishery under the FMP 1 are described above. The past/present effects on Environmental Justice issues are described in Section 3.9.6. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicators used in this analysis is the same as that used in the direct/indirect analysis (Table 4.5-78).

<u>Environmental Justice</u>

- **Direct/Indirect Effects.** Under FMP 1, insignificant effects to baseline Environmental Justice issues are anticipated.

- **Persistent Past Effects.** Persistent past effects include the following events and activities. Enactment of local and state taxes and the Fisheries Resource Landing Tax have increased revenues to many Alaskan communities, including those with significant Alaska Native populations. The initiation of the MSA phased out foreign fishing activities, adversely effected salmon populations on the high seas. The establishment of the CDQ program encouraged investment by Alaska residents from predominantly Alaska Native communities in groundfish fisheries, in order to promote economic development. Commercial fishing has become a dominant source of employment and income for many Native Alaskans.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. Other fisheries, other economic development activities, and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. Other federal and state fisheries allocate quota, to CDQ groups, provide opportunities for non-CDQ Alaska Natives to participate in fish harvesting and processing, and provide tax revenue to communities in Alaska with substantial Alaska Native populations. Changes in economic conditions in these other Alaska fisheries (e.g., crab fisheries closures and reduced salmon fisheries) could impact Environmental Justice issues in several ways in combination with changes in relative allowable catch, value of groundfish and associated revenues to Alaskan Native communities.

Environmental Justice issues could be impacted by decreases in other economic activities that create opportunities for employment and income for Alaska Natives. Reductions in construction of public and private infrastructure, and limited economic development activities in many small coastal communities can adversely affect Alaska Natives.

Reductions in state and local revenue may adversely affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire debt service. When these communities have significant Alaska Native populations, adverse Environmental Justice effects may result.

Fluctuations in natural conditions, such as short-term and long-term climate change, could adversely affect availability of fish and wildlife for Alaska Native subsistence use and commercial fishing.

- **Cumulative Effects.** Under FMP 1, an insignificant cumulative effect is identified for Environmental Justice, with the exception of the Alaska Peninsula/Aleutian Islands. The direct/indirect effects on income for subsistence pursuits, and participation and employment opportunities for Alaska Natives in the fishery generally increase. Reductions in revenues to local communities could potentially effect Environmental Justice issues, but not of a magnitude to be significant. Effects from bycatch of salmon and Steller sea lion subsistence activities are cumulatively insignificant. The external effects from the crab closures and downturn in the salmon industry and reductions in employment funded by public revenue, and reductions in revenue to Alaskan Native communities are adverse, primarily in the Alaska Peninsula/Aleutian Islands, where cumulative effects are conditionally significant adverse for Environmental Justice issues.

4.5.9.6 Market Channels and Benefits to U.S. Consumers

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. The past/present effects on market channels and benefits to U.S. consumers are described in Section 3.9 (Table 3.9-127) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is benefits to U.S. consumers (Table 4.5-79).

Direct/Indirect Effects of FMP 1

FMP 1 is not expected to have a significant effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. Under FMP 1 the BSAI and GOA groundfish fisheries are expected to continue to provide high and relatively stable levels of seafood products to domestic and foreign markets. An estimate of the final market value of BSAI and GOA seafood products is not available; however, it would be substantially greater than $1.5 billion, the projected 5-year mean of the total wholesale product value of BSAI and GOA groundfish after primary processing under FMP 1. This wholesale product value mean is higher than the comparative baseline, but the increase is not significant.

Cumulative Effects of FMP 1

For a summary of the direct/indirect and cumulative ratings see Table 4.5-79.

Market Channels and Benefits to U.S. Consumers

- **Direct/Indirect Effects.** Under this FMP, increases in benefits to U.S. consumers of groundfish products are expected to occur, but are insignificant.

- **Persistent Past Effects.** These effects on benefits to U.S. consumers of groundfish products include: Alaska Seafood Marketing Institute product promotion activities, research and public awareness regarding the health benefits of seafood consumption, aquaculture development increasing overall availability and demand for seafood products, and changes in processing technology increasing seafood quality.

- **Reasonably Foreseeable Future External Effects.** Other fisheries are adversely or beneficially contributing to market channels and benefits to U.S. consumers of groundfish products. Other fisheries provide relatively stable levels of seafood products to domestic and foreign markets; the supply of fish products could be influenced by competition in markets; foreign fisheries are being over fished; and there has been an increasing trend in domestic seafood consumption. Long-term climate change and regime shifts have the potential to adversely affect the market channels and benefits to U.S. consumers of groundfish products due to the natural fluctuations in groundfish stocks.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for benefits to U.S. consumers of groundfish products, and the effect is judged to be insignificant. The external impacts of other fisheries have the potential to contribute adversely or beneficially to the U.S. consumers of groundfish products and the groundfish market channels. However, the wholesale groundfish product value in conjunction with products from other fisheries is not expected to change benefits to U.S. consumers. The long-term climate change and regime shifts could adversely effect availability for market channels due to the natural fluctuations in groundfish stocks. Cumulative effects under FMP 1 are considered to be insignificant.

4.5.9.7 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (including Non-Consumptive and Non-Use Benefits) Alternative 1 Analysis

The predicted direct and indirect effects of the groundfish fishery under FMP 1 are described below. Benefits derived from marine ecosystems and associated species are used as a surrogate to evaluate non-consumptive and non-use benefits. The past/present effects on non-consumptive and non-use benefits to the U.S. general public are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis include the benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits) (Table 4.5-80).

Direct/Indirect Effects of FMP 1

FMP 1 is predicted to have no significant effects on the level of benefits the Bering Sea and GOA marine ecosystems and associated species provide relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 1 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.5.10 of this Programmatic SEIS.

The comparative baseline for the benefits that humans derive from the Bering Sea and GOA marine ecosystems is described in Section 3.9.7. To summarize this section, these marine ecosystems and species associated with them provide a broad range of benefits to the American public. Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. While there are difficulties in estimating the value the public places on protecting ecological conditions, Section 3.9.7 provides a qualitative discussion of possible benefits provided by the Bering Sea and GOA marine ecosystems. In addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing. Furthermore, some people may not directly interact with the Bering Sea and GOA marine ecosystems and the various species associated with them, but may derive satisfaction from knowing that the structure and function of these ecosystems are protected.

The focus in this analysis is on the direct and indirect effects of the alternatives on ecosystem benefits other than those that accrue to members of society who make a living harvesting, processing and distributing BSAI and GOA groundfish products or who purchase and consume these products. The direct and indirect effects of the alternatives on firms and communities that derive value from the commercial harvest and processing of groundfish are described elsewhere in the Programmatic SEIS. Similarly, the effects of the alternatives on consumers of groundfish products are discussed in a separate section of the Programmatic SEIS.

The value people assign to those marine ecosystem benefits that are unrelated to commercial groundfish fisheries are thought to be considerable. For example, the value of protecting the Steller sea lion alone may be substantial. As discussed in Section 3.9.7, a contingent valuation study suggests that there is a significant willingness to pay on the part of the American public for an expanded federal Steller sea lion recovery program. At this time, however, there is insufficient information to provide a comprehensive measure of the benefits derived from these ecosystems and the various species associated with them.

FMP 1 would maintain current management measures that mitigate the adverse effects of the groundfish fisheries on the Bering Sea and GOA marine ecosystems and associated species. These measures include a network of spatial/temporal closed areas that disperse fisheries geographically and seasonally, a prohibition on the use of non-pelagic trawl gear to fish for pollock in the BSAI, bycatch reduction measures such as the full retention requirement for Pacific cod and pollock, and measures to reduce the incidental catch of seabirds. Furthermore, as discussed in Section 4.5.10, FMP 1 is not expected to result in a significant change in the quantitative measures of any indicators of fishing impacts on marine ecosystems relative to the baseline. Consequently, the change in the level of benefits these ecosystems provide is not expected to be significant.

Cumulative Effects of FMP 1

For a summary of the direct/indirect and cumulative ratings please refer to Table 4.5-80.

Benefits Derived from Marine Ecosystems and Associated Species

- **Direct/Indirect Effects.** Under this FMP the adverse effects that the Alaska groundfish fishery could have on marine ecosystems are increased. FMP 1 is predicted to have a conditionally significant adverse impact on the levels of some of the benefits these ecosystems and the associated species they generate.

- **Persistent Past Effects.** Persistent past effects on benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits) include the following: an increase in public awareness of marine ecosystems (e.g., BSAI and GOA marine ecosystems) and associated endangered species (e.g., Steller sea lions); increased participation in recreational fishing and eco-tourism activities; and public perception associated with lawsuits challenging NOAA Fisheries for failing to meet the requirements of the Endangered Species Act in its management of Alaska groundfish fisheries. These persistent past effects drive the public to value the marine ecosystem and associated species and the public derives satisfaction from knowing that the structure and function of these ecosystems are protected.

- **Reasonably Foreseeable Future External Effects.** Other fisheries are adversely contributing to benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits). Fishing levels in other domestic and foreign fisheries may be affecting the productivity of the marine ecosystem. Long-term climate change and regime shift has the potential to adversely affect the benefits the public derives from marine ecosystems and associated species due to the natural fluctuations in groundfish stocks.

- **Cumulative Effects.** Under FMP 1, a cumulative effect is identified for the benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits), and the effect is judged to be conditionally significant adverse. The external impacts of other fisheries have the potential to contribute adversely to the benefits the public derives from marine ecosystems and associated species. Current fisheries management practices could continue the introduction of non-native species; changes in pelagic forage availability; removal of top predators (potential for seabird by-catch and subsistence harvests of marine mammals); and increased risk of changes in species, functional, and structural habitat diversity for the ecosystem. Long-term climate changes and regime shifts, in combination with fisheries-related pressures, could adversely affect species diversity due to the natural fluctuations in groundfish stocks.

4.5.10 Ecosystem Alternative 1 Analysis

Ecosystems are populations (consisting of single species) and communities (consisting of two or more species) of interacting organisms and their physical environment that form a functional unit with a characteristic trophic structure (food web) and material cycles (movement of mass and energy among the groups). The following analyses of potential direct, indirect, and cumulative effects of FMP 1 apply to the BSAI and GOA ecosystems. Where available information allows, each ecosystem is addressed separately. In most cases, however, information is insufficient to allow individual consideration, and the two ecosystems are treated as a single entity.

The analyses of the alternatives examine three major factors through which commercial fishing can typically affect ecosystem characteristics:

1. Predator-prey relationships.

2. Energy flow and balance.

3. Diversity.

Within these three categories, ten indicators have been selected to allow assessments of the potential future direct, indirect, and cumulative effects of the alternatives:

To assess effects on predator-prey relationships:

1. **Change in pelagic forage availability.** This is a change in the availability of fish such as walleye pollock, Atka mackerel, herring, and other species that serve as food for top predators such as seabirds and marine mammals.

2. **Spatial and temporal concentration of fishery impact on forage.** This is the pattern in space and time of the commercial fishing effort.

3. **Removal of top predators.** This is a decrease in the number of top-predator fish (e.g., Pacific halibut, arrowtooth flounder), seabirds, or marine mammals in the ecosystem, either through direct removal (e.g., targeted catch, bycatch, subsistence harvest) or indirect biological pathways (e.g., decline in reproductive success).

4. **Introduction of non-native species.** This is the establishment of new populations of plants or animals that originate in other marine ecosystems foreign to the BSAI or GOA. In other parts of the world, such as the Great Lakes, introduced species have resulted in major changes to ecosystem characteristics, almost always considered undesirable for biological and economic reasons.

To assess effects on energy flow and balance:

5. **Energy removal.** This is a decrease in the total amount of energy in the ecosystem that is available as nutrients for living organisms.

6. **Energy redirection.** This is a change in the pattern of energy flow within the ecosystem. For example, a shift in energy from one part of the food web to another.

To assess effects on diversity:

7. **Change in species diversity.** This is an increase or decrease in the number of different species in the ecosystem.

8. **Change in functional (trophic) diversity.** This is a change in the variety of species that make up a trophic guild, that is, a group of species that obtain food in similar ways.

9. **Change in functional (structural habitat) diversity.** This is a change in the variety of organisms, such as corals, that grow in ways that provide structures for other species to live in and around. Many of the species providing structural habitat are bottom-dwellers.

10. **Change in genetic diversity.** This is a change in the variety of genes within a population (single species). In general, greater genetic diversity bestows a greater ability of the population to deal with environmental stressors such as changes in food availability, water quality, or climate.

Direct/Indirect Effects FMP 1 on Ecosystems

The following sections discuss the potential direct/indirect effects of FMP 1 on the ten indicators noted above.

Predator-Prey Relationships

Pelagic forage availability is assessed by evaluating population trends in pelagic forage biomass for species with age-structured population models. This includes walleye pollock in the GOA (Figure H.4-17 of Appendix H) and Bering Sea walleye pollock and Aleutian Islands Atka mackerel (Figure H.4-18 of Appendix H). Trends in bycatch of other forage species (herring, squid, and forage species group) in the groundfish fisheries are used as a measure of the potential impact on those groups in the BSAI and GOA (Figure H.4-19 and Figure H.4-20 of Appendix H). Table 4.5-81 summarizes the average values from 2003-2008 for these measures and the percent change in the average values from the comparative baseline levels. Under FMP 1, pelagic forage biomass in the BSAI (Bering Sea walleye pollock + Aleutian Islands Atka mackerel) would decline by about 10 percent from the baseline, and pelagic forage biomass (specifically, walleye pollock) in the GOA would increase by about 50 percent over the baseline. Twenty-year biomass projections show similar trends. Average biomass would remain within the bounds of estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species would increase by over 75 percent in the BSAI and decline by about 5 percent in the GOA. The projected absolute quantity of bycatch in each region is relatively small (2,930 mt and 250 mt, respectively). Estimates of forage biomass from food web models of the EBS suggest that this bycatch would be a small proportion of the total forage biomass (Aydin *et al.* 2002). However, the lack of population-level assessments for some species in the forage species group means that corresponding species-level effects are unknown. On the basis of this analysis, FMP 1 is determined to have an insignificant effect on the BSAI and GOA ecosystems with respect to pelagic forage availability.

Spatial and Temporal Concentration of Fishery Impact on Forage

Spatial and temporal concentration of fishery impact on forage species is assessed qualitatively by considering the potential for the alternatives to concentrate fishing on forage species in regions utilized by predators that are tied to land, such as pinnipeds and breeding seabirds. Additionally, possibility for concentration of fishing effort to result in an ESA listing or lack of recovery to an ESA-listed species is also considered. FMP 1 would continue the existing closures around Steller sea lion rookeries, the ban on forage fish, and the spatial and temporal allocation of TAC for pollock and Atka mackerel, resulting in an insignificant effect of the spatial/temporal concentration of the fishery on forage species. Bering Sea pollock fisheries have been showing an increasing catch in northern fur seal foraging habitat in the baseline, and more research is required to evaluate whether the amounts of pollock removed are having a population-level effect on the fur seals.

Removal of Top Predators

Removal of top predators, either through directed fishing or bycatch, is assessed by evaluating the trophic level of the catch relative to trophic levels of the groundfish biomass (Figures H.4-21 through H.4-24 of Appendix H), bycatch levels of sensitive top predator species such as birds and sharks (Figures H.4-25 and H.4-26 of Appendix H), and a qualitative evaluation of the potential for catch levels to cause one or more top-level predator species to fall below biologically acceptable limits (MSST for groundfish and ESA listing or lack of recovery to an ESA-listed species). Trophic level of the catch in both the BSAI and GOA is a very stable property, changing less than 3 percent on average from the baseline, and trophic levels of the groundfish species for which we have age-structured models, and which dominate the catch, change less than 0.2 percent on average. Similarly, top predator bycatch amounts would increase slightly in the BSAI (+5.9 percent) and decrease slightly, on average, in the GOA (-1.8 percent) relative to the baseline. The absolute values of average catch of these species are estimated to be 715 mt and 1,290 mt in the respective regions under this FMP. The significance threshold for this effect is defined as catch levels high enough to cause the biomass of one or more top level predator species to fall below minimum biologically acceptable limits (MSST for target species and ESA listing or lack of recovery to an ESA-listed species) (Table 4.1-7).

The above indicators result in no change to the established baseline condition. The baseline determination concludes that historical whaling has resulted in low present-day abundance of whale species in the North Pacific Ocean. FMP 1 would not further impair the recovery of these species through direct takes. Similarly, levels of seabird and pinniped bycatch in groundfish fisheries in this alternative would not lead to an ESA listing for any of those populations or prevent any of the species from recovery under the ESA. Sections 4.5.7 and 4.5.8 discuss the effects of groundfish fishery direct takes on specific seabird and marine mammal populations. The effect of shark bycatch on shark populations is unknown at present, and research directed at better assessing population levels of these sensitive (late maturing, low fecundity, low natural mortality) species is needed to identify the potential impacts of groundfish fisheries on this resource. Section 4.5.3 discusses current trends in shark populations as considered in the other species category. Stability in trophic level of the catch is indicative of little effect of the fishery on top predators within the target and PSC species groups (Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut). See Section 4.5.1 for details on these target species and Section 4.5.2 for Pacific halibut. Overall, this alternative would have insignificant and unknown effects on top predators.

Introduction of Non-Native Species

The introduction of non-native species through ballast water exchange and hull-fouling organism release from fishing vessels could potentially disrupt the Alaskan marine food web structure. Recent work done primarily in Port Valdez and PWS shows that biological introductions of non-indigenous species has occurred, although these introductions cannot be ascribed to a particular vessel type such as oil tankers or fishing vessels (Hines and Ruiz 2000). There have been 24 species of non-indigenous plants and animals documented in Alaskan waters, primarily in shallow-water marine and estuarine ecosystems, with 15 species recorded in PWS, where most of the research has been conducted. One example of a likely introduction is the predatory seastar (*Asterias amurensis*), which is found in other areas of Alaska but has not previously been found in Cook Inlet. These predators have the potential to have a major impact on benthic communities. However, impacts from these introductions have not yet been observed in Alaskan waters. It is possible that most of these introductions were from tankers or other ships that have large amounts of ballast exchange. However, exchange via fishery vessels that take on ballast from areas where invasive species have already been established and that transit in Alaskan inshore waters has been identified as a threat in a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). The state management plan emphasizes the seriousness of non-native introductions, with respect both to biological changes and resulting economic impacts. Therefore, the potential for one or more non-native species to establish viable Alaskan populations is evaluated as having a conditionally significant adverse effect on the comparative baseline.

Total groundfish catch levels are used as an indicator of potential changes in the amount of these releases via groundfish fishery vessels (Figure H.4-27 and Figure H.4-28 of Appendix H, Table 4.5-81). Under FMP 1, total catch would decrease by less than one percent in the BSAI and increase by about 12 percent in the GOA relative to the baseline. These projected catch levels are similar to recent catches in these areas, indicating a similar level of effort and thus a similar potential for fishing vessel introduction of non-native species through ballast water exchange or hull-fouling organism release. Under FMP 1, therefore, there would be an insignificant change from the baseline with respect to the potential for introducing non-native species from fishing vessels and gear.

Energy Flow and Balance

As discussed in Section 3.10, fishing may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal back into the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. Baseline energy removals, in the form of total catch, were less than one percent of the total system energy as determined by mass-balance modeling of the system and were determined to have an insignificant impact on the ecosystem. Total retained catch removals under FMP 1 would decrease by less than one percent in the BSAI and increase by about 20 percent in the GOA relative to the baseline (Table 4.5-81). These are still less than one percent of the total system energy as estimated from mass-balance modeling for the eastern Bering Sea. Therefore, impacts on energy removals are determined to be insignificant with respect to the potential for producing changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7). Further examination of the potential for fishery removals to induce changes in system-level characteristics should be undertaken using present-day ecosystem models of the BSAI and GOA.

Energy re-direction, in the form of discards, disposal of fish processing offal, or unobserved gear-related mortality, can potentially change the natural pathways of energy flow in the system. For example, discards of dead flatfish or small benthic invertebrates might be consumed at the surface by scavenging birds that would normally not have access to those sources of energy. Animals damaged when passing through the meshes of trawls may later die and be consumed by scavengers. Bottom trawls can expose benthic organisms, making them more vulnerable to predation. Discards and offal production can cause local enrichment and change species composition or water quality if discards or offal returns are concentrated locally. These effects were determined to be insignificant at the ecosystem level in the baseline. Trends in total discards (Table 4.5-81, Figure H.4-29 and Figure H.4-30 of Appendix H) under FMP 1 show about a 5 percent increase in the BSAI and a 15 percent decrease in the GOA relative to the baseline. This amount of change is determined to be small in comparison to historical amounts of discards and is determined to have an insignificant potential effect on ecosystem-level energy cycling characteristics.

Change in Species Diversity

Fishing can alter different measures of diversity. Species-level diversity, or the number of species, can be altered if fishing removes a species from the system. Fishing can alter functional diversity from a trophic standpoint if it selectively removes or depletes a trophic guild member, thus changing the distribution of biomass within a trophic guild. Functional diversity from a structural habitat standpoint can be altered if fishing methods such as bottom trawling remove or deplete organisms such as corals, sea anemones, or sponges that provide structural habitat for other species. Fishing can alter genetic diversity by selectively removing faster growing fish or removing spawning aggregations that might have genetic characteristics that are different from other spawning aggregations. Large, old fishes may be more heterozygous than younger fish (i.e., have more genetic differences or diversity) and some stock structures may have a genetic component (see review in Jennings and Kaiser 1998). Consequently, one would expect a decline in genetic diversity to result from heavy exploitation of a fishery.

Significance thresholds for effects of fishing on species diversity are defined as catch removals high enough to cause the biomass of one or more species (target or non-target) to fall below, or to be kept from recovering from levels already below, minimum biologically acceptable limits (MSST for target species, ESA listing for non-target) (Table 4.1-7). Indicators of significance are population levels of target and non-target species relative to MSST or ESA listing thresholds, linked to fishing removals. Bycatch amounts of sensitive (low population turnover rates) groups that lack population estimates (skates, sharks, grenadiers, and sessile invertebrates, such as corals, inhabiting Habitat Areas of Particular Concern, or HAPC) may also indicate potential for fishing impact on these species (Table 4.5-81, Figure H.4-31 and Figure H.4-32 of Appendix H). Closed areas also provide protection, particularly to less-mobile species like HAPC biota, so the amount of area closures across habitat types can indicate the degree of species-level diversity protection. Baseline determinations of insignificance were concluded for most of these indicators, and were unknown for skates and sharks.

Under FMP 1, closed areas would remain the same and bycatch of HAPC biota would increase by about 10 percent in the BSAI and decrease by almost 30 percent in the GOA. Although it is unknown whether bycatch amounts of HAPC biota would be at levels high enough to bring these species to minimum population thresholds, area closures would likely be sufficient to prevent species removal for these sessile animals. Catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds. It is unknown whether bycatch amounts of skates, sharks and grenadiers would be at levels high enough to bring species within these groups to minimum population thresholds. Further research on the species-level distribution, abundance trends, and life history parameters of these species is necessary to assess the risk of their falling below minimum population abundance thresholds. Although forage species population levels are not known, their relatively high turnover rates and the ban on forage fish fisheries in this alternative is considered sufficient to protect them from falling below minimum biologically acceptable limits. However, some of the species in the forage group are not well studied (such as stichaeids, gunnels) and life-history parameter determination should be a priority in the future to better assess the risk of their falling below acceptable population thresholds of abundance.

On the basis of the preceding considerations, we determine that FMP 1 would have insignificant and unknown effects on species diversity. More years of survey data and life history parameter determination for skates, sharks and grenadier species may better define population trends and the need for further protection. See Sections 4.5.1 (target species), 4.5.2 (prohibited species), 4.5.3 (other species), 4.5.4 (forage species), 4.5.5 (non-specified species), 4.5.6 (habitat), 4.5.7 (seabirds) and 4.5.8 (marine mammals) for more detailed analyses of the potential for fishery removals to affect minimum population thresholds and species diversity for each of these groups.

<u>Change in Functional Diversity</u>

Functional (either trophic or structural habitat) diversity can be altered through fishing if fishing selectively removes one member of a functional guild, which may result in increases in other guild members. A functional guild is a group of species that use resources within the ecosystem in similar ways. Significance thresholds are defined as catch removals high enough to cause a change in functional diversity outside the range of natural variability observed for the system. Indicators of the possible magnitude of effects include qualitative evaluation of guild or size diversity changes relative to fishery removals, bottom gear effort changes that would provide a measure of benthic guild disturbance, and bycatch amounts of HAPC biota, a structural habitat guild. Under FMP 1, the species composition and amounts of removals, and the bottom gear effort and bycatch amounts of HAPC biota (Table 4.5-82, Figure H.4-31 and Figure H.4-32 of Appendix H), would be relatively similar to the comparative baseline, in which fishing impacts on functional guild diversity were determined to be insignificant for trophic diversity and structural habitat diversity.

Members of the HAPC biota guild serve important functional roles, known only in a preliminary way, to provide fish and invertebrates with structural habitat and refuge from predation. The abundance of these structural species necessary to provide protection is not known, and it may be important to retain populations of these organisms that are well distributed spatially in order to fulfill their functional role. Some of these organisms have life-history traits that make them very sensitive to fishing removals. The long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. Therefore, it is important to evaluate the spatial distribution of areas closed to bottom fishing with respect to coral distribution to ensure a broad spatial distribution that would be necessary for them to fulfill their functional role. Present-day Steller sea lion trawl closures are spread throughout the Aleutian chain, but these closures may be more inshore than most of the coral. For this reason, the areas closed to trawling in this alternative may not be sufficient to provide additional protection beyond the baseline for these sensitive organisms.

Change in Genetic Diversity

Genetic diversity can be affected by fishing through heavy exploitation of certain spawning aggregations or systematic targeting of older age classes that tend to have greater genetic diversity. Genetic diversity has not been well assessed in the comparative baseline and is unknown for many species. On the basis of evidence from other, more highly fished systems, the degree of spatial/temporal management of TAC, and the lack of target species falling below MSST due to a decline in genetic diversity, it is concluded that effects of fishing on genetic diversity are insignificant or unknown. Under FMP 1, no target species would fall below MSST and the same spatial and temporal management of TAC and similar catch and selectivity patterns in the fisheries would apply, so we would expect an insignificant impact of fishing on genetic diversity. However, because actual genetic diversity remains unknown for most species, the potential direct/indirect effects of fishing on genetic diversity are also largely unknown.

Cumulative Effects Analysis of FMP 1 on Ecosystems

The following sections briefly discuss the potential cumulative effects of FMP 1 on the ten ecosystem indicators explained in Section 4.5.10. These potential cumulative effects are summarized in Table 4.5-82. Data and calculations supporting the energy removal analyses for the alternatives are presented in Section 4.5.11.

Change in Pelagic Forage Availability

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 1 on pelagic forage availability are expected to be insignificant. The BSAI pelagic forage biomass, as estimated by Bering Sea pollock and Aleutian Islands Atka mackerel, is predicted to decrease by 9.2 percent, and the total biomass of GOA pollock is predicted to increase by 50.9 percent. These fishery-induced changes would be within the natural level of abundance or variability for prey species relative to predator demands (Table 4.1-7).

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). For example, before full observer coverage began in the late 1980s, the herring bycatch in BSAI trawl fisheries, principally those targeting pollock, may have been 8,000 to 10,000 tons (7,300 to 9,100 mt) per year (ADF&G 2003a). Past fishing pressures may also exert a persistent effect on these species, particularly on GOA capelin populations (Section 3.10.3). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may still exist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will remove an annual increment of pelagic forage biomass. Herring harvested for sac roe have averaged about 50,000 tons (45,500 mt) per year, and the commercial catch of herring for bait averages about 8,000 tons (7,300 mt) per year. The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below the threshold level (MSST). Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Because the State of Alaska has not established annual harvest assessment programs for subsistence fisheries other than salmon, there is little monitoring of subsistence fish harvests, and annual statewide catch data are not compiled (ADF&G 2001). Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The Exxon Valdez disaster of 1989 suggests that a large petroleum spill coinciding in space and time with herring or capelin spawning, would most likely produce population declines and other adverse effects on pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, would be likely to affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability would occur in the event of a large petroleum spill. The conditions under which this effect would be significant relate to the areas affected and seasonal timing of the spill. If these events coincide with spawning locations and times, a significantly adverse cumulative effect on pelagic forage availability would most likely result. Additive or interactive contributions from State of Alaska commercial fisheries and subsistence fish harvests are not expected to be significant. A future climatic regime shift would not appreciably offset, but could intensify, this potential cumulative effect if the productivity of pelagic forage species is reduced.

Spatial/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** The direct/indirect effects of the spatial/temporal concentration of fishing effort under FMP 1 on pelagic forage availability are expected to be insignificant. FMP 1 would continue the existing closures around Steller sea lion rookeries, the ban on forage fish, and the spatial/temporal allocation of TAC of pollock and Atka mackerel, which have been determined to result in an insignificant impact on the spatial/temporal concentrations of fishing efforts on forage species (Section 4.5.11).

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may have persisted into the present and future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlap with the groundfish fishery will more likely be temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The Exxon Valdez disaster of 1989 suggests that a large petroleum spill, coinciding in space and time with herring or capelin spawning, would most likely produce population declines, and adverse effects on other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that might be synergistic with spatial/temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could result in the reasonably foreseeable future, synergistic with the spatial/temporal concentration of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries, principally for herring, and subsistence fish harvests converge in space and time with a large-scale petroleum spill, forage fish populations could be significantly depressed as to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species in ways that might reduce or intensify this potential cumulative effect.

Removal of Top Predators

- **Direct/Indirect Effects.** The implementation of FMP 1 is predicted to have insignificant effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This alternative would not impair the continued recovery of whale populations, which are still reduced due to direct take in the past. Levels of seabird and marine mammal bycatch in the groundfish fisheries would not lead to listing any of these species or preventing recovery under the ESA. Because there is little available information on shark bycatch and current population status, the direct/indirect effects of this alternative on sharks are rated as unknown.

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks (Sections 3.5.3 and 4.5.3), seabirds (Sections 3.7.1 and 4.5.7), and marine mammals (Sections 3.8 and 4.5.8). Historical whaling, particularly very high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the low present-day abundance of whale species in the North Pacific (Section 4.5.8). State of Alaska directed groundfish fisheries, which are small and sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the Western Bering Sea have also contributed to the bycatch of top predators, in some cases at high level. Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, and past harvests may have had a sustained effect on some populations that persists today (Section 3.10.1). Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a portion of the Pacific halibut population, a top predator (Section 4.5.2). The current policy is likely to continue in the future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from NPO longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Section 3.7. The State of Alaska directed groundfish fisheries will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large petroleum spill at sea could result in the direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on total numbers of top predators could result primarily from continued high levels of seabird bycatch by NPO longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, it is likely that the present high levels of seabird bycatch will continue in the future. The conditions under which this cumulative effect could be significant include the continuation of high external seabird bycatch rates in conjunction with a large petroleum spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the reasonably foreseeable future, and could intensify or reduce the potential cumulative effect by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** Under FMP 1, total catch (target and nontarget species) would decrease by less than one percent in the BSAI and increase by about 12 percent in the GOA relative to the baseline (Table 4.5-81). These catch levels indicate that this alternative would maintain about the same potential for fishing-vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms that currently exists under baseline conditions. Therefore, the direct/indirect effect of FMP 1 on predator-prey relationships through the introduction of exotic species is evaluated as insignificant.

- **Persistent Past Effects.** For decades, the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). In Washington State and British Columbia, Atlantic salmon (*Salmo salar*) have been farmed in floating saltwater net pens since the late 1980s, and deliberate releases of individual fish considered "non-performing" due to their sub-standard size total hundreds of thousands annually (ADF&G 2002a). Since first reports in 1990, there has been an increasing trend of incidental take of Atlantic salmon in the State of Alaska directed salmon fisheries (GOA), and the first specimen of an Atlantic salmon from the Bering Sea was captured in a bottom trawl south of the Pribilof Islands in 1997 (Brodeur and Busby 1998). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the future. In addition, commercial shipping, including cruise ships and barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with FMP 1, it is conceivable that viable populations could eventually become established in the BSAI and/or GOA, producing a conditionally significant adverse cumulative effect (Table 4.1-7). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that might allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA.

Energy Removal

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 1 on energy removal are expected to be insignificant. Baseline energy removals, in the form of total catch, are less than one percent of the total ecosystem energy, as estimated by mass-balance modeling, and were determined to have an insignificant impact on the ecosystem. Total retained catch removals under FMP 1 would decrease by less than one percent in the BSAI and increase by about 20 percent in the GOA relative to the baseline (Table 4.5-81). These are still less than one percent of the total system energy as estimated from mass-balance modeling for the eastern Bering Sea. Therefore, estimated energy removals under FMP 1 would not have the potential to produce changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and correspondingly decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 6 percent of the cumulative biomass removed annually under this alternative (Table 4.5-82).The State of Alaska directed groundfish and subsistence fisheries would remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the Western Bering Sea and in international waters of the Central Bering Sea (doughnut hole) will also remove biomass in the future. However, these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features and are viewed as only partly comparable systems. Their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 1 is predicted to have an insignificant cumulative effect on energy removal in the reasonably foreseeable future. The total domestic groundfish catch under this alternative is estimated to remove less than one percent of the total system energy. If the combined total catch of the State of Alaska herring and crab and IPHC halibut fisheries in the future is similar to the 1997-2001 average, the cumulative total catch of these external fisheries plus the BSAI and GOA groundfish fisheries will increase by about 6 percent over the estimated total catch for FMP 1 alone (Table 4.5-82). This additional increment of biomass removal is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability due to expected energy removals by the BSAI and GOA groundfish fisheries (Table 4.5-82).

Energy Redirection

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 1 on energy redirection are expected to be insignificant. Projected trends in total discards modeled for FMP 1 show about a 5 percent increase in the BSAI and a 15 percent decrease in the GOA (Table 4.5-82). These effects would be small relative to the baseline and would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability due to fishery discarding and offal production practices (Table 4.1-7).

- **Persistent Past Effects.** Because ecosystem energetics is a dynamic process, it is difficult to know whether past changes in energy cycling and in pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed prior to passage of the MSA. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than they were 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and from subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. The pattern of such disposal at sea is not expected to change much in the future. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 1 is predicted to have an insignificant cumulative effect on energy redirection. The cumulative effect of FMP 1, in combination with external sources, is not expected to depart significantly from the comparative baseline condition to produce long-term changes outside the range of natural variability. At the local level, water quality degradation can be expected from the release of fish processing offal into low-energy environments, such as coves and bays, where nutrients from these wastes can concentrate in sheltered waters and alter local patterns of energy cycling. Although this is not an ecosystem-level effect, it is noted as a consequence of commercial fishing that will continue into the future. The discharge of offal from fish processing facilities and of graywater and other refuse from marine vessels into Alaskan waters is regulated through EPA and ADEC permitting programs.

Change n Species Diversity

- **Direct/Indirect Effects.** The expected direct/indirect effects of FMP 1 on species diversity are rated as unknown for skates, sharks, non-specified species and other species and insignificant for other groups. Under FMP 1, catch levels for target species, prohibited species, seabirds, and marine mammals would be insufficient to bring these species below minimum population thresholds. Forage species life history characteristics, along with the ban on initiating a forage fish fishery under this alternative, and maintaining closed areas that provide protection for HAPC biota (for example, corals) would help to prevent these species from falling below minimum population abundance thresholds. Further research will be required to assess whether FMP 1 bycatch levels for skates, sharks, non-specified species and other species, all poorly understood, will reduce species within these groups, thus, resulting in population-level impacts.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1.4). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate species (including HAPC) are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to direct mortality as bycatch, but lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change (Section 3.7).

  As stated in Section 3.10.3, Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show positive correlations with prey abundance, and cyclic fluctuations in species abundance occurred in both fished and unfished species. It was concluded that in the eastern Bering Sea ecosystem, the trophic level of the harvest increased slightly since the 1950s and stabilized as of 1994, suggesting that the comparative baseline harvest levels are sustainable. These authors also concluded that the fish populations examined are stable. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA. Although commercial fishing has not been largely implicated in BSAI and GOA ecosystem changes, studies of other ecosystems with much greater fishing pressures indicate that fishing, in combination with climate change, can alter ecosystem species composition and productivity (Jennings and Kaiser 1998, Livingston and Tjelmeland 2000). Assessing the extent to which this has occurred in the BSAI and GOA ecosystems, or may occur in the future, will require further research.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may deplete numbers to levels near or below biologically acceptable limits. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 1, a conditionally significant adverse effect on species diversity could result from a high level of seabird bycatch by the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may establish a viable population that could change species diversity in a negative way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species. Under some combination of these conditions, the biomass of one or more species could fall below, or be kept from recovering from levels already below, minimum biologically acceptable limits (Table 4.1-7).

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** Potential direct/indirect effects on trophic diversity relate to changes in the variety of species within trophic guilds. The greater the diversity of species within guilds, the more resilient the ecosystem is likely to be, because competing species within the same guild can replace or substitute one another in response to environmental stressors, thereby maintaining the structure of the food web. Under FMP 1, the predicted direct/indirect effects of the groundfish fisheries on trophic diversity are rated as insignificant, because they are expected to be similar to the comparative baseline conditions (Table 4.1-7).

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 1 could produce a conditionally significant adverse effect on trophic diversity. The primary condition for this effect is largely speculative. A climatic regime shift could make a trophic guild containing one or more target species more vulnerable to fishing pressure. A regime shift in the future, similar to well-documented examples that have occurred in the past (Sections 3.3 and 3.10.1.5), could decrease species diversity within a trophic guild by reducing the productivity or shifting the distributional range of one or more member species. If this climatic effect went undetected and without compensatory adjustments to fishing effort, the continued removal of particular target species, especially slow-growing species such as rockfish, could decrease their representation within trophic guilds.

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to structural habitat diversity is removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures used as habitat by other species, including economically important groundfish species and their prey. In FMP 1, the species composition and amounts of removals, bottom gear effort and bycatch amounts of HAPC biota, and areas closed to trawling relative to coral distribution are relatively similar to the baseline. Therefore, the change from baseline condition that would result from this alternative is evaluated as insignificant with respect to structural habitat diversity. Some of these organisms have physical characteristics and life-history traits that make them sensitive to fishing removals. The very long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. It is important to ensure that the spatial distribution of areas closed to bottom fishing is broad enough, relative to coral distribution, to allow the corals to fulfill their functional role. Present trawl closures protecting Steller sea lion habitat are spread throughout the Aleutian chain, but these closures may be farther inshore than most of the coral. Because the areas that would be closed to trawling under FMP 1 would be similar to the comparative baseline conditions, they might not be sufficient to provide protection to these sensitive organisms.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska-managed scallop fishery employs bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. In addition, a large petroleum spill could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** Direct/indirect effects of FMP 1, rated insignificant, could contribute to a conditionally significant adverse cumulative effect on structural habitat diversity under any of the following three conditions. First, the additive effect of the scallop fishery, employing bottom dredges, could add to the effects of bottom trawling by the groundfish fishery on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity, and thus the population size and/or distribution of bottom-dwelling invertebrates that provide structural habitat.

<u>Change in Genetic Diversity</u>

- **Direct/Indirect Effects.** If FMP 1 were implemented, no target species would fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to the comparative baseline conditions. Consequently, the effect of the groundfish fisheries on genetic diversity would be insignificant under this alternative. However, because genetic diversity remains unknown for most species, the potential direct/indirect effects of fishing are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity, then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be determined in the absence of current conditions. Heavy exploitation of certain spawning aggregations occurred historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to cumulatively affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 1 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would affect the genetic diversity of species targeted or taken incidentally by the groundfish fisheries.

4.5.11 Summary of Alternative 1 Analysis

The direct, indirect, and cumulative ratings for all resource categories analyzed under this alternative are summarized in Tables 4.5-83 through 4.5-89.

Table No.	Resource Category	Components	Section 4.5 Reference
4.5-83	Target Groundfish Species	BSAI and GOA Walleye Pollock, BSAI and GOA Pacific Cod, BSAI and GOA Sablefish, BSAI and GOA Atka Mackerel, BSAI Yellowfin Sole, GOA Shallow Water Flatfish, BSAI Rock Sole, BSAI and GOA Flathead Sole, BSAI and GOA Arrowtooth Flounder, BSAI Greenland Turbot, GOA Deepwater Flatfish, BSAI Alaska Plaice, BSAI Other Flatfish, GOA Rex Sole, BSAI and GOA Pacific Ocean Perch, GOA Thornyhead Rockfish, BSAI and GOA Northern Rockfish, BSAI and GOA Shortraker/Rougheye Rockfish, BSAI Other Rockfish, GOA Slope Rockfish, GOA Pelagic Shelf Rockfish, GOA Demersal Shelf Rockfish	4.5.1
4.5-84	Prohibited, Other, Forage and Non-specified Species	Pacific Halibut, Pacific Salmon and Steelhead Trout, Pacific Herring, Crab Other Species Category Forage Fish Category Grenadier	4.5.2 4.5.3 4.5.4 4.5.5
4.5-85	Habitat	BSAI, GOA	4.5.6

Table No.	Resource Category	Components	Section 4.5 Reference
4.5-86	Seabirds	Black-footed Albatross, Laysan Albatross, Short-tailed Albatross, Northern Fulmar, Shearwaters, Storm-petrels, Cormorants, Spectacled Eider, Steller's Eider, Jaegers, Gulls, Kittiwakes, Terns, Murres, Guillemots, Murrelets, Auklets, Puffins	4.5.7
4.5-87	Marine Mammals	Steller Sea Lion, Northern Fur Seals, Pacific Walrus, Harbor Seals, Spotted Seal, Bearded Seal, Ringed Seal, Ribbon Seal, Northern Elephant, Sea Otter, Blue Whale, Fin Whale, Sei Whale, Minke Whale, Humpback Whale, Gray Whale, Northern Right Whale, Bowhead Whale, Sperm Whale, Beaked Whales (Baird's, Cuvier's and Stejneger's), Pacific White-Sided Dolphin, Killer Whale, Beluga Whale, Harbor Porpoise, Dall's Porpoise	4.5.8
4.5-88	Socioeconomics	Harvesting and Processing Sector (Catcher Vessels, Catcher Processors, Inshore Processors and Motherships) Regional Socioeconomic Profiles (Population, Processing Ownership and Activity, Catcher Vessel Ownership and Activity, Tax Revenue, Employment and Income) CDQ Allocations Subsistence (Subsistence Use of Groundfish, Subsistence Use of Steller sea lions, Salmon Subsistence Fisheries, Indirect Subsistence Factors: Income and Joint Production) Environmental Justice Market Channels and Benefits to U.S. Consumers (Product Quantity, Product Year-Round Availability, Product Quality, Product Diversity) Non-Market Goods (Benefits Derived from Marine Ecosystems and Associated Species)	4.5.9.1 4.5.9.2 4.5.9.3 4.5.9.4 4.5.9.5 4.5.9.6 4.5.9.7
4.5-89	Ecosystem	Forage Fish Availability, Spatial/Temporal Concentration of Fisheries, Introduction of Non-Native Species, Removal of Top Predators, Energy Redirection, Energy Removal, Species Diversity, Guild Diversity, Genetic Diversity	4.5.10

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4.6 Alternative 2 Analysis

The goal of Alternative 2 is to have a more aggressive harvesting policy while preventing overfishing. This alternative is described in detail in Section 2.6.3.

4.6.1 Target Groundfish Species Analysis

This section examines the potential direct, indirect, and cumulative effects that the implementation of Alternative 2 is expected to have on the target groundfish species. The potential effects of two policy "bookends" are analyzed, FMP 2.1 and FMP 2.2. These represent the policy boundaries of Alternative 2. As actually implemented, Alternative 2 could include policy measures anywhere within the range between the two bookends. The impact analyses start with the baseline (2002) status of the BSAI and GOA target groundfish stocks described in Section 3.5.1, including past trends that are likely to persist into the foreseeable future. Then, a computer-based analytic model is used to project how specific characteristics of the target groundfish stocks would respond directly and indirectly to management actions under each FMP. These projections from the model are the predicted direct and indirect effects (impacts) of the FMP on the target groundfish stocks. Section 4.1.5 describes the analytic model and explains how it is applied.

The model output for each target groundfish stock is defined in terms of collected data and calculated measures that are standards used by fisheries managers to regulate the number of fish removed from the sea so that the fisheries will be sustainable over the long-term. These data and measures include the fishing mortality rate (F), the overfishing level (OFL), total and spawning biomass levels (B), the minimum stock size threshold (MSST), maximum sustainable yield (MSY), mean age of the stock in years, and the sex ratio of the stock (number of males compared to number of females). As discussed in the following subsections, relevant data are not always available for all stocks. When data gaps prevent application of the model to a specific stock, the projected direct or indirect effect is evaluated as unknown (U).

Each target groundfish stock is modeled with respect to the following direct and indirect effects:

Direct Effects

Fishing Mortality: This is the rate at which the stock is depleted by direct mortality imposed by removing the fish from the sea.

Change in Biomass Level: This is the change over time in the biomass of the stock, as measured in metric tons (mt). Two measures are used: total biomass, which is the estimated biomass of the entire stock, and spawning biomass, which is the estimated biomass of all of the spawning females in the stock.

Spatial/Temporal Concentration of Catch: This is the degree to which the fishery will concentrate in a particular geographic area during a particular period of time each season. This pattern in space and time can affect fishing mortality and can also influence habitat suitability for spawning, rearing, and feeding.

Direct and/or Indirect Effects

Habitat Suitability: This is the degree to which habitat has the right characteristics to support the target stock at one or more life-history stages (spawning, rearing of juveniles, availability of food at all stages, availability of refuge areas to allow escape from predators at all stages). Habitat suitability can be affected directly, for example by mechanical damage from bottom trawling, or influenced indirectly, for example by the gradual depletion of corals that provide hard substrate.

Prey Availability: This is the extent to which prey species are present in the environment and available as food to the target stock. Like habitat suitability, this measure can be affected directly, for example by the direct removal of prey species by the fishery, or indirectly, for example by a change in the structure of the food web.

To determine their probable significance, the projected direct and indirect effects in each of the impact categories listed above are evaluated against significance criteria. The criteria are designed to be relevant and meaningful in terms of the target groundfish stocks. Each significance criterion includes a threshold value above (or below) which the projected effect would be considered significant. Each criterion also includes a definition of what would constitute a beneficial (positive, +) or adverse (negative, -) effect. The possible evaluations are significant and beneficial (S+), insignificant (I), significant and adverse (S-), and unknown (U). Evaluations of conditionally significant beneficial or adverse (CS + or -) are not made for projected direct and indirect effects on target groundfish species, because the model can show only whether the significance threshold is or is not exceeded. The significance criteria used for the target groundfish stocks are presented in Appendix A, Table 4.1-1.

Each of the following subsections presents the model results and rationale for the expected direct and indirect effects of FMPs 2.1 and 2.2 on the target groundfish stocks. The significance ratings for these potential direct and indirect effects are presented in Appendix A, Table 4.6-1. Following the direct and indirect effects discussions on each stock, the expected cumulative effects on that stock are evaluated and discussed. The evaluation of potential cumulative effects builds on the direct and indirect effects evaluations as a starting point, and then brings in persistent past effects as well as reasonably foreseeable future natural events and human activities external to fisheries management. The cumulative effects assessment method uses the same impact categories and significance criteria discussed above for direct and indirect effects. This method is described further in Section 4.1.4.

4.6.1.1 Pollock

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA pollock for each of the bookends under Alternative 2. Numerous fishery management actions have been implemented that affect the pollock fisheries in the EBS and GOA. These actions are described in more detail in Sections 3.5.1.1 and 3.5.1.15 of this Programmatic SEIS. Pollock is managed as separate stocks in the BSAI and GOA, and falls under Tier 1 in both the BSAI and GOA groundfish FMPs.

Direct/Indirect Effects of FMP 2.1

FMP 2.1 includes the following features:

- The ABC is increased to be equivalent to the OFL level, and the F_{OFL} fishing rate is not lowered for stock sizes below $B_{40\%}$.

- The BSAI optimum yield range of 1.4 - 2.0 million mt is removed, and the optimum yield is set to the sum of the individual species OFL levels.

- PSC limits and bycatch limits are removed.

- Trawl closure areas and gear restrictions are removed.

- Fishing is allowed in current closed areas, such as Walrus Island closures, red king crab savings area, Bogoslof area, Pribilof Island closure, and nearshore Bristol Bay closure.

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H. Under FMP 2.1, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 9.6 million mt in 2005, then stabilize to about 10.0 million mt. The 2003-2007 average total biomass is 10.2 million mt. This reduction in biomass under FMP 2.1 is expected to have a significantly adverse impact on the EBS pollock stock.

In the Aleutian Islands region, the assessments are based trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Given that under FMP 2.1 directed fishing for pollock in this region is allowed, the expectation is that the stock will remain stable or decrease in the future. A similar pattern is expected for the Bogoslof Island (however, catch data from this region were unavailable for inclusion in the projection analysis).

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,070,000 mt by 2007 (Table H.4-23 of Appendix H). The average biomass over this period is expected to be 941,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels. Thus, the effects of FMP 2.1 on the GOA pollock stock are considered to be insignificant.

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-1 of Appendix H and Figure H.4-1 of Appendix H. Under FMP 2.1, projections indicate that EBS pollock spawning biomass will decrease to about 60 percent of the 2002 level by 2007. The projected average for 2003-2007 is 2.43 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Since under FMP 2.1 these areas are expected to have relatively large increases in fishing (compared to 2002), we expect the spawning stock size to be stable or decrease in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 171,000 mt by 2007 under FMP 2.1. This is below the estimated B_{msy} level of 210,000 mt with an average over 2003-2007 of 148,300 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H and Figure H.4-12 of Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase by about 140 percent and equal the $F_{35\%}$ value of 0.448 for the period 2003-2007 (Table H.4-1 of Appendix H). Fishing mortality for the Bogoslof and Aleutian Islands region is expected to increase to the natural mortality rate of 0.3 under FMP 2.1 (Table H.4-2 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections increasing to the $F_{35\%}$ levels of 0.350 for all projection years (Table H.4-23 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 involves the resumption of fishing in a number of areas currently closed, and these areas are largely in the Aleutian Islands. It is unknown how changes in spatial/temporal concentrations will affect pollock stocks. Since pollock are relatively low-valued groundfish species, the viability of pollock fisheries may be sensitive to changes in pollock densities and concentrations. However, the concentration of the harvest is not expected to be of a magnitude to sufficiently alter the genetic structure or reproductive success of either the EBS or GOA populations.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL, removing the buffer between these two harvest regulations. Model projections of future catches of EBS and GOA pollock are at or below the OFL level from 2003 to 2008. For GOA pollock, the stock is expected to be above the MSST for the years 2003-2007. The EBS pollock stock appears to be above the MSST during the years 2003-2005, but for 2006 and 2007, the stock may be declared as below the MSST and require separate management measures for a rebuilding plan (since a 10-year projection from the 2006 and 2007 years result in spawning biomass estimates that are below the B_{msy} level in 2016 and 2017).

Age and Size Composition

Under FMP 2.1, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.32 years (Table H.4-1 of Appendix H). This compares with a mean age in the equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 2.77 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+) (Table H.4-23 of Appendix H).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under FMP 2.1. However, since the catch levels are much higher than the 2002 levels, this assertion becomes more tenuous.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.1.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. Since the catch is much higher than in 2002, it may cause significant qualitative changes in predator-prey interactions as a result of actions taken under FMP 2.1 (for the period 2003-2007). However, changes in prey availability are not expected to jeopardize the ability of either the EBS or GOA pollock stocks to sustain at or above the MSST. Therefore, FMP 2.1 would have an insignificant effect on EBS and GOA pollock through prey availability.

Summary of Effects of FMP 2.1 on Pollock

Although the ABC and OFL levels for pollock are equivalent under FMP 2.1, the F_{OFL} is not reduced for lower stock sizes, and the harvest of pollock under FMP 2.1 is increased relative to recent levels, the fishing rates on pollock drops below the B_{msy} reference point. This is substantially different than the pattern in recent years (and the baseline 2002 data). It could be argued that these levels are within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. However, the direct and indirect effects of FMP 2.1 on EBS pollock biomass are considered significant (Table 4.6-1).

Cumulative Effects of FMP 2.1

External effects and the resultant cumulative effects associated with FMP 2.1 are shown in Tables 4.5-1 and 4.5-2.

EBS Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 2.1 (see Section 4.6.1.1).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the BSAI pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Removals of pollock occur in the Russian pollock fishery, and the catch is not accounted for in the annual harvest rates set for the US fishery. Therefore, the removals can be considered a potential adverse effect on fishing mortality. Catch and bycatch of pollock in the State of Alaska pollock fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of EBS pollock, and is insignificant. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be significantly adverse under FMP 2.1 (see Section 4.6.1.1).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the Russian and State of Alaska pollock fisheries. However, any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effects for change in biomass is identified under FMP 2.1. The effect is determined to be significantly adverse. Under this FMP, a large percentage reduction in biomass over the period 2003-2007 is predicted. The pollock stock is predicted to fall below MSST over the modeled period. The external factors are not expected to improve or mitigate the effect. Therefore the cumulative effect is judged to be significantly adverse.

Spatial/Temporal Concentration of Catch
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of catch is considered to be insignificant under FMP 2.1 (see Section 4.6.1.1).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had a beneficial effect on pollock recruitment by reducing the adult pollock biomass, lingering beneficial effects are identified for change in reproductive success. In addition, past commercial whaling and sealing also removed large predators of pollock adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** The Russian and State of Alaska pollock fisheries are identified as having potential adverse contributions to changes in genetic structure. However, removals in these fisheries could have a potential beneficial effects on pollock recruitment by reducing the adult pollock biomass. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** The cumulative effect on pollock reproductive success and genetic variability is considered insignificant under FMP 2.1. The concentration of harvest by the groundfish fisheries in combination with external effects are not expected to be of sufficient magnitude to adversely effect this stock.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.1 would have insignificant effects on pollock prey availability (see Section 4.6.1.1).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on pollock prey species are potentially adverse or beneficial; a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries are determined to have potential adverse contributions since bycatch and catch of forage species is likely to occur.

- **Cumulative Effects.** Cumulative effects are identified for prey availability, and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, as described in Section 4.6.1.1 FMP 2.1 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects identified for EBS pollock stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.1). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the EBS. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the Russian and State of Alaska fisheries since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its effect on the EBS pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 2.1 (see Section 4.6.1.1 Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, State of Alaska, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** Catch and bycatch of pollock in the State of Alaska pollock fisheries and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1, are identified for mortality of GOA pollock, but the effects are judged to be insignificant for the FMP. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMP 2.1. As modeled under the FMP, the age 2-10+ biomass of GOA pollock is expected to increase (see Table H.4-23 of Appendix H). The increase is anticipated primarily because recruitment is expected to improve from recent low levels.

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.15), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the State of Alaska pollock and shrimp fisheries. However, any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under the FMP 2.1; however, the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized. Therefore, the effects of FMP 2.1 on GOA pollock through the change in biomass are considered insignificant.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** As the density and quotas of pollock change during the modeled period, the concentration of the pollock fishery will change from the 2002 pattern; although, it is not possible to predict exactly how the pattern will change. However, the concentration of harvest by the groundfish fisheries is not expected to be of sufficient magnitude to adversely effect this stock. Therefore, FMP 2.1 is considered to have insignificant effects on GOA pollock through genetic structure and reproductive success.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.15) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** State of Alaska pollock fisheries and the State of Alaska shrimp fishery are identified as potential adverse contributors. However, these fisheries are unlikely to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** The cumulative effect on pollock reproductive success and genetic variability is considered insignificant under FMP 2.1. The concentration of harvest by the groundfish fisheries in combination with external effects are not expected to be of sufficient magnitude to adversely effect this stock. Therefore, the effects of FMP 2.1 on GOA pollock through the change in reproductive success and genetic variability are considered insignificant.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, as described under direct/indirect effects, the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for EBS pollock, climate changes and regime shifts could have potentially adverse or beneficial effects on pollock prey species. The other fisheries are determined to be potential adverse contributors. Since bycatch and catch of forage species used by pollock is unlikely to occur.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the FMP, and the combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST. Therefore, the cumulative effect of FMP 2.1 on GOA pollock through prey availability is considered insignificant.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, as described under direct/indirect effects, the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stocks include past foreign, JV, and State of Alaska, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.15). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska pollock and shrimp fisheries since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock would be either adverse or beneficial as described for EBS pollock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, the effects on the GOA pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

Direct/Indirect Effects of FMP 2.2

FMP 2.2 is less aggressive than FMP 2.1, and is similar to FMP 1 in many respects with the following exceptions:

- Current bycatch and incidental catch restrictions are removed.

- The BSAI optimum yield range of 1.4 - 2.0 million mt is removed, and the optimum yield is set to the sum of the individual species ABC levels.

<u>Total Biomass</u>

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H Under FMP 2.2, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 10.3 million mt in 2005, then increase to about 10.9 million mt by 2007. The 2003-2007 average total biomass is 10.8 million mt. Because the EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years, the effects of FMP 2.2 on EBS pollock through the change in biomass is insignificant.

In the Aleutian Islands region, the assessments are based trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. If under FMP 2.2, directed fishing for pollock in this region is allowed, the expectation is that the stock will remain stable or decrease in the future. A similar pattern is expected for the Bogoslof Island.

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,240,000 mt by 2007 (Table H.4-23 of Appendix H). The average biomass over this period is expected to be 1,040,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels. Thus, the effects of FMP 2.2 on GOA pollock through the change in biomass is considered insignificant.

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-1 Appendix H. Under FMP 2.2, projections indicate that EBS pollock spawning biomass will decrease to about 67 percent of the 2002 level by 2007. The projected average for 2003-2007 is 2.73 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Since under FMP 2.2 these areas may have developed fisheries, we expect the spawning stock size to remain stable or decrease in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 240,000 mt by 2007 under FMP 2.2. This is above the estimated B_{msy} level of 210,000 mt although the average from 2003-2007 is 188,000 mt. Model projections of future levels are shown in Table H.4-23 Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase by about 69 percent and average 0.315 for the period 2003-2007. These values are below the $F_{35\%}$ level of 0.448 and the $F_{40\%}$ level of 0.342, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. This pattern in fishing mortality is due to the fact that the projected catch is expected to come closer to the actual ABC in future years. The proportion of SPR conserved under these mortality rates is 40 percent in 2003. The average implied SPR rate of fishing from 2003-2007 is 42 percent, well below the value estimated for 2002 (indicating a higher fishing mortality rate for this FMP) (Table H.4-1 of Appendix H). Thus, the effect of FMP 2.2 on EBS pollock through mortality is considered insignificant. Fishing mortality for the Bogoslof and Aleutian Islands region may increase to 75 percent of natural mortality under FMP 2.2 (Table H.4-2 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.126 in 2003 followed by increases to 0.172 by 2007. The values for $F_{35\%}$ and $F_{40\%}$ are 0.350 and 0.294, respectively. The SPR rate in 2002 is estimated at 55 percent and averages about 60 percent for the period 2003-2007. This fishing mortality rate pattern is due to the fact that under this FMP, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$ (Table H.4-23 of Appendix H). Thus, the effect of FMP 2.2 on GOA pollock through mortality is considered insignificant.

Spatial/Temporal Concentration of Fishing Mortality

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (Jan 20-March). Under FMP 2.2, an average of 1.67 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial/temporal allocations as presented in Section 3.5.1.1. This concentration of harvest is not expected to be of sufficient magnitude to alter the genetic variability or reproductive success of the EBS pollock stock. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period.

In the GOA, pollock fishery in a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.15. Under FMP 2.2, an average of 75,600 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 111,000 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery will likely change from the 2002 pattern. However, this concentration of harvest is not expected to be of sufficient magnitude to alter the genetic variability or reproductive success of the GOA pollock stock.

Status Determination

Under FMP 2.2, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For FMP 2.2, GOA pollock spawning biomass is below the B_{msy} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007.

Age and Size Composition

Under FMP 2.2, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.43 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years (Table H.4-1 Appendix H). For GOA pollock the 2007 value is 3.07 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+) (Table H.4-23 of Appendix H).

Sex Ratio

In the models, the sex ratio of EBS and GOA pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under FMP 2.2 (for the period 2003-2007).

Summary of Effects of FMP 2.2 – Pollock

Because the EBS and GOA pollock are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 2.2 are considered insignificant. Fishing rates are lower than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Cumulative Effects of FMP 2.2 – EBS Pollock

While the internal modeling results change, the external effects and cumulative effects for FMP 2.2 in the EBS are the same as those discussed for FMP 1 and presented in Table 4.5-1. These effects are summarized below.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 2.2 (see Section 4.6.1.1 Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the BSAI pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** As described for the FMP 2.1 cumulative effects section, removals of pollock occur in the Russian pollock fishery are considered to be a potential adverse contributor, while removals in the Alaska pollock fisheries are not considered to contribute to pollock mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of EBS pollock, but the effect is judged to be insignificant. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be insignificant under FMP 2.2 (see Section 4.6.1.1 Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects are the same as those described above for FMP 2.1 and include the Russian and State of Alaska pollock fisheries, and marine pollution.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified, and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.6.1.1 Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects under FMP 2.2 are identical to those discussed for FMP 2.1 and include lingering beneficial effects on reproductive success.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the Russian and State of Alaska pollock fisheries have the potential to cause adverse effects on genetic structure and potential beneficial effects on pollock recruitment by reducing the adult pollock biomass. Cannibalism-related declines in pollock recruitment have been observed at high pollock spawning biomasses (see Section 3.5.1.1). Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see Section 4.6.1.1). However, it is determined that the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on pollock prey species could have potential beneficial or potential adverse effects (see the cumulative effects discussion for FMP 2.1). On the other hand, marine pollution has been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effects are insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see Section 4.6.1.1 Direct/Indirect Effects). However, it is determined that the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects identified for EBS pollock stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.1) Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the EBS. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 adverse effects are possible from the Russian and State of Alaska fisheries, and marine pollution. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock could be either beneficial or adverse.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability, and the effects on the EBS pollock stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, State of Alaska, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, catch and bycatch of pollock in the State of Alaska pollock fisheries, and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Marine pollution is identified as having a potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of GOA pollock, and the effects are judged to be insignificant for the FMP. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMP 2.2 (see Section 4.6.1.1).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.15), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described in FMP 2.1, effects on biomass are indicated due to removals in the State of Alaska pollock fisheries. Marine pollution is identified as having a potential adverse contribution to change in biomass, and climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified, and the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized. Therefore, the cumulative effect of FMP 2.2 on GOA pollock through the change in biomass is considered insignificant.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** As the density and quotas of pollock change during the modeled period, the concentration of the pollock fishery will change from the 2002 pattern; it is not possible to predict exactly how the pattern will change. However, for GOA pollock under FMP 2.2, the stock is expected to be above MSST for the years 2003-2007 (see Direct/Indirect Effects). Therefore, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.15) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the State of Alaska pollock fisheries and marine pollution are identified as potential adverse contributors.

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration under FMP 2.2; however, the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized. Therefore, the cumulative effects of FMP 2.2 on GOA pollock through the change in genetic structure and reproductive success are insignificant.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see above). However, as described under direct/indirect effects, the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, climate changes and regime shifts could have potential adverse or beneficial effects on pollock prey species. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown on Table 4.5-2 are determined to be potential adverse contributors.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST. Therefore, the cumulative effect of FMP 2.2 on GOA pollock through the change prey availability is considered are insignificant.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see Direct/Indirect Effects). However, it is determined that the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stocks include past foreign, JV, and State of Alaska, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.15). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects**. Future external effects are possible from the State of Alaska pollock and shrimp fisheries since either of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock would be either adverse or beneficial as described for EBS pollock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability, and the effect on the GOA pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

4.6.1.2 Pacific Cod

Pacific cod are managed under Tier 3a in the BSAI and GOA.

Direct/Indirect Effects of FMP 2.1

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-3 Appendix H. Under FMP 2.1, model projections indicate that total BSAI biomass is expected to increase to a value of 2,061,000 mt in 2003, then decrease to a value of 1,868,000 mt in 2007, with a 2003-2007 average value of 1,938,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-24 of Appendix H. Under FMP 2.1, model projections indicate that total GOA biomass is expected to increase steadily to a value of 631,000 mt in 2007, with a 2003-2007 average value of 598,000 mt.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-3 of Appendix H and Figure H. 4-2 of Appendix H. Under FMP 2.1, model projections indicate that BSAI spawning biomass is expected to decrease steadily to a value of 346,000 mt in 2007, with a 2003-2007 average value of 373,000 mt. Projected spawning biomass dips below the B_{MSY} proxy value of 361,000 mt in 2006 and 2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-24 of Appendix H and Figure H. 4-13 of Appendix H. Under FMP 2.1, model projections indicate that GOA spawning biomass is expected to decrease to a value of 69,700 mt in 2006, then increase to a value of 71,700 mt in 2007, with a 2003-2007 average value of 74,800 mt. Projected spawning biomass dips below the B_{MSY} proxy value of 79,000 mt in 2004, 2005, 2006, and 2007.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-3 of Appendix H. Under FMP 2.1, model projections indicate that BSAI fishing mortality will increase to a value of 0.409 in 2003, then remain there through 2007, giving a 2003-2007 average of 0.409. This value is equal to the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for any value of biomass under this FMP.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-24 of Appendix H. Under FMP 2.1, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.421 in 2004, then decrease to a value of 0.417 in 2007, with a 2003-2007 average of 0.419. These values are equal to or slightly below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for any value of biomass under this FMP.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a “control” treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are equal to or below their respective OFLs in all years under FMP 2.1 (Table H.4-3 of Appendix H). The BSAI Pacific cod stock is projected to be above MSST in 2003-2006 but below MSST in 2007. The GOA Pacific cod stock is projected to be above MSST in 2003 but below MSST in 2004. Information from the projection model is insufficient to determine the status of GOA Pacific cod with respect to MSST in 2005-2007 under this FMP (Table H.4-24 of Appendix H).

Age and Size Composition

Under FMP 2.1, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.6 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 2.1, the projected mean age of the GOA Pacific cod stock in 2008 is 2.7 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 on Pacific cod would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under this FMP.

Summary of Effects of FMP 2.1 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 2.1, both stocks are projected to fall below MSST at least once during the period 2003-2007, the biomass of both stocks is projected to be below $B_{40\%}$ throughout the period 2003-2007, the biomass of both stocks is expected to show an overall decrease during the period 2003-2007 and beyond, and all catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 2.1 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 2.1 on BSAI or GOA Pacific cod.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 2.1 on fishing mortality is rated insignificant, because the projection model indicates that fishing mortality would be less than or equal to the OFL throughout the period 2003-2007. However, the impact of FMP 2.1 on the biomass of the BSAI and GOA

Pacific cod stocks is rated significantly adverse, because the biomass of the BSAI Pacific cod stock is projected to fall below the MSST in 2007 and the GOA Pacific cod stock is projected to be below the MSST in 2004 (information from the projection model is insufficient to determine the status of GOA Pacific cod with respect to the MSST in 2005-2007 under this FMP).

The existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST. Furthermore, the impacts of spatial-temporal concentration on genetic structure under FMP 2.1 are expected to be not much greater than those of the existing concentration. However, because the BSAI and GOA Pacific cod stocks are projected to fall below their respective MSSTs at least once during the period 2003-2007 under FMP 2.1, the available evidence is insufficient to conclude whether changes in genetic structure due to spatial-temporal concentration of the catch under FMP 2.1 would materially impact either stock's ability to maintain itself at or above the MSST. Therefore, the magnitude of this effect is rated unknown for both stocks.

The existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST. Furthermore, the impacts of spatial-temporal concentration on reproductive success under FMP 2.1 are expected to be not much greater than those of the existing concentration. However, because the BSAI and GOA Pacific cod stocks are projected to fall below their respective MSSTs at least once during the period 2003-2007 under FMP 2.1, the available evidence is insufficient to conclude whether changes in reproductive success due to spatial-temporal concentration of the catch under FMP 2.1 would materially impact either stock's ability to maintain itself at or above the MSST. Therefore, the magnitude of this effect is rated unknown for both stocks.

The existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST. However, the level of groundfish harvest under FMP 2.1 is expected to be somewhat higher than the existing level and the BSAI and GOA Pacific cod stocks are projected to fall below their respective MSSTs at least once during the period 2003-2007 under FMP 2.1. Nevertheless, the fact that Pacific cod prey on many things besides groundfish makes it unlikely that changes in prey availability under FMP 2.1 would materially impact either stock's ability to maintain itself at or above the MSST. Therefore, the magnitude of this effect is rated insignificant for both stocks.

The existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST. Furthermore, the level of habitat disturbance under FMP 2.1 is expected to be not much greater than the existing level. However, because the BSAI and GOA Pacific cod stocks are projected to fall below their respective MSSTs at least once during the period 2003-2007 under FMP 2.1, the available evidence is insufficient to conclude whether changes in habitat suitability under FMP 2.1 would materially impact either stock's ability to maintain itself at or above the MSST. Therefore, the magnitude of this effect is rated unknown for both stocks (Table 4.6-1).

Cumulative Effects of FMP 2.1

For further information regarding persistent past effects listed below in the text and in the tables, see Sections 3.5.1.2 and 3.5.1.16. External effects and the resultant cumulative effects associated with FMP 2.1 are shown in Tables 4.5-3 and 4.5-4.

BSAI Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stock is insignificant under FMP 2.1 (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of BSAI Pacific cod, and is judged to be insignificant. Model projections indicate catch will be equal to, but not exceed the OFL for all years, and all catch and bycatch from external fisheries are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events are not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stock is expected to be significantly adverse under FMP 2.1 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery in the BSAI. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified under FMP 2.1. The effect is judged to be significantly adverse. Due to the internal effects of the FMP, biomass of BSAI stock is projected to fall below the MSST in 2007. The additional mortality from external human controlled events will likely cause additional reduction in biomass.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1, the effects of the spatial/temporal distribution of catch on the genetic structure and reproductive success of the population are unknown (see Section 4.6.1.2 Direct/Indirect Effects).

- **Persistent Past Effects.** Paste effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries and subsistence use in the BSAI have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown. Evidence is insufficient to conclude whether the combined effects of the internal and external actions/events would impact the stock's ability to maintain itself at or above MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of the FMP would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.1 would have insignificant effects on Pacific cod prey availability (see Section 4.6.1.2).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 levels of habitat disturbance may lead to changes in spawning or rearing success in the BSAI Pacific cod population. However, the evidence is insufficient to conclude that any changes that did occur would impact the stock's ability to sustain MSST. Therefore, the effect is rated as unknown (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod stock include past foreign, JV, domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stock are unknown, although a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its significance on the BSAI Pacific cod stock is unknown.

GOA Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stock is insignificant under FMP 2.1 (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries, and State of Alaska groundfish fisheries are identified for the GOA Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries in the GOA, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of GOA Pacific cod, and the effect is judged to be insignificant. Model projections indicate catch will be equal to, but not exceed the OFL for all years, and all catch and bycatch from external fisheries are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stock is expected to be significantly adverse under FMP 2.1 (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stock. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery and the State of Alaska groundfish fisheries in the GOA. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified under FMP 2.1. The effect is judged to be significantly adverse. Due to the internal effects of the FMP, biomass of GOA stock is projected to fall below the MSST in 2004. The additional mortality from external human controlled events could cause additional reduction in biomass.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1, the effects of the spatial/temporal distribution of catch on the genetic structure and reproductive success of the population are unknown (see direct/indirect discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.16) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, State of Alaska groundfish fisheries, and subsistence use in the GOA have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown. Evidence is insufficient to conclude whether the combined effects of the internal and external actions/events would impact the stock's ability to maintain itself at or above MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of the FMP would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.1 would have insignificant effects on Pacific cod prey availability (see Section 4.6.1.2).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described in the discussion of the Bering Sea stock, climate changes and regime shifts on Pacific cod prey species in the GOA could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 levels of habitat disturbance may lead to changes in spawning or rearing success in the GOA Pacific cod population. However, the evidence is insufficient to conclude that any changes that did occur would impact the stock's ability to sustain MSST. Therefore, the effect is rated as unknown (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod stock include past foreign, JV, domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, State of Alaska groundfish fisheries, and climate changes and regime shifts (see Section 3.5.1.16). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described for the Bering Sea, impacts on habitat from climate changes and regime shifts on the GOA Pacific cod stock could be either beneficial or adverse. Marine pollution has been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its significance on the GOA Pacific cod stock is unknown since the effect of the FMP is unknown.

Direct/Indirect Effects of FMP 2.2 – BSAI Pacific Cod

All direct and indirect effects of FMP 2.2 on BSAI Pacific cod are expected to be insignificant, because the analytic model results indicate that none of the threshold values for the significance criteria in Appendix A, Table 4.1-1 would be reached.

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Under FMP 2.2, model projections indicate that total BSAI biomass is expected to increase to a value of 2,078,000 mt in 2004, then decrease to a value of 2,057,000 mt in 2006, then increase to a value of 2,072,000 mt in 2007, with a 2003-2007 average value of 2,065,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Under FMP 2.2, model projections indicate that total GOA biomass is expected to increase steadily to a value of 675,000 mt in 2007, with a 2003-2007 average value of 622,000 mt.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Under FMP 2.2, model projections indicate that BSAI spawning biomass is expected to decrease to a value of 403,000 mt in 2003, then increase to a value of 435,000 mt in 2005, then decrease to a value of 425,000 mt in 2007, with a 2003-2007 average value of 422,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Under FMP 2.2, model projections indicate that GOA spawning biomass is expected to decrease to a value of 79,100 mt in 2005, then increase to a value of 85,700 mt in 2007, with a 2003-2007 average value of 83,100 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Under FMP 2.2, model projections indicate that BSAI fishing mortality will increase to a value of 0.297 in 2004, then decrease to a value of 0.287 in 2007, with a 2003-2007 average of 0.293. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for stocks above $B_{40\%}$.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Under FMP 2.2, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.324 in 2003, then decrease to a value of 0.289 in 2005, then increase to a value of 0.312 in 2007, with a 2003-2007 average of 0.304. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.2, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under FMP 2.2. The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007.

Age and Size Composition

Under FMP 2.2, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.7 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 2.2, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.2 on Pacific cod would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under this FMP.

Summary of Effects of FMP 2.2 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 2.2, both stocks are projected to remain above MSST throughout the period 2003-2007. The biomass of the BSAI stock is projected to be below $B_{40\%}$ in 2003 but above $B_{40\%}$ in 2004-2007, while the biomass of the GOA stock is projected to be below $B_{40\%}$ throughout the period 2003-2007. The biomass of the BSAI stock is expected to show an overall increase during the period 2003-2007 and beyond, while the biomass of the GOA stock is expected to show an overall decrease during the period 2003-2007 and beyond. All catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 2.2 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 2.2 on BSAI or GOA Pacific cod. Table 4.5-7 summarizes the effects of FMP 2.2 on Pacific cod stocks in the BSAI and GOA, respectively.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 2.2 on fishing mortality and biomass is rated insignificant, because the projection model indicates that fishing mortality would be less than the OFL and biomass would be above the MSST throughout the period 2003-2007.

Because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on genetic structure under FMP 2.2 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on reproductive success under FMP 2.2 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of groundfish harvest under FMP 2.2 is expected to be not much greater than the existing level, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success in the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of habitat disturbance under FMP 2.2 is expected to be not much greater than the existing level, the magnitude of this effect is rated insignificant for both stocks (Table 4.6-1).

Cumulative Effects of FMP 2.2 – BSAI Pacific Cod

For further information regarding past effects see Section 3.5.1.2. BSAI internal, external, and cumulative effects are depicted on Table 4.5-3.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stock is insignificant under FMP 2.2 (see direct/indirect effects discussion presented above).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, but they are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of BSAI Pacific cod, and the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stock is expected to be insignificant under FMP 2.2 (see Section 4.6.1.2).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery in the BSAI. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect on the change in biomass is identified, and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the IPHC longline and State of Alaska crab fisheries, subsistence use in the BSAI, and marine pollution could contribute adversely to genetic changes and reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration, and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.2 would have insignificant effects on Pacific cod prey availability (see direct/indirect effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown on Table 4.5-3 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Because the level of habitat disturbance under the FMP is expected to be no greater than the existing level, the effect is rated as insignificant (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod stock include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stock could be either beneficial or adverse and marine pollution could have an adverse effect on habitat.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability, and the combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST. Therefore, the effect of FMP 2.2 on BSAI Pacific cod through habitat suitability is considered insignificant.

GOA Pacific Cod

External effects and the resultant cumulative effects associated with FMP 2.2 are shown in Table 4.5-4.

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stock is insignificant under FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stock. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 in the GOA, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries in the GOA, but are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of GOA Pacific cod, and the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stock is expected to be insignificant under FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.16), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery, and in the State of Alaska groundfish fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect on the change in biomass is identified and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized. Therefore, the cumulative effect of FMP 2.2 on GOA pollock through the change in biomass is considered to be insignificant.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.16) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment particularly in the GOA where the State of Alaska groundfish fishery is very localized, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the IPHC longline and State of Alaska crab fisheries, subsistence use, and State of Alaska groundfish fisheries, and marine pollution all have the potential to cause adverse effects.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 2.2 would have insignificant effects on Pacific cod prey availability (see Direct/Indirect Effects).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 in the GOA, the effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse. Marine pollution has been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown on Table 4.5-4 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is rated as insignificant (see Section 4.6.1.2).

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.16). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA Pacific cod stock could be either beneficial or adverse and marine pollution has been identified as a potential adverse contributing factor.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST.

4.6.1.3 Sablefish

Sablefish are managed as one stock in the BSAI and GOA under Tier 3b; therefore, BSAI and GOA areas are discussed together in this section.

Direct/Indirect Effects of FMP 2.1

Direct/indirect effects are summarized in Table 4.6-1.

Catch/ABC

FMP 2.1 is projected to significantly increase average sablefish yield compared to the baseline. Higher yields are projected because a higher fishing rate ($F_{35\%}$) is used for F_{ABC}.

Total Biomass

FMP 2.1 is projected to have a significant impact on total biomass (age 2-31+) compared to the baseline. Fishing mortality is higher for this alternative (Tables H.4-11and H.4-30 of Appendix H). Total biomass is unchanged for this FMP rather than increasing as projected for alternatives that replicate baseline conditions.

Spawning Biomass

FMP 2.1 is projected to have a significantly adverse impact on spawning biomass compared to the baseline. Spawning biomass is projected to decrease by 2007, approaching some benchmarks that imply some risk to the reproductive success of the stock. Projected 2007 spawning biomass is 35 percent of the unfished value for this alternative, approaching the historic low spawning biomass (30 percent, 1975) and the lowest spawning biomass (34 percent, 1977) that produced above average year-classes (Sigler *et al.* 2002) (Tables H.4-11 and H.4-30 of Appendix H) and Figures H.4-9 and H.4-14 of Appendix H.

Fishing Mortality

Under FMP 2.1, the fishing mortalities imposed on the sablefish stock in the BSAI are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL. Fishing mortality is comparatively low because catch usually is less than ABC in the BSAI (Table H.4-11 of Appendix H). In contrast, the fishing mortalities imposed on the sablefish stock in the GOA are similar to the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Table H.4-30 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 2.1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. Although numerous current closed/restricted areas are repealed by FMP 2.1, these repeals little affect areas where adult sablefish are caught.

Status Determination

Under FMP 2.1, sablefish is not overfished but is projected to be approaching an overfished condition. Sablefish spawning biomass is projected to fall below B_{MSY} ($B_{35\%}$ for Tier 3 stocks) and remain there for at least a decade.

Age and Size Composition

FMP 2.1 is projected to have an insignificant impact on mean age compared to the baseline. The mean age decreases somewhat due to increased fishing mortality, but not enough to be classified as significant. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

BSAI mean age likely is overestimated. The model assumes that the lower exploitation rate for the BSAI compared to the GOA will translate into greater mean age for the BSAI. However sablefish migration is substantial enough to erase the effects of differential exploitation rates between the GOA and BSAI. The mean age for the GOA best represents the mean age for the BSAI/GOA because sablefish abundance is much greater for the GOA.

Sex Ratio

The sex ratio of the adult population is 40 males: 60 females, based on sex ratio data collected during sablefish longline surveys. This FMP probably would have no significant effect on the sex ratio compared to the baseline.

Habitat Suitability

FMP 2.1 would increase exploitation rates and so would increase any effects that additional fishing may have to decrease habitat suitability.

Predator-Prey Relationships

FMP 2.1 is projected to have a significant impact on total biomass (age 2-31+) compared to the baseline. Although total biomass doesn't change, fewer sablefish are projected for this FMP compared to alternatives that replicate baseline conditions. Thus this FMP is projected to have a significant effect on the amount of sablefish biomass that would be available to the ecosystem and the amount of predation that would be due to sablefish.

Cumulative Effects of FMP 2.1

External effects and the resultant cumulative effects associated with FMP 2.1 are depicted on Table 4.5-5. For further information regarding persistent past effects listed below in the text and in table, see the past/present effects analysis in Sections 3.5.1.3 and 3.5.1.17.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 2.1 (see Section 4.6.1.3).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska groundfish fisheries are identified for Sablefish. Large removals of Sablefish occurred, particularly in the JV and domestic fisheries. Catches that were under reported during the late 1980s may have contributed to abundance declines in the 1990s (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Sablefish are predicted to continue in the IPHC longline fishery, and State of Alaska groundfish fishery, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels and do not add additional fishing mortality. Due the highly migratory nature, Canadian fisheries, fishing within Canadian waters could be harvesting sablefish considered to be part of the GOA population. These removals are not accounted for in the TAC setting process and can be considered as having a potential adverse contribution to the cumulative case. Likewise, marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to direct Sablefish mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of sablefish, and is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the Sablefish stock is expected to be significantly adverse under FMP 2.1 (see Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of Sablefish and other past effects on biomass have been identified (see Sections 3.5.1.3 and 3.5.1.17), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to catch and bycatch in the IPHC longline and State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Sablefish mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified. The effect is judged to be significantly adverse since the combination of internal and external factors is expected to sufficiently reduce the Sablefish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure or reproductive success. While spatial/temporal concentration of catch occurred in the State of Alaska directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska groundfish fisheries, and Canadian fisheries all have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population or affect recruitment. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of harvest and is considered to be insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Sablefish prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Sablefish prey species (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Sablefish prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Sections 3.5.1.3 and 3.5.1.17). Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Sablefish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish habitat suitability (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for Sablefish include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Sections 3.5.1.3 and 3.5.1.17). Past fishing for Sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described for prey availability impacts on habitat from climate changes and regime shifts on the Sablefish stock could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability and are considered insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is jeopardized.

Direct/Indirect Effects of FMP 2.2

Direct/indirect effects are summarized in Table 4.6-1.

Catch/ABC

FMP 2.2 is projected to significantly increase average sablefish catch, but not ABC, compared to the baseline. Yields likely increase because fisheries where sablefish are caught as bycatch can catch the full ABC. For example, sablefish primarily are caught in a directed fishery, but also as bycatch in fisheries such as Greenland turbot in the Bering Sea. Setting the OY to the sum of the ABCs likely increases the amount of sablefish caught as bycatch.

Fishing Mortality

Under FMP 2.2, the fishing mortalities imposed on the sablefish stock are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Tables H.4-11and H.4-30 of Appendix H).

Total Biomass

FMP 2.2 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. Fishing mortality is higher for FMP 2.2, but catches remain relatively small compared to total biomass, so that the increased catches have an insignificant impact on total biomass (Tables H.4-11 and H.4-30 of Appendix H).

Spawning Biomass

FMP 2.2 is projected to have an insignificant impact on spawning biomass compared to the baseline. Fishing mortality is higher for FMP 2.2, but catches remain relatively small compared to spawning biomass, so that the increased catches have an insignificant impact on spawning biomass (Tables H.4-11 and H.4-30 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 2.2 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. FMP 2.2 closed areas are the same as baseline.

Status Determination

Under FMP 2.2, sablefish is not overfished nor approaching an overfished condition.

Age and Size Composition

FMP 2.2 is projected to have an insignificant impact on mean age compared to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

BSAI mean age likely is overestimated. The model assumes that the lower exploitation rate for the BSAI compared to the GOA will translate into greater mean age for the BSAI. However sablefish migration is substantial enough to erase the effects of differential exploitation rates between the GOA and BSAI. The mean age for the GOA best represents the mean age for the BSAI/GOA because sablefish abundance is much greater for the GOA.

Sex Ratio

The sex ratio of the adult population is 40 males: 60 females, based on sex ratio data collected during sablefish longline surveys. This FMP probably would have no significant effect on the sex ratio compared to the baseline.

Habitat Suitability

FMP 2.2 would increase exploitation rates and so would increase any effects that additional fishing may have to decrease habitat suitability.

Predator-prey Relationships

FMP 2.2 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline, so this FMP should have an insignificant effect on the amount of sablefish biomass available to the ecosystem and the amount of predation due to sablefish.

Cumulative Effects of FMP 2.2

External effects and the resultant cumulative effects associated with FMP 2.2 are depicted on Table 4.5-5. For further information regarding persistent past effects listed below in the text and in table, see the past/present effects analysis in Sections 3.5.1.3 and 3.5.1.17.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 2.2 (see direct/indirect effects discussion above).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska groundfish fisheries are identified for Sablefish. Large removals of Sablefish occurred, particularly in the JV and domestic fisheries. Catches that were under reported during the late 1980s may have contributed to abundance declines in the 1990s (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, bycatch and removals of Sablefish are predicted to continue in the IPHC longline fishery, State of Alaska groundfish fishery, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Due the highly migratory nature, Canadian fisheries, fishing within Canadian waters could be harvesting sablefish considered to be part of the GOA population. These removals are not accounted for in the TAC setting process and can be considered as having a potential adverse contribution to the cumulative case. Likewise, marine pollution is identified as having a reasonably foreseeable potential adverse contribution, but climate changes and regime shifts are not identified as being contributors to direct Sablefish mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of sablefish and is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be insignificant under FMP 2.2 (see Section 4.6.1.3).

- **Persistent Past Effects.** While past large removals of sablefish and other past effects on biomass have been identified (see Sections 3.5.1.3 and 3.5.1.17), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects on biomass are indicated due to catch and bycatch in the IPHC longline and State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass, but climate changes and regime shifts are not identified as being contributors to Sablefish mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified and is considered insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Sablefish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion for this FMP).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure or reproductive success. While spatial/temporal concentration of catch occurred in the State of Alaska directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, the IPHC longline and State of Alaska groundfish fisheries, Canadian fisheries and marine pollution, all have the potential to cause adverse effects.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration, and is considered insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish prey availability (see Direct/Indirect Effects).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Sablefish prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on sablefish prey species (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects of climate changes and regime shifts on Sablefish prey species could be beneficial or adverse. Marine pollution has been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown on Table 4.5-5 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** A cumulative effect is identified for prey availability, and the effect is considered insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the sablefish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish habitat suitability (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for sablefish include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Sections 3.5.1.3 and 3.5.1.17). Past fishing for Sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, effects are possible from the State of Alaska fisheries, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the Sablefish stock could be beneficial or adverse and marine pollution has been identified as a potential adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, they are determined to be is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is jeopardized.

4.6.1.4 Atka Mackerel

This section provides the effects analysis for BSAI and GOA Atka mackerel for each of the bookends under Alternative 2. The goal of Alternative 2 is to have a more aggressive harvesting policy while preventing overfishing of target groundfish stocks.

For further information regarding persistent past effects listed below in the text and in the tables, see the past/present effects analysis in Sections 3.5.1.4 and 3.5.1.18. Atka mackerel are managed as separate stocks in the BSAI and GOA; in the BSAI the species is managed under Tier 3a of the ABC and OFL definitions. However, in the GOA Atka mackerel are managed under Tier 6.

Direct/Indirect Effects of FMP 2.1

Model projections of future BSAI Atka mackerel catch and biomass levels under Alternative 2 assume the ABC level to equal the OFL.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced. Direct/indirect effects are summarized in Table 4.6-1.

<u>Catch and Fishing Mortality</u>

The average expected yield for BSAI Atka mackerel for the period 2003-2007 is 73,300 mt (Table H.4-17 of Appendix H). The catch and ABC values, which are equivalent in the projections, are expected to decrease through 2006. The average fishing mortality imposed on the BSAI Atka mackerel stock in 2002 is 0.251. Model projections show this value will increase to 0.564 in 2003, and remain at that level through 2007. The fishing mortality rate under FMP 2.1 (0.564) is equivalent to the F_{MSY} proxy ($F_{35\%}$) which is the rate associated with the OFL. Overall, the projections show a 125 percent increase in the average fishing mortality rate from 2002 to 2007.

Under the specifications of the projection model, no new fisheries could be developed that were not present during the time period 1997-2001. The current GOA ABC and TAC level is 600 mt. This low level of TAC is intended to preclude a directed fishery and only provide for bycatch in other fisheries. This harvest strategy has been applied to GOA Atka mackerel since 1997. Under FMP 2.1, the ABC for GOA Atka mackerel would be set equal to the OFL of 6,200 mt. At this harvest level, it is likely that a fishery for GOA Atka mackerel would be developed; however, catches could not be projected within the model for FMP 2.1 (Table H.4-38 of Appendix H).

Total Biomass

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. Under FMP 2.1, model projections indicate that total BSAI Atka mackerel is expected to decline to a value of 388,000 mt by 2005, then increase to a value of 410,000 mt by 2007, with a 2003-2007 average value of 412,000 mt. Overall, the projections show about a 15 percent decrease in total biomass from 2002 to 2007 under FMP 2.1.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Therefore, model projections are unable to predict future biomass levels. However, as noted above, it is likely that a fishery for GOA Atka mackerel would be developed under FMP 2.1. The likely impact of this fishery, while not modeled explicitly, is that the stock of Atka mackerel in the GOA would remain stable or decrease.

Spawning Biomass

Female spawning biomass of BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H and Figure H.4-11 of Appendix H. Under FMP 2.1, model projections indicate that BSAI spawning biomass is expected to decline to a value of 65,300 mt by 2005, then increase to a value of 73,700 mt by 2007, with a 2003-2007 average value of 76,500 mt. Overall, the projections show about a 38 percent decrease in female spawning biomass from 2002 to 2007 under FMP 2.1. Projected spawning biomass exceeds the proxy BMSY value ($B_{35\%}$) of 77,800 mt in 2003, but dips below the B_{MSY} value for the years 2004-2007.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Therefore, model projections are unable to predict future biomass levels. However, as noted above, it is likely that a fishery for GOA Atka mackerel would be developed under FMP 2.1. The likely impact of this fishery, while not modeled explicitly, is that the stock of Atka mackerel in the GOA would remain stable or decrease.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1, the current network of spatial/temporal closed areas is repealed, except for the temporal/spatial closures designated in the Steller sea lion protection measures which will remain in place.

The directed fishery for Atka mackerel is prosecuted by catcher processor bottom trawlers. The patterns of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring in the same few locations each year, at depths that typically range between 100 and 200 m. The localized pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next since local populations in the Aleutians appear to be replenished by immigration and recruitment. In addition, the management measures which distribute TAC spatially and temporally, remain in place. That is, the overall BSAI TAC is allocated to three management areas (western, central, and Bering Sea/eastern Aleutians), and the regional TACs are further allocated to two seasons and there are limits to the amount of catch that can be taken inside of Steller sea lion critical habitat. Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, these measures provide protection to Atka mackerel by reducing the risk of localized depletion through effort limitations and reductions. However, under FMP 2.1 catches of BSAI Atka mackerel would increase. It is unknown whether the increased effort would be accommodated through increased concentration of the catch or expanded exploitation in new areas, or a combination of both strategies. As such, the impacts of the spatial/temporal concentration of fishing mortality under FMP 2.1 is unknown.

Under FMP 2.1 there is the potential for development of a GOA Atka mackerel fishery and a substantial increase in fishing mortality. This could result in much higher concentrations of fishing mortality in time and space. However, it is unknown whether the potential increases in the spatial/temporal concentrations of GOA Atka mackerel catches under FMP 2.1 would affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success.

Status Determination

Model projections of future catches of BSAI Atka mackerel are equivalent to the OFL in all projection years under FMP 2.1(Table H.4-17 of Appendix H). Female spawning biomass is above $B_{35\%}$ (B_{MSY} proxy) in 2003, thus the BSAI Atka mackerel stock is determined to be above its MSST in the year 2003. Female spawning biomass dips below $B_{35\%}$ but remains above ½$B_{35\%}$ in each of the projection years 2004 to 2007. Long-term projections show that the stock does not rebuild to the $B_{35\%}$ level within 10 years of each of the projection years (2004 to 2007), therefore the BSAI Atka mackerel stock is determined to be below its MSST and overfished in the years 2004 to 2007.

GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Age and Size Composition

Under FMP 2.1, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.61 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

It is unknown what the actual level of GOA Atka mackerel catch would be under FMP 2.1. Although it is thought that changes in the age and size compositions of GOA Atka mackerel are more likely to be driven by variation in recruitment than to the effects of fishing, there is the potential for a substantial increase in fishing mortality under FMP 2.1 which could impact the age and size compositions in the short-term.

Sex Ratio

A 50:50 sex ratio is assumed for the BSAI Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future are unknown.

Habitat Suitability

Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, Steller sea lion protection measures may provide habitat protection for Atka mackerel through effort limitations and reductions. However, under FMP 2.1 catches of BSAI Atka mackerel would increase. It is unknown whether the increased effort would be accommodated through increased concentration of the catch or expanded exploitation in new areas, or a combination of both strategies. It is unknown whether the level of habitat disturbance caused by the fishery under FMP 2.1 would be sufficient to affect the sustainability of the stock through a decrease in reproductive success. As such, the impacts to habitat suitability under FMP 2.1 are unknown.

Under FMP 2.1 there is the potential for development of a GOA Atka mackerel fishery and a substantial increase in fishing mortality. It is likely that the increased effort would be accommodated through increased concentration of the catch and expanded exploitation in new areas. It is unknown whether the level of habitat disturbance caused by the fishery under FMP 2.1 would be sufficient to affect the sustainability of the stock through a decrease in reproductive success. As such, the impacts to habitat suitability under FMP 2.1 are unknown.

Predation-Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions that are currently difficult to quantify. Higher catches of Atka mackerel could impact the amount of Atka mackerel available to the ecosystem. Under FMP 2.1, fewer commercial-sized Atka mackerel would be available as prey and predators in the ecosystem. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.1 will not impact prey availability for BSAI and GOA Atka mackerel. Overall however, information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1.

Summary of Effects of FMP 2.1 – Atka Mackerel

The criteria used to estimate the significance of impacts of the FMPs on the BSAI and GOA stock of Atka mackerel are outlined in Section 4.1.1.1. The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis as the model projections yielded results that were deemed either significant (beneficial or adverse), insignificant, or unknown.

The ratings use the overfishing mortality rate (F_{OFL}) and the MSST for the fishing mortality effect and the MSST for all other effects, as a basis for the beneficial or adverse impacts of FMP 2.1. Because the mean projected BSAI Atka mackerel fishing mortality rates are equal to the overfishing mortality rate for the projection years 2003-2007, the overfishing aspect of the fishing mortality effect is insignificant for Alternative 2.1. The spawning stock biomass of BSAI Atka mackerel in 2003 is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is determined to be above its MSST for the year 2003 under FMP 2.1. However, the BSAI Atka mackerel stock is determined to be below its MSST and overfished in the years 2004 to 2007. Thus, the impact of the change in biomass aspect of the fishing mortality effect is determined to be significantly adverse. Although the BSAI Atka mackerel stock is determined to be below its MSST in the years 2004 to 2007, it is unknown whether the potential increases in the spatial/temporal concentrations of BSAI Atka mackerel catches under FMP 2.1 would affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success. Therefore the impact of the spatial temporal concentration of the catch is unknown. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.1 will not impact prey availability for BSAI Atka mackerel and the impact to the prey availability effect is determined to be insignificant. Because it is unknown whether the level of habitat disturbance caused by the fishery under FMP 2.1 would be sufficient to affect the sustainability of the BSAI Atka mackerel stock through a decrease in reproductive success, the impact to habitat suitability under FMP 2.1 is determined to be unknown.

Relative to the comparative baseline, under FMP 2.1, the BSAI Atka mackerel stock is overfished. Spawning biomass declines through 2005, after which biomass increases. Long-term (10 and 20 year) projections of spawning biomass show a very stable trend in biomass after 2007, with levels just below the $B_{35\%}$ level of 77,800 mt.

The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under FMP 2.1. As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration and habitat suitability effects is also unknown under FMP 2.1. Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.1 will not impact prey availability for GOA Atka mackerel, and the impact to prey availability is determined to be insignificant.

Relative to the comparative baseline, under FMP 2.1, the GOA Atka mackerel stock is likely to remain at low and possibly decreased abundance. There is the potential for a directed fishery to develop for GOA Atka mackerel.

Cumulative Effects of FMP 2.1 – BSAI Atka Mackerel

External effects and the resultant cumulative effects associated with FMP 2.1 for BSAI Atka mackerel are depicted on Table 4.5-6.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 2.1 (see Section 4.6.1.4).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the BSAI Atka mackerel stock. While large removals of Atka mackerel did occur in the past, there does not appear to be a lingering effect on the BSAI Atka mackerel populations (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as the only external event that could cause effects on the BSAI Atka mackerel population. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 is identified for mortality of BSAI Atka mackerel and the effect is judged to be insignificant. Fishing effort would not exceed the OFL and the stock is above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be significantly adverse under FMP 2.1 (see Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of Atka mackerel and other past effects on biomass have been identified (see Section 3.5.1.4), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified under FMP 2.1. The effect is judged to be significantly adverse. Due to the internal effects of the FMP, biomass of the BSAI stock is projected to fall below the MSST from 2004 to 2007. The additional mortality from external human controlled events will likely cause additional reduction in biomass.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** It is unknown whether the potential increases in the spatial/temporal concentrations of BSAI Atka mackerel catches under FMP 2.1 would affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success (see Direct/Indirect Effects).

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. Past commercial whaling and sealing also removed large predators of Atka mackerel adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown since it is not known how the changes in spatial/temporal concentration of the fishery under the FMP would affect the sustainability of the stock.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is judged insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of Atka mackerel prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability and the effect is insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the Atka mackerel stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** It is unknown whether the level of habitat disturbance caused by the fishery under FMP 2.1 would be sufficient to affect the sustainability of the stock (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for BSAI Atka mackerel stocks include past foreign, JV, domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.4). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its significance on the BSAI Atka mackerel stock is unknown.

Direct/Indirect Effects of FMP 2.2

Model projections of future BSAI Atka mackerel catch and biomass levels under FMP 2.2 assume the maximum permissible fishing mortality rate according to Amendment 56 ABC/OFL definitions.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA; therefore model projections of future biomass levels were not produced. Direct/indirect effects are summarized in Table 4.6-1.

Catch and Fishing Mortality

The average expected yield for BSAI Atka mackerel for the period 2003-2007 is 63,400 mt. The catch and ABC values, which are equivalent in the projections, are expected to decrease through 2006. The average fishing mortality imposed on the BSAI Atka mackerel stock in 2002 is 0.251. Model projections show this value will increase to 0.447 in 2003, decrease to 0.387 by 2005, then increase to 0.406 in 2007. Overall, the projections show a 62 percent increase in the average fishing mortality rate from 2002 to 2007. These values are well below the F_{MSY} proxy value of 0.564 which is the rate associated with the OFL (Table H.4-17 of Appendix H).

Projections of GOA Atka mackerel under FMP 2.2 indicate that catches will likely average 300 mt through 2007 (Table H.4-38 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g. Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

Total Biomass

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. Under FMP 2.2, model projections indicate that total BSAI Atka mackerel is expected to decline to a value of 412,000 mt by 2005, then increase to a value of 442,000 mt by 2007, with a 2003-2007 average value of 432,000 mt. Overall, the projections show an 8 percent decrease in total biomass from 2002 to 2007 under FMP 2.2.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Therefore, model projections are unable to predict future biomass levels.

Spawning Biomass

Female spawning biomass of BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H. Under FMP 2.2, model projections indicate that BSAI spawning biomass is expected to decline to a value of 77,700 mt by 2005, then increase to a value of 87,600 mt by 2007, with a 2003-2007 average value of 87,600 mt. Overall, the projections show a 26 percent decrease in female spawning biomass from 2002 to 2007 under FMP 2.2. Projected spawning biomass dips slightly below the proxy BMSY value of 77,800 mt in 2005, but otherwise exceeds the B_{MSY} value for the projection years 2003-2007.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Therefore, model projections are unable to predict future biomass levels.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.2, the current network of spatial/temporal closed areas is in place. The closures designated in the Steller sea lion protection measures probably have the largest impact relative to Atka mackerel.

The directed fishery for Atka mackerel is prosecuted by catcher processor bottom trawlers. The patterns of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring in the same few locations each year, at depths that typically range between 100 and 200 m. The localized pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next since local populations in the Aleutians appear to be replenished by immigration and recruitment. In addition, management measures would be in place that have the effect of spreading out the harvest in time and space. The overall BSAI TAC would be allocated to three management areas (western, central, and Bering Sea/eastern Aleutians). The regional TACs would be further allocated to two seasons and there would be limits to the amount of catch that can be taken inside of Steller sea lion critical habitat. Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, these measures provide protection to Atka mackerel by reducing the risk of localized depletion through effort limitations and reductions. The temporal/spatial concentration of the catch under FMP 2.2 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST.

Status Determination

Model projections of future catches of BSAI Atka mackerel are below the OFL in all years under FMP 2.2 (Table H.4-17 of Appendix H). Female spawning biomass is above $B_{35\%}$ (B_{MSY} proxy) in 2003-2004 and 2006-2007. Female spawning biomass dips slightly below $B_{35\%}$ in 2005, but rebuilds to the $B_{35\%}$ level by the following year, therefore the BSAI Atka mackerel stock is determined to be above its MSST and is not overfished under FMP 2.2.

GOA Atka mackerel are in Tier 6 and the stock's MSST is unknown; therefore a status determination cannot be made.

Age and Size Composition

Under FMP 2.2, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.73 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level, therefore, it is unlikely that the age and size compositions would change in the future under FMP 2.2. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than to the effects of fishing.

Sex Ratio

A 50:50 sex ratio is assumed for the BSAI Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future are unknown.

Habitat Suitability

Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, Steller sea lion protection measures may provide habitat protection for Atka mackerel through effort limitations and reductions. The level of habitat disturbance caused by the fishery under FMP 2.2, is not likely to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST.

Predator/Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.2. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.2 will not impact prey availability for BSAI and GOA Atka mackerel.

Summary of Effects of FMP 2.2 – Atka Mackerel

The criteria used to estimate the significance of impacts of the FMPs on the BSAI and GOA stock of Atka mackerel are outlined in Section 4.1.1.1. The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis as the model projections yielded results that were deemed either significant (beneficial or adverse), insignificant, or unknown.

The ratings use the overfishing mortality rate (F_{OFL}) and the MSST for the fishing mortality effect and the MSST for all other effects, as a basis for the beneficial or adverse impacts of FMP 2.2. Because the mean projected BSAI Atka mackerel fishing mortality rates are below the overfishing mortality rate, and the spawning stock is above its MSST in each of the projection years (2003-2007), the fishing mortality effect is insignificant for FMP 2.2. As noted above, the BSAI Atka mackerel stock is determined to be above its MSST under FMP 2.2. Thus, for all other effects, it was determined that FMP 2.2 did not jeopardize the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST, therefore the effects were insignificant.

Relative to the comparative baseline, under FMP 2.2, the BSAI Atka mackerel stock is not overfished. Spawning biomass declines through 2005, after which biomass increases. Long-term projections (10 and 20 year projections) of spawning biomass show a very stable trend in biomass after 2007, with levels similar to the 2007 level of 87,600 mt.

The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under FMP 2.2. As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration and habitat suitability effects are also unknown under FMP 2.2. Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.2 will not impact prey availability for BSAI Atka mackerel and the impact to the prey availability effect is determined to be insignificant.

Relative to the comparative baseline, under FMP 2.2, the GOA Atka mackerel stock is likely to remain at a low abundance under continued low exploitation as a bycatch fishery only.

Cumulative Effects of FMP 2.2

External effects and the resultant cumulative effects associated with FMP 2.2 are shown in Tables 4.5-6.

BSAI Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 2.2 (see Section 4.6.1.4). Overall, the projections show a 62 percent increase in the average fishing mortality rate from 2002 to 2007. These values are well below the F_{MSY} proxy value of 0.564 which is the rate associated with the OFL.

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the BSAI Atka mackerel stock. While large removals of Atka mackerel did occur in the past, there does not appear to be a lingering effect on the BSAI Atka mackerel populations (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as the only external event that could cause effects on the BSAI Atka mackerel population. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.2 is identified for mortality of BSAI Atka mackerel, and the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be insignificant under FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** While past large removals of Atka mackerel and other past effects on biomass have been identified (see Section 3.5.1.4), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 in the BSAI, marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass, and climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Atka mackerel biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The temporal/spatial concentration of the catch under the FMP does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST and the impact is judged insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** As discussed for FMP 2.1, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Also, since past fisheries could have had a beneficial effect on Atka mackerel recruitment by reducing the adult Atka mackerel biomass, lingering beneficial effects are identified for change in reproductive success. In addition, past commercial whaling and sealing also removed large predators of Atka mackerel adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, marine pollution could contribute adversely to genetic changes and reduced recruitment, and climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration, and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is judged insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of Atka mackerel prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. Marine pollution has been identified as a reasonably foreseeable future adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for prey availability, and the effect is insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the Atka mackerel stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The level of habitat disturbance caused by the fishery under FMP 2.2, does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST, and the effect is judged insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for BSAI Atka mackerel stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.4) Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As discussed under FMP 2.1, impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has been identified as a potential adverse contributing factor.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Atka mackerel stock to sustain itself at or above MSST is jeopardized.

Cumulative Effects of FMP 2.1 and FMP 2.2 – GOA Atka Mackerel

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced. Therefore, the internal effects of the FMPs are unknown for all categories with the exception of prey availability. In addition, the external effects and cumulative effects are the same for each FMP. Cumulative effects are summarized in Table 4.5-7.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Atka mackerel stock is unknown under FMP 2.1 and FMP 2.2. The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under both FMP.

- **Persistent Past Effects.** Past effects of the past foreign, JV, and domestic, fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, and JV fisheries, and have had a lingering effect on the GOA Atka mackerel population, which has not yet recovered (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the population is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 2.1 and FMP 2.2 is identified for mortality of GOA Atka mackerel, but the significance of the effect is unknown. GOA Atka mackerel are in Tier 6 and the stock's MSST is unknown; therefore a status determination cannot be made.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Atka mackerel stock is unknown under FMP 2.1 and FMP 2.2. Current reliable estimates of total and spawning biomass are unknown for GOA Atka mackerel.

- **Persistent Past Effects.** Persistent effects of the past foreign, JV, and domestic fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, and JV fisheries, and have had a lingering effect on the GOA Atka mackerel population, which has not yet recovered (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the population is affected. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified under FMP 2.1 and FMP 2.2, however, the significance of the effect is unknown.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel, which are in Tier 6, the significance of the spatial temporal concentration effects is also unknown under both FMP.

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. The past highly localized fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Also, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Also, climate changes and regime shifts could impact spawning success since a shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 2.1 and FMP 2.2 will not impact prey availability for BSAI Atka mackerel. The impact to prey availability is determined to be insignificant.

- **Persistent Past Effects.** While lingering population level effects on the invertebrate prey of Atka mackerel from past foreign, state, and domestic fisheries, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Atka mackerel prey species could be either beneficial or adverse depending on the direction of change. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is unknown since the direction of external effects is unknown.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the habitat suitability effects is also unknown under FMP 2.1.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA Atka mackerel stocks include past foreign, JV, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.18). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from climate changes and regime shifts on the GOA Atka mackerel could be either favorable or unfavorable depending on the direction of change. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, its significance on the GOA Atka mackerel stock is unknown.

4.6.1.5 Yellowfin Sole and Shallow Water Flatfish

Numerous fishery management actions have been implemented that affect the yellowfin sole fisheries in the BSAI. These actions are described in more detail in Section 3.5.1.5 of this SEIS. Yellowfin sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species by the National Standard Guidelines.

Eight flatfish species inhabit shallow waters and are managed in the shallow water flatfish assemblage in the GOA. They include: northern and southern rock sole, yellowfin sole, starry flounder, butter sole, English sole, Alaska plaice and sand sole. Survey results from 2001 indicate that over half of the estimated biomass (54 percent) of this assemblage are northern and southern rock sole. The shallow water group is managed as a Tier 4 and Tier 5 species in the GOA (Turnock *et al.* 2001).

For further information regarding persistent past effects listed below in the text and in these tables (see Sections 3.5.1.5 and 3.5.1.19).

BSAI Yellowfin Sole – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Direct/indirect effects are summarized in Table 4.6-1.

<u>Total Biomass</u>

The total biomass of yellowfin sole at the start of 2002 is estimated to be 1,552,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 2.1, model projections indicate that the total BSAI biomass is expected to decline more than 12 percent of the 2002 value to 1,361,000 mt by 2007, with a 2003-2007 average value of 1,435,000 mt. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to decline about 8 percent of the 2002 value to 1,420,000 mt by 2007, with a 2003-2007 average value of 1,467,000 mt.

<u>Spawning Biomass</u>

Spawning biomass of female yellowfin sole at the start of 2002 is estimated to be 450,700 mt. Model projections of future yellowfin sole spawning biomass estimates are shown in Table H.4-4 of Appendix H and Figure H.4-3 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to decline more than 25 percent of the 2002 value to 337,100 mt by 2007, with a 2003-2007 average value of 386,700 mt. Projected female spawning biomass is estimated to remain above the BMSY proxy value of 336,900 mt by the end of the five year projection.

Under FMP 2.2, model projections indicate that female spawning biomass is expected to decline 19 percent of the 2002 value to 364,900 mt by 2007, with a 2003-2007 average value of 402,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 336,900 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the yellowfin sole stock in 2002 is 0.064. Under FMP 2.1, model projections show this value will increase each year starting in 2004 ending at 0.138 in 2007. Under this FMP fishing mortality is at, but does not exceed, the F_{MSY} proxy value in 2007 (Table H.4-4 of Appendix H).

Under FMP 2.2, model projections show that this value will be 0.115 for 2003-2005 and decrease to 0.109 by 2007. This maximum value under this FMP is less than the F_{MSY} proxy value of 0.138, the rate associated with the OFL (Table H.4-4 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI yellowfin sole harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, Red King crab savings area, etc.), or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that yellowfin sole fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would not be affected under FMP 2.2.

Status Determination

Model projections of future catches of BSAI yellowfin sole are at (but do not exceed) the OFLs in 2003-2007 under FMP 2.1 and FMP 2.2. Female spawning biomass is above the MSST level in 2003-2007, as it was in the 2002 baseline year.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 5.9 years. Under FMP 2.2, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 6.1 years. This compares with a mean age in the equilibrium unfished BSAI stock of 8.0 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of yellowfin sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on yellowfin sole would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Yellowfin Sole

Table 4.6-1 summarizes the effects of FMP 2.1 and FMP 2.2 on BSAI yellowfin sole. The rating of conditionally significant (either beneficial or adverse) is not applicable in this analysis as the model projections yielded results that were determined either significant (beneficial or adverse), insignificant, or unknown.

The ratings utilize FOFL and the MSST as a basis for beneficial or adverse impacts on fishing mortality and changes in reproductive success for each FMP. A thorough description of the rationale for the MSST can be found in the National Standard Guidelines 50 CFR Part 600 (FR Vol. 63, No. 84, 24212-24237). Under FMP 2.1 and FMP 2.2, the spawning stock biomass of BSAI yellowfin sole is expected to be above the MSST throughout the five year projection. Since the fishing mortality rate does not exceed FOFL and the stock is projected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant.

Relative to the 2002 comparative baseline, the yellowfin sole stock is projected to continue to not be overfished under these FMPs. The 20 year projection indicates that the female spawning stock is expected to decline until 2010 to below B_{MSY} levels and will increase thereafter through the end of the projection to about the B_{MSY} level in 2023.

Cumulative Effects of FMP 2.1 and FMP 2.2

External effects and the resultant cumulative effects associated with FMP 2.1 and FMP 2.2 are shown in Table 4.5-8.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI yellowfin sole is rated as insignificant under FMP 2.1 and FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of yellowfin sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI yellowfin sole, but is rated as insignificant. Fishing mortality at projected levels is at, but do not exceed the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** It is not expected that FMP 2.1 or FMP 2.2 will result in an significant effect on yellowfin sole (see Section 4.6.1.5).

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the yellowfin sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Section 3.5.1.5 and 3.10).

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI yellowfin sole and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the spawning biomass is above the BMSY value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI yellowfin sole catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of yellowfin sole due to climate changes and regime shifts are potentially beneficial or adverse as described above for change in biomass. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI yellowfin sole.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the yellowfin sole catch and this effect is ranked as insignificant. The spatial/temporal distribution of yellowfin sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI yellowfin sole is ranked as insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI yellowfin sole stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Section 3.5.1.5 and 3.10).

- **Reasonably Foreseeable Future External Effects.** As described for change in biomass, effects of climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse. Marine pollution has been identified as having a potential adverse contribution since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for change in prey availability; however, these effects are considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI yellowfin sole is ranked as insignificant (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are identified for BSAI yellowfin sole include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Section 3.5.1.5 and Section 3.6.

- **Reasonably Foreseeable Future External Effects.** As described for change in biomass, climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for BSAI yellowfin sole habitat suitability and these effects are considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the yellowfin sole stock to sustain itself at or above the MSST is jeopardized.

GOA Shallow Water Flatfish – Direct/Indirect Effects of FMP 2.1and FMP 2.2

Direct/indirect effects are summarized in Table 4.6-1.

Total Biomass and Spawning Biomass

Estimates of total and spawning biomass are not available for the GOA shallow water flatfish species.

Fishing Mortality

The catch of GOA shallow water flatfish in 2002 was estimated to be 6,800 mt. Model projections of future catch are shown in Table H.4-27 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to decrease from the 2002 value to 1,200 mt in 2003 and then increase gradually to 1,400 mt in 2006 and 2007. The 2003-2007 average catch is 1,300 mt (20 percent of the 2002 catch). Under FMP 2.2, model projections indicate that the catch is expected to decrease from 6,000 mt in 2003 to 5,000 mt in 2007. The 2003-2007 average catch is 5,600 mt.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual GOA shallow water flatfish harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates.

Because FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA shallow water flatfish fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual GOA shallow water flatfish harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information for flatfish species in the shallow water complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species in the National Standard Guidelines. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition projections are not available for the GOA shallow water flatfish species.

Sex Ratio

The sex ratio of shallow water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on shallow water flatfish would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Shallow Water Flatfish

The direct and indirect effects of FMP 2.1 and FMP 2.2 on GOA shallow water flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the five year projection and what level of fishing mortality corresponds to the modeled catch estimated under this FMP (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

External effects and the resultant cumulative effects associated with FMP 1 are shown in Table 4.5-9.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shallow water flatfish is rated as insignificant under FMP 2.1 and FMP 2.2 (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past JV and domestic fisheries have been identified as having lingering past adverse effects on the GOA shallow water flatfish complex (see Section 3.5.1.19).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shallow water flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since shallow water flatfish species bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA shallow water flatfish, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Since the total and spawning biomass estimates for GOA shallow water species is unavailable, the effects of FMP 2.1 and FMP 2.2 on change in biomass is unknown.

- **Persistent Past Effects.** The past JV and domestic fisheries are identified as having past lingering adverse effects on the biomass levels of GOA shallow water flatfish (see Section 3.5.1.19).

- **Reasonably Foreseeable Future External Events.** Future external effects on mortality are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the shallow water flatfish species biomass level. For more information on climate changes and regime shifts (see Sections 3.5.1.19 and 3.10). The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for change in biomass of GOA shallow water flatfish, but is rated as unknown. Fishing mortality at projected levels is well below the OFL for this stock. It is unknown if the combined effects of internal removals and removals are likely to jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of the annual GOA shallow water flatfish harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates. Because FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA shallow water flatfish fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. However, little is known about the spatial/temporal characteristics of GOA shallow water flatfish, therefore the effects of FMP 2.1 and FMP 2.2 are rated as unknown.

- **Persistent Past Effects.** Past effects have not been identified for the change in genetic structure or the change in reproductive success of GOA shallow water flatfish.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of shallow water flatfish species due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution, and th State of Alaska scallop fishery has been identified as a non-contributing factor to the change in genetic structure and reproductive success since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** Cumulative effects are possible for the change in genetic structure and reproductive success of GOA shallow water flatfish, but are rated as unknown. It is unknown if the combined effects of internal removals and removals due to reasonably foreseeable future external events are likely to jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA shallow water flatfish is determined to be unknown (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA shallow water flatfish stock complex and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.1.19 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution. The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of shallow water flatfish prey species is not expected to occur in this fishery.

- **Cumulative Effects.** Cumulative effects for change in prey availability are unknown. The predation-mediated impacts of FMP 2.1 and FMP 2.2 on shallow water flatfish are governed by a complex web of indirect interactions that are currently difficult to quantify.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA shallow water flatfish complex is considered to be unknown (see Direct/Indirect Effects).

- **Persistent Past Effects.** Past effects identified for GOA shallow water flatfish include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Section 3.5.1.19 and Section 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse contribution. The State of Alaska scallop fishery is also identified as a potential adverse contributor to GOA shallow water flatfish habitat suitability (see Section 3.6).

- **Cumulative Effects.** Cumulative effects are identified for GOA shallow water flatfish habitat suitability; however, these effects are unknown. It is unknown if the combination of internal and external habitat disturbances will to lead to a detectable change in spawning or rearing success such that the ability of the GOA shallow water flatfish stock to maintain current population levels is jeopardized.

4.6.1.6 Rock Sole

BSAI rock sole is described in more detail in Section 3.5.1.6 of this Programmatic SEIS. Rock sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Direct/indirect effects are summarized in Table 4.6-1.

Total Biomass

The total biomass of rock sole at the start of 2002 is estimated to be 970,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-7 of Appendix H. Under FMP 2.1, model projections indicate that the total BSAI biomass is expected to decline 30 percent of the 2002 value to 680,000 mt by 2007, with a 2003-2007 average value of 764,000 mt. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to decline about 33 percent of the 2002 value to 645,000 mt by 2007, with a 2003-2007 average value of 744,000 mt.

Spawning Biomass

Spawning biomass of female rock sole at the start of 2002 is estimated to be 331,000 mt. Model projections of future rock sole spawning biomass estimates are shown in Table H.4-7 and Figure H.4-6 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to decline 47 percent of the 2002 value to 176,400 mt by 2007, with a 2003-2007 average value of 237,500 mt. Projected female spawning biomass is estimated to remain above the B_{MSY} proxy value of 136,700 mt throughout the five year projection.

Under FMP 2.2, model projections indicate that female spawning biomass is expected to decline 51 percent of the 2002 value to 161,300 mt by 2007, with a 2003-2007 average value of 229,000 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 136,700 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the rock sole stock in 2002 is 0.055. Under FMP 2.1, model projections show this value will increase each year reaching 0.126 in 2007. Under FMP 2.2, model projections show this value will steadily increase to 0.161 by 2007. These maximum values are less than the F_{MSY} proxy value of 0.21, the rate associated with the OFL (Table H.4-7 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI rock sole harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.) or areas where they avoided because of high bycatch.

The spatial/temporal characteristics of the annual BSAI rock sole harvest could be affected under FMP 2.2 if managers adopt PSC limits proportional to the abundance levels of the bycatch species. However, it is not known how this would affect future fishing behavior in terms of avoidance of bycatch species.

Status Determination

Model projections of future catches indicate that the fishing mortality rate does not exceed the OFL and that female spawning stock size of BSAI rock sole are above the MSST levels in 2003-2007 under FMP 2.1 and FMP 2.2. The rock sole stock is also above the MSST level in 2002 baseline year.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI rock sole stock in 2008, as computed in model projections is 4.4 years. Under FMP 2.2, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 4.6 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of rock sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on rock sole would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Rock Sole

Under FMP 2.1 and FMP 2.2, the spawning stock biomass of BSAI rock sole is expected to be above the MSST through 2007. Since the F_{OFL} is not exceed and the female spawning stock is currently above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the rock sole stock is projected to continue to not be overfished under these FMPs. The 20 year projection (Figure H.4-6 of Appendix H) indicates that the female spawning stock is expected to decline until 2010 to B_{MSY} levels and will increase thereafter through the end of the projection in 2023 under FMP 2.1. Under FMP 2.2, the 20 year projection indicates that the female spawning stock is expected to decline until 2010. Beginning in 2009 it will be below the B_{MSY} level for three years before increasing to the end of the projection in 2003, exceeding the B_{ABC} level in 2015.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects are summarized in Table 4.5-10 for BSAI rock sole.

Mortality

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of fishing mortality on the BSAI rock sole is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rock sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI rock sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effects of the fisheries on BSAI rock sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the rock sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.6 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI rock sole, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the BSAI rock sole. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of BSAI rock sole. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of rock sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI rock sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rock sole catch, and is ranked as insignificant. The spatial/temporal distribution of rock sole catch is not expected to change significantly. The combined effect of internal removals and removals due to Reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in prey availability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do effect the availability of some forage species (i.e. capelin); however, studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in habitat suitability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI rock sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI rock sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the rock sole stock to sustain itself at or above the MSST is jeopardized.

4.6.1.7 Flathead Sole

BSAI and GOA flathead sole are described in more detail in Sections 3.5.1.7 and 3.5.1.20 of this Programmatic SEIS. Flathead sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2002, flathead sole were managed independent of the other flatfish complex in the GOA. Until recently, flathead sole were managed under Tier 3; as of 2004 GOA flathead sole are managed under Tier 3. GOA flathead sole were modeled under the Tier 4 category for this analysis.

BSAI Flathead Sole – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total Biomass

Total biomass of BSAI flathead sole at the start of 2003 is estimated to be 513,000 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 2.1, model projections indicate that BSAI biomass is expected to decrease to a value of 454,000 mt in 2007, with a 2003 to 2007 average value of 475,000 mt. Under FMP 2.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 477,000 mt in 2008, with a 2003-2008 average value of 485,000 mt.

Spawning Biomass

Spawning biomass of BSAI flathead sole at the start of 2003 is estimated to be 229,400 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 and Figure H.4-7 of Appendix H. Under FMP 2.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 146,300 mt in 2007. The projected average biomass from 2003-2007 is 185,600 mt. Under FMP 2.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 149,200 mt in 2008, with a 2003-2008 average value of 187,100 mt.

Fishing Mortality

Under FMP 2.1, the projected fishing mortality imposed on the BSAI flathead sole stock is 0.11 in 2003, and increases to 0.145 in 2007. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 63 percent in 2003 and decreases to 57 percent in 2007, with an average of 60 percent from 2003-2007 (Table H.4-8 of Appendix H).

Under FMP 2.2, the projected fishing mortality imposed on the BSAI flathead sole stock is approximately 0.099 in 2003, increasing to 0.156 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 66 percent in 2003, increasing to 76 percent in 2005, and decreases to 57 percent in 2008, with an average of 67 percent from 2003-2008 (Table H.4-8 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 involves the resumption of fishing in a number of areas currently closed, and these areas are largely in the EBS. The projected average harvest from 2003-2008 increased to 35,300 mt, due largely to increased catch in the directed flathead sole fishery (13,960 mt, 40 percent) and the Pacific cod trawl fishery (14,320 mt, 41 percent).

Under FMP 2.2, the average projected catch from 2003-2008 is 19,200 mt, of which 6,700 mt (34 percent) occurred in the EBS shelf flathead sole fishery with the remaining harvest divided approximately evenly between the yellowfin sole, rock sole, Pacific cod, and walleye pollock fisheries.

Status Determination

Under FMP 2.1 and FMP 2.2, the ABC is set equal to the OFL, removing the buffer between these two harvest regulations. Model projections of future catches of BSAI flathead sole are below the OFL level from 2003 to 2008.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections, is 4.02 years. Under FMP 2.2, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-8 of Appendix H), is 4.38 years. This compares with a mean age in the equilibrium unfished stock of 5.39 years.

Sex Ratio

The sex ratio of BSAI flathead sole is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 and FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 2.1 and FMP 2.2.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Flathead Sole

Although the ABC and OFL levels for flathead sole are equivalent under FMP 2.1, the F_{OFL} is not reduced for lower stock sizes, and the harvest of flathead sole under FMP 2.1 is increased relative to recent levels, the fishing rates on flathead sole do not exceed the $F_{40\%}$ reference point and are within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Thus, the direct and indirect effects of FMP 2.1 on flathead sole are considered insignificant.

Because the BSAI flathead sole are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 2.2 are considered insignificant. Fishing rates are lower than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Relative to the 2002 comparative baseline, the flathead sole stock is projected to continue to not be overfished under this FMP. Under FMP 2.1, the twenty year projection (Figure H.4-7 of Appendix H) indicates that the female spawning stock expected to decrease until 2010 at which time it will be begin to steadily increase throughout the end of the projection. Under FMP 2.2, the twenty year projection indicates that the female spawning stock expected to decrease until 2009 at which time it will be begin to steadily increase throughout the end of the projection. The female spawning stock is estimated to remain above B_{ABC} throughout the projection for both FMPs.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects of BSAI flathead sole are summarized in Table 4.5-11.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI flathead sole is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI flathead sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on BSAI flathead sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the flathead sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.7 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI flathead sole, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the spawning biomass is above the B_{MSY} value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI flathead sole catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch, and is ranked as insignificant. The spatial/temporal distribution of flathead sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects are not identified for the change in prey availability of the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.7.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI flathead sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at or above the MSST is jeopardized.

GOA Flathead Sole – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass

Estimates of total and spawning biomass are currently unavailable for this species.

Fishing Mortality

The catch of GOA flathead sole in 2002 was estimated to be 2,000 mt. Model projections of future catch are shown in Table H.4-28 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to decrease to 1,600 mt in 2003 and slowly increase to 2,400 in 2006 and 2007. The 2003-2007 average catch is estimated at 2,100 mt.

Under FMP 2.2, model projections indicate that the catch is expected to decrease to 1,600 mt in the first two years of the projections and then be at 1,500 mt in the last two years. The 2003-2007 average catch is 1,600 mt (80 percent of the 2002 catch). The average annual fishing mortality imposed on the flathead sole stock in 2002 is 0.055. Model projections show this value will increase to 0.137 in 2007. These values are well below the F_{MSY} proxy value of 0.21, the rate associated with the OFL.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the GOA flathead sole harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA flathead sole fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual GOA flathead sole harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information GOA flathead sole requires that they are classified into the Tier 4 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are currently unavailable for this species.

Sex Ratio

The sex ratio of flathead sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on flathead sole would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – GOA Flathead Sole

The direct and indirect effects of FMP 2.1 and FMP 2.2 on GOA flathead sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the five year projection and what level of fishing mortality corresponds to the modeled catch estimated under this FMP (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects of GOA flathead sole are summarized in Table 4.5-12.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA flathead sole is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Removals by these fisheries have had a lingering adverse effect on GOA flathead sole (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole. The State of Alaska scallop fishery has also been identified as a non-contributing factor since GOA flathead sole bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA flathead sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonable foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in biomass level is rated as unknown since MSST is unable to be determined at this time.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Large removals of flathead sole by these fisheries is determined to have had a lingering effect on the GOA flathead sole stock (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the flathead sole biomass level. For more information on climate changes and regime shifts see Sections 3.5.1.20 and 3.10. The State of Alaska scallop fishery is identified as a non-contributing factor for change in biomass level since flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA flathead sole, but is unknown. The MSST is not able to be determined and the total and spawning biomass estimates are currently unavailable. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA flathead sole stock. However, climate changes and regime shifts have been identified as having a beneficial or adverse effect on GOA flathead sole reproductive success see Section 3.5.1.20 for more information on the effects of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA flathead sole. The State of Alaska scallop fishery has been identified as a non-contributing factor to change in genetic structure and change in reproductive success since GOA flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch; however, this effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA flathead sole stock and include climate changes and regime shifts. For more information on the effects of climate changes and regime shifts on the GOA flathead sole stock see Section 3.5.1.20.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole prey availability. The State of Alaska scallop fishery gear could impact flathead sole benthic prey availability and/or quality.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to sustain itself at current population levels.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects identified for GOA flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.20.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole habitat suitability. For information on the effects of fishery gear on EFH see Section 3.6.

- **Cumulative Effects.** A cumulative effect is identified for GOA flathead sole habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at current population levels.

4.6.1.8 Arrowtooth Flounder

BSAI and GOA arrowtooth flounder are described in more detail in Sections 3.5.1.8 and 3.5.1.21 of this Programmatic SEIS. Arrowtooth flounder is managed as its own stock under the BSAI and GOA groundfish FMPs under the Tier 3 management category, thus MSSTs are defined for these species.

BSAI Arrowtooth Flounder – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total Biomass

The total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-6 of Appendix H. Under FMP 2.1, model projections indicate that the total BSAI biomass is expected to decline 28 percent of the 2002 value to 588,000 mt by 2007, with a 2003-2007 average value of 669,000 mt. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to decline about 27 percent of the 2002 value to 594,000 mt by 2007, with a 2003-2007 average value of 673,000 mt.

Spawning Biomass

Spawning biomass of female BSAI arrowtooth flounder at the start of 2002 is estimated to be 475,900 mt. Model projections of future arrowtooth flounder spawning biomass estimates are shown in Table H.4-6 and Figure H.4-5 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to decline 32 percent of the 2002 value to 323,500 mt by 2007, with a 2003-2007 average value of 384,000 mt. Projected female spawning biomass is estimated to remain above the B_{MSY} proxy value of 182,900 mt throughout the five year projection.

Under FMP 2.2, model projections indicate that female spawning biomass is expected to decline 31 percent of the 2002 value to 327,600 mt by 2007, with a 2003-2007 average value of 386,700 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 182,900 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the BSAI arrowtooth flounder stock in 2002 is 0.015. Under FMP 2.1, model projections under this FMP show this value will increase to double the 2002 baseline value in 2007. Under FMP 2.2, model projections show this value will steadily increase to 0.032 by 2007. These projected values are below the F_{MSY} proxy value (0.38), the rate associated with the OFL (Table H.4-6 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI arrowtooth flounder harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.) or areas which were previously avoided because of high bycatch.

Because FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that arrowtooth flounder fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual BSAI arrowtooth flounder harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

Model projections of future catches of BSAI arrowtooth flounder are below the OFL in 2004-2007 under FMP 2.1 and FMP 2.2. The BSAI arrowtooth flounder female spawning biomass is above the MSST level throughout the five year projection and in the 2002 baseline year.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections, is 4.5 years. Under FMP 2.2, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-6 of Appendix H), is 4.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.4 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the BSAI have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 2.1 and FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on BSAI arrowtooth flounder would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Arrowtooth Flounder

Under FMP 2.1 and FMP 2.2, the spawning stock biomass of BSAI arrowtooth flounder is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the BSAI spawning biomass is projected to continue to not be overfished under these FMPs. The 20 year projection (Figure H.4-5 of Appendix H) indicates that both female spawning stocks are expected to remain above B_{ABC} levels through the end of the projection in 2023.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI arrowtooth flounder are summarized in Table 4.5-13.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI arrowtooth flounder is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of arrowtooth flounder. The IPHC longline fishery is identified as a potential adverse contributor to BSAI arrowtooth flounder mortality since arrowtooth flounder are caught as bycatch in this fishery. Finally, the State of Alaska herring fishery is identified as a non-contributing factor to BSAI arrowtooth flounder mortality since bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on arrowtooth flounder biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the arrowtooth flounder biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Section 3.5.1.8 and 3.10. The IPHC longline fishery has been identified as a potential adverse contributor to BSAI arrowtooth flounder biomass level since bycatch is expected to occur in this fishery. Finally, the State of Alaska herring fishery is identified as a non-contributing factor since arrowtooth flounder bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

<u>Spatial/Temporal Concentration of Catch</u>
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI arrowtooth flounder. Climate changes and regime shifts are identified as having had potential adverse or beneficial effects on the reproductive success of BSAI arrowtooth flounder see Section 3.5.1.8 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of arrowtooth flounder due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI arrowtooth flounder. The IPHC longline fishery is identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since the removals are not expected to be significant. The State of Alaska herring fishery is also identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch, and is ranked as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified include the past foreign, JV, and domestic fisheries, State of Alaska groundfish fisheries, State of Alaska herring fisheries and climate changes and regime shifts (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potential beneficial or adverse. Some forage species (i.e. capelin and herring), shrimp and pollock respond to variations in water temperatures which vary with the climate. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor to prey availability since the bycatch of prey species is not expected in this fishery. The State of Alaska herring fishery is identified as a potential adverse contributor to prey availability by reducing the availability of herring.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI arrowtooth flounder include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.8.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery and the State of Alaska herring fishery are both identified as non-contributing factors to BSAI arrowtooth flounder habitat suitability. The impacts from the fishery gear is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for BSAI arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

GOA Arrowtooth Flounder – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total Biomass

The total biomass of GOA arrowtooth flounder at the start of 2002 is estimated to be 1,816,000 mt. Model projections of future total GOA biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 2.1, model projections indicate that the total GOA biomass is expected to increase 15 percent of the 2002 value to 2,086,000 mt by 2007, with a 2003-2007 average value of 1,982,000 mt. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to increase about 14 percent of the 2002 value to 2,080,000 mt by 2007, with a 2003-2007 average value of 1,979,000 mt.

Spawning Biomass

Spawning biomass of female GOA arrowtooth flounder at the start of 2002 is estimated to be 1,113,800 mt. Model projections of future arrowtooth flounder spawning biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to increase 2 percent of the 2002 value to 1,125,800 mt by 2007, with a 2003-2007 average value of 1,127,200 mt. Projected female spawning biomass is estimated to remain above the B_{MSY} proxy value of 432,700 mt throughout the five year projection.

Under FMP 2.2, model projections indicate that female spawning biomass is expected to increase 3 percent of the 2002 value to 1,151,300 mt by 2007, with a 2003-2007 average value of 1,140,200 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 432,700 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the GOA arrowtooth flounder stock in 2002 is 0.017. Under FMP 2.1, model projections indicate that fishing mortality will remain at about this level at 0.017 or 0.018 each year through 2007. Under FMP 2.2, model projections show this value will steadily decrease to 0.01 by 2007. These projected values are below the F_{MSY} proxy value (0.165), the rate associated with the OFL (Table H.4-29 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual GOA arrowtooth flounder harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.) or areas which were previously avoided because of high bycatch.

Because FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that arrowtooth flounder fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual GOA arrowtooth flounder harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

Model projections of future catches of GOA arrowtooth flounder are below the OFLs in 2004-2007 under FMP 2.1 and FMP 2.2. The GOA arrowtooth flounder female spawning biomass is above the MSST level throughout the five year projection and in the 2002 baseline year.

Age and Size Composition

Under FMP 2.1, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-29 of Appendix H), is 5.0 years. Under FMP 2.2, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-29 of Appendix H), is 5.0 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.1 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the GOA have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1and FMP 2.2 on GOA arrowtooth flounder would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1.

Summary of Effects of FMP 2.1 and FMP 2.2 – GOA Arrowtooth Flounder

Under FMP 2.1 and FMP 2.2, the spawning stock biomass of GOA arrowtooth flounder is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under this FMP are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the GOA spawning biomass is projected to continue to not be overfished under these FMPs. The 20 year projection (Table H.4-29 of Appendix H) indicates that both female spawning stocks are expected to remain above B_{ABC} levels through the end of the projection in 2023.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA arrowtooth flounder are summarized in Table 4.5-14.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA arrowtooth flounder is rated as insignificant under FMP 2.1 and FMP 2.2.
- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA arrowtooth flounder stock.
- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI arrowtooth flounder under this FMP.
- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on GOA arrowtooth flounder biomass is insignificant.
- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the GOA arrowtooth flounder stock.
- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI arrowtooth flounder under this FMP.
- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.
- **Persistent Past Effects.** Past effects identified for the change in genetic structure and reproductive success of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch, and is ranked as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified include climate changes and regime shifts (see Section 3.5.1.21).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey availability are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for the habitat suitability of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on habitat suitability are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for GOA arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

4.6.1.9 Greenland Turbot and Deepwater Flatfish

BSAI Greenland turbot and GOA deepwater flatfish are described in more detail in Sections 3.5.1.9 and 3.5.1.22 of this Programmatic SEIS. Greenland turbot is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category; thus MSSTs are defined for these species. The reference fishing mortality rate and ABC for the GOA deepwater flatfish management group are determined by the amount of population information available. ABCs for Dover sole were calculated using Tier 5. Greenland turbot and deepsea sole are in Tier 6 because no reliable biomass estimates exist.

BSAI Greenland Turbot – Direct/Indirect Effects of FMP 2.1

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 2.1, model projections indicate that the total BSAI biomass is expected to decline 39 percent of the 2002 value to 64,000 mt by 2007, with a 2003-2007 average value of 77,000 mt.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-5 and Figure H.4-4 of Appendix H. Under FMP 2.1, model projections indicate that female spawning biomass is expected to decline 57 percent of the 2002 value to 29,300 mt by 2007, with a 2003-2007 average value of 42,500 mt. Projected female spawning biomass is estimated to decline below the B_{MSY} proxy value of 47,570 mt (after five years of harvest at the F_{MSY} value) by the end of the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Model projections show this value will increase to 0.483 for each year of the projection through 2007. This level of harvest is at, but does not exceed the F_{MSY} proxy value, the rate associated with the OFL (Table H.4-5 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI Greenland turbot harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.), although these locations are shallow areas which are not habitat for adult Greenland Turbot. In addition, they may fish in areas they purposefully avoided in the baseline year due to high bycatch rates.

Status Determination

Model projections of future catches of BSAI Greenland turbot do not exceed the OFL in 2003-2007 under FMP 2.1. However, the female spawning stock is below the MSST level during the five year projection under the FMP 2.1 harvest scenario. The Greenland turbot stock is above the MSST level in the baseline year 2002.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.1 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 on Greenland turbot would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1.

Summary of Effects of FMP 2.1 – BSAI Greenland Turbot

Under FMP 2. 1, the spawning stock biomass of BSAI Greenland turbot is expected to be below the MSST. The fishing mortality rate does not exceed $F_{OFL,}$ but the stock is expected to fall below the MSST. Therefore the expected changes under this FMP are substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, there are significantly adverse direct effects on the change in reproductive success, genetic structure and the change in biomass under this FMP. The other direct and indirect effects are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the Greenland turbot stock is projected to be overfished under this FMP. The 20 year projection (Figure H.4-4 of Appendix H) indicates that the female spawning stock is expected to decline until 2007 to below B_{MSY} levels and will increase thereafter through the end of the projection but still remain below the B_{MSY} spawning stock level in 2023.

Cumulative Effects of FMP 2.1

Cumulative effects for BSAI Greenland turbot are summarized in Table 4.5-15.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under FMP 2.1 since the projected fishing mortality rates are at the OFL for this stock.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is at the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on BSAI Greenland turbot biomass is significantly adverse.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the Greenland turbot biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.9 and 3.10.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Greenland turbot, and is rated as significantly adverse. The female spawning biomass level is projected to fall below the B_{MSY} proxy value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is likely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 the effect of the spatial/temporal concentration of catch is considered significantly adverse for the stock.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the spatial/temporal concentration of BSAI Greenland turbot catch. Climate changes and regime shifts are suspected of having an effect on the reproductive success of the Greenland turbot stock (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Greenland turbot catch and is rated as significantly adverse. The expected changes under FMP 2.1 are substantial enough to expect that the reproductive success and genetic structure of the spawning stocks would be affected. The combined effect of internal removals and removals due to reasonably foreseeable external events is likely to sufficiently alter the genetic structure and the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in prey availability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI Greenland turbot stock. Past foreign, JV, and domestic fisheries have been identified as having influenced the availability of Greenland turbot prey, mainly pollock which is their main prey item in the BSAI. Climate changes and regime shifts have also been identified as influencing Greenland turbot prey availability (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in habitat suitability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI Greenland turbot include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of Greenland turbot, largely through the impacts of fishing gear on benthic habitats (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Greenland turbot habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Greenland turbot stock to sustain itself at or above the MSST is jeopardized.

GOA Deepwater Flatfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

The catch of GOA deepwater flatfish in 2002 was estimated to be 600 mt. Model projections of future catch are shown in Table H.4-25 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to increase over four times the 2002 value to 2,400 mt by 2007, with a 2003-2007 average value of 2,600 mt. Under FMP 2.2, model projections indicate that the catch is expected to increase twice the 2002 value to 1,200 mt by 2007, with a 2003-2007 average value of 1,200 mt.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual GOA deepwater flatfish harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA deepwater flatfish fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual this fishery would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 5 or Tier 6 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratio of deepwater flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on deepwater flatfish would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Deepwater Flatfish

The direct and indirect effects of FMP 2.1 and FMP 2.2 on GOA deepwater flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the five year projection and what level of fishing mortality corresponds to the modeled catch estimated under these FMPs (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA deepwater flatfish are summarized in Table 4.5-16.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA deepwater flatfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA deepwater flatfish stock.

- **Reasonably Foreseeable Future External Effects.** Past effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of deepwater flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA deepwater flatfish and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Total and spawning biomass estimates are unavailable for the deepwater flatfish species, therefore, the effects of FMP 2.1 and FMP 2.2 on the change in biomass level are unknown.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the GOA deepwater flatfish stock complex.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the deepwater flatfish species biomass level. For more information on climate changes and regime shifts (see Sections 3.5.1.22 and 3.10). The State of Alaska scallop fishery has been identified as a non-contributing factor for change in biomass level since deepwater flatfish species bycatch is not expected to occur.

- **Cumulative Effects.** Cumulative effects are possible for the change in biomass level of GOA deepwater flatfish, but is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown for the stock since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts which are suspected of having an effect on the reproductive success of the deepwater flatfish stock complex (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of GOA deepwater flatfish due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor to change in genetic structure and reproductive success since bycatch of GOA deepwater flatfish species is not expected to occur.

- **Cumulative Effects.** Cumulative effects are possible for the spatial/temporal concentration of the GOA deepwater flatfish catch; however, this effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA deepwater flatfish complex is unknown.

- **Persistent Past Effects.** Paste effects are identified for the change in prey availability of the GOA deepwater flatfish stock complex and include climate changes and regime shifts (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery has been identified as a potential adverse contributor to benthic prey availability (see Section 3.6).

- **Cumulative Effects.** A cumulative effects is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to maintain current populations.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA deepwater flatfish complex is unknown.

- **Persistent Past Effects.** Past effects identified for GOA deepwater flatfish include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of deepwater flatfish, largely through the impacts of fishing gear on benthic habitats (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery has been identified as a potential adverse contributor to habitat suitability (see Section 3.6).

- **Cumulative Effects.** A cumulative effect is identified for GOA deepwater flatfish habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the deepwater flatfish stock complex to maintain current population levels is jeopardized.

BSAI Greenland Turbot – Direct/Indirect Effects of FMP 2.2

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 2.2, model projections indicate that the total BSAI biomass is expected to decline about 19 percent of the 2002 value to 86,000 mt by 2007, with a 2003-2007 average value of 91,000 mt.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 2.2, model projections indicate that female spawning biomass is expected to decline 31 percent of the 2002 value to 46,600 mt by 2007, with a 2003-2007 average value of 53,800 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,570 mt for 2003-2006 and then drop 930 mt below the B_{MSY} proxy value in 2007.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Model projections show this value will increase to 0.19 in 2003 and 2004 and then decrease to 0.16 in 2007. This maximum value under this FMP is less than the F_{MSY} proxy value of 0.48, the rate associated with the OFL (Table H.4-5 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Since this FMP allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that Greenland turbot fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual BSAI Greenland turbot harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

Model projections of future catches of BSAI Greenland turbot are below the OFLs in all years under FMP 2.2. The Greenland turbot female spawning stock is above the MSST level under this FMP, as in the baseline year 2002.

Age and Size Composition

Under FMP 2.2, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.6 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50.No information is available to suggest that this would change under FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.2 on Greenland turbot would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.2.

Summary of Effects of FMP 2.2 – BSAI Greenland Turbot

Under FMP 2.2, the spawning stock biomass of BSAI Greenland turbot is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stock is expected to remain above the MSST, the expected changes under this FMP are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under this FMP are considered insignificant (Table 4.6-1).

Relative to the 2002 comparative baseline, the Greenland turbot stock is projected to continue to not be overfished under this Alternative. The 20 year projection (Figure H.4-4 of Appendix H) indicates that the female spawning stock is expected to decline until 2007 to B_{MSY} levels and will increase thereafter through the end of the projection to above B_{ABC} spawning stock levels in 2023.

Cumulative Effects of FMP 2.2

Cumulative effects for BSAI Greenland turbot are summarized in Table 4.5-15.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** External effects on mortality are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on BSAI Greenland turbot biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the female spawning biomass is above the B_{MSY} value from 2003-2006. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
  - Change in Genetic Structure of Population
  - Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.2 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects identified for the spatial/temporal concentration of BSAI Greenland turbot are the same as those described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of Greenland turbot are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Greenland turbot catch and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.2, the change in prey availability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for the change in prey availability of the BSAI Greenland turbot are the same as those described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.2, the change in habitat suitability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for the habitat suitability of BSAI Greenland turbot are the same as those described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on habitat suitability are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Greenland turbot habitat suitability and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Greenland turbot stock to sustain itself at or above the MSST is jeopardized.

4.6.1.10 Alaska Plaice and Other Flatfish and Rex Sole

BSAI Alaska plaice and other flatfish and GOA rex sole fisheries are described in more detail in Sections 3.5.1.10 and 3.5.1.23 of this Programmatic SEIS.

BSAI Alaska Plaice – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

<u>Total Biomass</u>

Total biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 1,083,000 mt. Model projections of future total Alaska plaice BSAI biomass are shown in Table H.4-9 of Appendix H. Under FMP 2.1, model projections indicate that BSAI biomass is expected to increase to a value of 1,098,000 mt in 2007, with a 2003-2007 average value of 1,089,000 mt. Under FMP 2.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,112,000 mt in 2008, with a 2003-2008 average value of 1,097,000 mt.

<u>Spawning Biomass</u>

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 274,800 mt. Model projections of future total BSAI biomasses are shown in Table H.4-9 and Figure H.4-8 of Appendix H. Under FMP 2.1, model projections indicate that BSAI Alaska plaice biomass is expected to decrease to a value of

270,700 mt in 2005, and then increase to 273,200 mt in 2007. The projected average biomass from 2003-2007 is 272,400 mt. Under FMP 2.2, model projections indicate that BSAI Alaska plaice biomass is expected to decrease to a value of 273,200 mt in 2005 and increase to 279,300 mt in 2008, with a 2003-2008 average value of 275,400 mt.

Fishing Mortality

Under FMP 2.1, the projected fishing mortality imposed on the BSAI Alaska plaice stock is 0.032 in 2003, and decreases to 0.026 in 2007. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 86 percent in 2003 and increases to 88 percent in 2007, with an average of 87 percent from 2003-2007 (Table H.4-9 of Appendix H).

Under FMP 2.2, the projected fishing mortality imposed on the BSAI Alaska plaice stock is approximately 0.027 in 2003, decreasing to 0.021 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 88 percent in 2003 and increases to 90 percent in 2008, with an average of 89 percent from 2003-2008 (Table H.4-9 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 involves the resumption of fishing in a number of areas currently closed, and these areas are largely in the EBS. Although most of the bycatch of Alaska plaice still occurs in the yellowfin sole fishery, a greater proportion is taken in the Pacific cod trawl fishery. An average of 17,800 mt was projected to be annually harvested from 2003-2008, with 10,710 mt (60 percent) from the yellowfin sole fishery and 4,040 mt (22 percent) from the Pacific cod trawl fishery.

Under FMP 2.2, the average projected catch from 2003-2008 is 13,000 mt, of which 9,500 mt (73 percent) occurred in the EBS shelf yellowfin sole fishery and 1,900 mt (14 percent) occurred in the EBS shelf rock sole fishery.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL, removing the buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below the OFL level from 2003 to 2008.

Under FMP 2.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below ABC and OFL levels from 2003 to 2008.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections, is 4.36 years. Under FMP 2.2, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections (Table H.4-9 of Appendix H), is 4.38 years. This compares with a mean age in the equilibrium unfished stock of 4.51 years.

Sex Ratio

The sex ratio of BSAI Alaska plaice is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 and FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 2.1 and FMP 2.2.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Alaska Plaice

Although the ABC and OFL levels for Alaska plaice are equivalent under FMP 2.1, and the F_{OFL} is not reduced for lower stock sizes, the harvest of Alaska plaice under FMP 2.1 is reduced so the direct and indirect effects are considered insignificant. Fishing rates are at the $F_{85\%}$ level, which are lower than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment.

Because the BSAI Alaska plaice are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 2.2 are considered insignificant. Fishing rates are lower than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Relative to the 2002 comparative baseline, the Alaska plaice stock is projected to continue to not be overfished under this FMP. The twenty year projection (Figure H.4-8 of Appendix H) indicates that the female spawning stock is expected to remain at a high and stable level well above B_{ABC}.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI Alaska plaice are summarized in Table 4.5-17.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Alaska plaice stock is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor to mortality of BSAI Alaska plaice. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as contributors to mortality since a change is not expected to be significant in magnitude to cause mortality.

- **Cumulative Effects.** Under FMP 2.1 and FMP 2.2, a cumulative effect is identified for BSAI Alaska plaice mortality; however, that effect is considered insignificant. Alaska plaice are fished above the ABC and OFL values. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Alaska plaice stock is expected to be insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution events are identified as potential adverse contributors to BSAI Alaska plaice change in biomass level. Acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to change in biomass level, since recruitment is affected by climate changes and regime shifts through a combination of prey availability and habitat suitability effects.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Alaska plaice change in biomass; however, it is determined to be insignificant. The combination of internal and external factors are not expected to reduce Alaska plaice biomass such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 are determined to have an insignificant effect on BSAI Alaska plaice spatial/temporal characteristics.

- **Persistent Past Effects.** No persistent past effects have been identified for the genetic structure of the BSAI Alaska plaice population. Although, climate changes and regime shifts have been identified as having a potential beneficial or adverse effect on BSAI Alaska plaice reproductive success.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contribution to BSAI Alaska plaice genetic structure and reproductive success. Acute and/or chronic events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and could also result in reduced recruitment. Climate changes and regime shifts have been identified as potential beneficial or adverse contributor to the reproductive success of BSAI Alaska plaice, but as a non-contributing factor to the genetic structure of Alaska plaice. The reproductive success is affected through a combination of climate induced changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect has been identified for the spatial/temporal concentration of BSAI Alaska plaice; however, it is determined to be insignificant. The combined internal and external events are not expected to significantly alter the reproductive success or genetic structure such that it jeopardizes the capacity of the stock to maintain itself above MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 is determined to have an insignificant effect on BSAI Alaska plaice prey availability.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having potential adverse or beneficial effects on BSAI Alaska plaice prey availability. Little research has been conducted on benthic invertebrates, the main prey species of Alaska plaice, therefore the magnitude and direction of the effects imposed by climate changes and regime shifts are unknown.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor to the prey availability of BSAI Alaska plaice. Acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above the MSST. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to BSAI Alaska plaice prey availability. However, as stated above, since little research has been conducted on the effects of climate changes on benthic invertebrates, the magnitude and direction of the changes are unknown.

- **Cumulative Effects.** A cumulative effect has been identified for the BSAI Alaska plaice change in prey availability; however, the effect is identified as insignificant. The combination of internal and external removals of prey species is not expected to decrease prey availability such that the BSAI Alaska plaice stock is unable to maintain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 is determined to have an insignificant effect on Alaska plaice habitat suitability.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries have been identified as having adverse effects on BSAI Alaska plaice habitat. See Sections 3.5.1.10 and 3.6 for more information on the effects of fishing gear on flatfish habitat. Climate changes and regime shifts are also identified as having a potential adverse or beneficial effect on Alaska plaice habitat (see Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to BSAI Alaska plaice habitat suitability. Acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success of Alaska plaice. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions to BSAI Alaska plaice habitat suitability. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment is favored.

- **Cumulative Effects.** A cumulative effect for BSAI Alaska plaice change in habitat suitability is identified and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the BSAI Alaska plaice stock to maintain itself at or above the MSST is jeopardized.

BSAI Other Flatfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass

Total and spawning biomass estimates are not available for these species.

Fishing Mortality

The catch of BSAI other flatfish in 2002 was estimated to be 2,600 mt. Model projections of future catch are shown in Table H.4-10 of Appendix H. Under FMP 2.1, model projections indicate that the 2003 catch is expected to increase from the 2002 value to 3,300 mt in 2003 and then gradually decrease each year to 2,800 mt in 2007 (7 percent increase from 2002). The 2003-2007 average catch is 3,000 mt. Under FMP 2.2, model projections indicate that the catch is expected to increase 18 percent from the 2002 value to 3,100 mt in 2003 and then decrease to 2,800 mt in 2007 (3 percent increase from 2002). The 2003-2007 average catch is 2,700 mt.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual BSAI Other flatfish harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed (Walrus Island, red king crab savings area, etc.) or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that Other flatfish fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of their harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratios the species of the Other flatfish category in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on other flatfish would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1of FMP 2.2 – BSAI Other Flatfish

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI other flatfish are summarized in Table 4.5-18.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other flatfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects have not been identified for BSAI other flatfish mortality.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other flatfish and is rated as insignificant. Fishing mortality rates for projected years are well below the other flatfish OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Past effects have not been identified for the BSAI other flatfish change in biomass level effect indicator.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other flatfish, but the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the spatial/temporal concentration of catch are the same as those described for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics of the BSAI other flatfish stock are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other flatfish catch; however, these effects are unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the change in prey availability are the same as those described for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for the change in prey availability are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for habitat suitability of BSAI other flatfish are the same as those described for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for habitat suitability of BSAI other flatfish are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for BSAI other flatfish habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

GOA Rex Sole – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass

Total and spawning biomass estimates are not available for this species.

Fishing Mortality

The catch of GOA rex sole in 2002 was estimated to be 3,000 mt. Model projections of future catch are shown in Table H.4-26 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to increase to 9,300 mt in 2003 and remain at 9,200 for 2004-2007. The 2003-2007 average catch is 9,300 mt. Under FMP 2.2, model projections indicate that the catch is expected to increase to 3,400 mt in 2004 and then decrease to 3,200 mt by 2007. The 2003-2007 average catch is 3,300 mt.

Spatial/Temporal Concentration of Fishing Mortality

The spatial/temporal characteristics of the annual GOA rex sole harvest could be affected under FMP 2.1 if harvesters chose to fish in the areas which were formerly closed, or areas they previously avoided due to high bycatch rates.

Since FMP 2.2 allows for setting PSC limits proportional to the abundance of the bycatch species, it is possible that GOA rex sole fishermen would spend less effort in bycatch avoidance in years where bycatch species were abundant. Otherwise, the spatial/temporal characteristics of the annual GOA rex sole harvest would not be affected under FMP 2.2 relative to the baseline year 2002.

Status Determination

The available information for GOA rex sole requires that they are classified into the Tier 5 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for this species.

Sex Ratio

The sex ratio of rex sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under these FMPs.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 on rex sole would be governed by a complex web of indirect interactions that are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 and FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Rex Sole

Except for the effects of mortality, the direct and indirect effects of FMP 2.1 and FMP 2.2 on GOA rex sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of this stock is over the five year projection and what level of fishing mortality corresponds to the modeled catch estimated under these FMPs. The projected catch for both FMPs are under the OFL for all projected years, therefore FMP 2.1 and FMP 2.2 is expected to have insignificant effects of GOA rex sole through mortality (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for rex sole are summarized in Table 4.5-19.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA rex sole is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Large removals of rex sole by the past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA rex sole stocks. See Section 3.5.1.23 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rex sole. The State of Alaska scallop fishery has also been identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA rex sole and is rated as insignificant. Fishing mortality rates for projected years are well below the rex sole OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Large removals of rex sole by past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA rex sole stocks see Section 3.5.1.23 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts have also been identified as having an indirect potential beneficial or adverse effect on the rex sole biomass level. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and the temperatures cooler, recruitment tends to be weak. The State of Alaska Scallop Fishery is identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole. For more information on climate changes and regime shifts see Sections 3.5.1.23 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA rex sole, but is rated as unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects are not identified for genetic structure of the population; however, climate changes and regime shifts are identified as having persistent past effects on the reproductive success of the GOA rex sole stock. See Sections 3.5.1.23 and 3.10 for more information of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the genetic structure of rex sole include the potential adverse effects of marine pollution since an acute and/or chronic pollution event could alter the genetic structure of the population by causing localized mortality. The State of Alaska scallop fishery and climate changes and regime shifts have both been identified as non-contributing factors to the change in genetic structure of rex sole stocks. These events are not expected to cause localized depletions that would alter the genetic sub-population structure of rex sole stock. Change in reproductive success of rex sole due to climate changes and regime shifts are identified as having a potential beneficial or adverse effect. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could also the reproductive success of GOA rex sole. Again, the State of Alaska scallop fishery has been identified as a non-contributing factor since the scallop fishery is not expected to contribute to rex sole removals.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rex sole catch; however, this effect is unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts are identified as having had effected the prey availability of the GOA rex sole stock. The actual effect of climate changes and regime shifts on rex sole prey availability is unknown, but could have had a potential beneficial or adverse effect. See Sections 3.5.1.23 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Past effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The State of Alaska scallop fishery has been identified as having a potential adverse effect on rex sole prey availability since the habitat disturbances caused by dredging could influence the availability of benthic prey.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for GOA rex sole include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. Habitat disturbances caused by the past foreign, JV, and domestic fisheries have also been identified as having persistent past effects on the GOA rex sole stock see Sections 3.5.1.23 and 3.10 for more information regarding the past fisheries and climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as having potential adverse effects on rex sole habitat suitability that may cause changes in the spawning or rearing success of the stock.

- **Cumulative Effects.** A cumulative effect is possible for GOA rex sole habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

4.6.1.11 Pacific Ocean Perch

Pacific ocean perch (*Sebastes alutus*) are managed under Tier 3 in both the BSAI and GOA. Sections 3.5.1.11 and 3.5.1.24 discuss the past/present analysis in further detail.

BSAI Pacific Ocean Perch – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total Biomass

Total biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 374,000 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 of Appendix H. Under FMP 2.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to decrease to a value of 360,000 mt in 2008, with a 2003-2008 average value of 366,000 mt. Under FMP 2.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 383,000 mt in 2008, with a 2003-2008 average value of 379,000 mt.

Spawning Biomass

Spawning biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 134,700 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 and Figure H.4-10 of Appendix H. Under FMP 2.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to decrease to a value of 122,400 mt in 2008, with a 2003-2008 average value of 127,700 mt. Under FMP 2.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to decrease to a value of 133,100 mt in 2005 and remain at this level through 2008, with a 2003-2008 average value of 133,600 mt.

Fishing Mortality

Under FMP 2.1, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock in each year from 2003 to 2008 is 0.057, which is equivalent to the $F_{35\%}$ proxy for the overfishing rate. At this fishing mortality rate, 35 percent of the spawner biomass per recruit would be conserved (Table H.4-12 of Appendix H).

Under FMP 2.2, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is approximately 0.040 from 2003 to 2006, increasing to 0.042 in 2007 and 2008. The proportion of spawner per recruit biomass conserved under these fishing mortality rates is 45 percent in 2003, increasing to 46 percent in 2005, and decreasing to 44 percent in 2008, with an average of 45 percent from 2003-2008 (Table H.4-12 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Although FMP 2.1 involves the resumption of fishing in a number of areas currently closed, these areas are largely in the EBS. Over the projection years 2003 to 2008 an average of 800 mt (of 17,700 mt total BSAI Pacific ocean perch catch) are taken annually as bycatch in Bering Sea fisheries, and an average of 11,900 mt are taken by the central Aleutian Islands Pacific ocean perch fishery.

Under FMP 2.2, the proportion of catch occurring in the eastern Aleutian Islands is increased relative to baseline conditions. The average projected catch from 2003-2008 is 13,100 mt, of which 7,700 mt (59 percent) occurred in the eastern Aleutian Islands. This catch is taken largely from directed Pacific ocean perch fisheries, although the Atka mackerel fishery is projected to harvest an average of 200 mt of Pacific ocean perch in each year from 2003 to 2008.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL, removing the buffer between these two harvest regulations. Under FMP 2.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Pacific ocean perch are at the OFL level from 2003 to 2008, and projected spawning stock biomass is above B_{MSY} ($B_{35\%}$) level of 120,200 mt. Thus, BSAI Pacific ocean perch are determined to be above the MSST level for the projection years of 2003-2008 for both FMPs.

Age and Size Composition

Under FMP 2.1, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections, is 9.93 years. Under FMP 2.2, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-12 of Appendix H), is 10.23 years. This compares with a mean age in the equilibrium unfished stock of 14.01 years.

Sex Ratio

The sex ratio of BSAI Pacific ocean perch is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.1 or FMP 2.2. However, because BSAI Pacific ocean perch are determined to be above the MSST for the projection years, at they are fished at or above the OFL under these FMPs, FMP 2.1 and FMP 2.2 are determined to have an insignificant effect through habitat suitability.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, because Pacific ocean perch feed mainly on euphausiid species, which are not caught within the groundfish fisheries, the direct and indirect effects of FMP 2.1 and FMP 2.2 are expected to be insignificant through prey availability.

Summary of Effects of FMP 2.1and FMP 2.2 – BSAI Pacific Ocean Perch

Under FMP 2.1, BSAI Pacific ocean perch are fished at rates equal to F_{OFL}, or $F_{35\%}$,, which is somewhat higher than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. However, the spawning biomass remains above the $B_{35\%}$ level, which is taken as a proxy for Bmsy. Thus, the direct and indirect effects under FMP 2.1 are considered insignificant. The removal of closed areas to fishing in the Bering Sea has little effect on the spatial distribution of the catch in this area, as little Pacific ocean perch are taken in Bering Sea fisheries. However, a fairly large proportion, 67 percent, of the Pacific ocean perch are harvested in the cental Aleutian Islands.

Because the BSAI Pacific ocean perch are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 2.2 are considered insignificant. Fishing rates are within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI Pacific ocean perch are summarized in Table 4.5-20.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific ocean perch stock is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to BSAI Pacific ocean perch mortality since bycatch in this fishery is not expected. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific ocean perch mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished at levels equal to the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific ocean perch stock is expected to be insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute significantly to BSAI Pacific ocean perch mortality since bycatch is not expected in this fishery. Therefore, the IPHC longline fishery is also not expected to cause significant changes in biomass levels. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to Pacific ocean perch change in biomass levels as a function of reproductive success.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the BSAI Pacific ocean perch population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.11) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery are not expected to contribute to changes in genetic structure or reproductive success of BSAI Pacific ocean perch since bycatch of BSAI Pacific ocean perch is not expected to occur. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. Generally, changes in climate changes that lead to increased advection of the Alaska current are believed to increase euphausiid production, a major prey item of BSAI Pacific ocean perch. Climate changes and regime shifts are not considered to contribute to changes in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific ocean perch prey species (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific ocean perch prey species are identified as potential beneficial or adverse contributors. In general, it is believed that climate changes and regime shifts that lead to the increased advection of the Alaska current also increase production of euphausiids, a major prey item of BSAI Pacific ocean perch. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for BSAI Pacific ocean perch stocks include past foreign, JV, and domestic fisheries, IPHC longline fisheries and climate changes and regime shifts (see Section 3.5.1.11). Intense bottom trawling on Pacific ocean perch habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries are also identified as having adverse effects on Pacific ocean perch habitat, although these fishing gear impacts are considered to be less significant than those associated with trawl gear (see Section 3.6). Climate changes and regime shifts have had both beneficial and adverse effects on Pacific ocean perch habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is identified as making adverse contributions to Pacific ocean perch habitat through fishing gear impacts. As stated above, these impacts are expected to be of lesser magnitude than those effects associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific ocean perch stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

GOA Pacific Ocean Perch – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total and Spawning Biomass and Fishing Mortality

FMP 2.1 represents a less precautionary approach of fishery management. An important measure in this bookend that would impact all target species is that ABC would be set equal to overfishing. This would eliminate the buffer between ABC and overfishing that exists in FMP 1. Also under FMP 2.1 the eastern GOA trawl closure in FMP 1 would be repealed. Both of these measures in combination would likely result in a larger catch of GOA Pacific ocean perch than has been the case in years past, and increase the risk of overfishing GOA Pacific ocean perch stocks. The bycatch model results for this bookend show increased catches for GOA Pacific ocean perch and therefore appear to be reasonable. Average fishing mortality during the years 2003 - 2008 is expected to be equal to F_{OFL} (0.060) (Table H.4-36 and Figure H.4-15 of Appendix H).

FMP 2.2 is much less aggressive in its approach than FMP 2.1. The two particular measures that impacted GOA Pacific ocean perch catch in FMP 2.1 are not part of FMP 2.2, so catch of GOA Pacific ocean perch in FMP 2.2 should be reduced relative to FMP 2.1 and result in catches similar to those of FMP 1. Bycatch model results for FMP 2.2 show catches comparable to FMP 1 for GOA Pacific ocean perch and therefore appear reasonable. Average fishing mortality during the years 2003 - 2008 is expected to be less than F_{OFL} (0.060).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1 the eastern GOA trawl closure in FMP 1 would be repealed. Under FMP 2.1, trawl fishing is permitted in the southeast/east Yakutat area and the ABC (12 percent of the total GOA ABC) normally allocated to that area would now likely to be caught.

The effect of FMP 2.1 on the spatial/temporal concentration of Pacific ocean perch catch is similar to what the baseline situation has been in past years. A major difference of FMP 2.1 versus the baseline for Pacific ocean perch would be the inclusion of the eastern GOA as an open trawl zone. ABC is apportioned by area and inclusion of the eastern GOA would spread effort out resulting in more protection against localized depletion. Fishing effort would continue to be compressed into a relatively short open season especially if high concentrations of Pacific ocean perch are harvested in the eastern GOA. This may result in increasing the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

FMP 2.2 would have similar effects on the spatial and temporal concentration of Pacific ocean perch catch as the baseline fishing. The inclusion of the eastern Gulf no-trawl zone is consistent with the baseline situation. ABCs are geographically apportioned among management areas which provides some protection against localized depletion. The Pacific ocean perch fishery would likely be concentrated into a relatively short open season, thereby increasing the risk of possible overfishing because of the difficulty of managing a short compressed fishery.

Status Determination

Under FMP 2.1, the projected B2003 of 111,900 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B2005 of 106,400 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Under FMP 2.2, the projected B2003 of 112,800 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B_{2005} of 112,800 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition

Under FMP 2.1 and FMP 2.2, the age composition of GOA Pacific ocean perch may be affected by fishing mortality as in FMP 1. No information is available to suggest that sex ratio would change under these FMPs, but the size composition of GOA Pacific ocean perch might change in proportion to the change in age composition.

Sex Ratio

No information is available to suggest that the sex ratio would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Under FMP 2.1 increased damage to epifauna by increased bottom trawl effort, and the opening of the eastern GOA to bottom trawling may adversely impact the habitat of juvenile Pacific ocean perch. FMP 2.1 also adversely impacts GOA Pacific ocean perch because by opening the eastern GOA to trawling it removes a *de facto* no take zone or refugium for Pacific ocean perch in this area which could reduce the reproductive potential of the stock. However, these impacts on habitat suitability are predicted to be insignificant because the GOA Pacific ocean perch stock is determined to remain above the MSST for all projection years.

Under FMP 2.2 damage to epifauna by bottom trawls may adversely impact juvenile Pacific ocean perch habitat. However, FMP 2.2 may reduce the impacts on habitat for GOA Pacific ocean perch by maintaining the eastern GOA closure to trawling. This provides a *de facto* no take zone or refugium for Pacific ocean perch in this area and provides protection from the potential effects of trawling on adult and juvenile rockfish habitat.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, because Pacific ocean perch feed mainly on euphausiid species, which are not caught within the groundfish fisheries, the direct and indirect effects of FMP 2.1 and FMP 2.2 are expected to be insignificant through prey availability.

Summary of Effects of FMP 2.1 and FMP 2.2 – GOA Pacific Ocean Perch

Under FMP 2.1 and FMP 2.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 2.1 and FMP 2.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability are believed to have an insignificant impact on stock sustainability. For further detail on the past/present effects analysis for GOA Pacific ocean perch, see Section 3.5.1.24 (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA Pacific ocean perch are summarized in Table 4.5-21.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific ocean perch stock is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished at or below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific ocean perch stock is expected to be insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of GOA Pacific ocean perch and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for prey availability; however, the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST. Therefore, the cumulative effect of FMP 2.1 and FMP 2.2 on GOA Pacific ocean perch is considered insignificant through prey availability.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have insignificant effects on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its effect on the GOA Pacific ocean perch stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

4.6.1.12 Thornyhead Rockfish

GOA thornyhead rockfish are described in more detail in Section 3.5.1.23 of this Programmatic SEIS. Until recently, thornyhead rockfish were managed as its own stock under the GOA groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2004, thornyhead rockfish will be managed under Tier 5. GOA thornyhead rockfish were modeled under the Tier 3 category for this analysis.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Total Biomass

Total (ages 5 through 55+) biomass of GOA thornyheads at the start of 2002 is estimated to be 54,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-37 of Appendix H. Under FMP 2.1, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly decrease to a value of 53,000 mt by 2007, with a 2003-2007 average value of 53,000 mt. Under FMP 2.2, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly increase to a value of 55,000 mt by 2007, with a 2003-2007 average value of 54,000 mt.

Spawning Biomass

Spawning biomass of female GOA thornyheads at the start of 2002 is estimated to be 23,500 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-37 and Figure H.4-16 of Appendix

H. Under FMP 2.1, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and decreasing to 23,200 mt by 2007, with a 2002-2007 average value of 23,400 mt. Under FMP 2.2, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and increasing to 24,300 mt by 2007, with a 2002-2007 average value of 23,900 mt.

Fishing Mortality

The average fishing mortality imposed on the GOA thornyhead stock in 2002 is projected to be 0.032 under current management. Under FMP 2.1, fishing mortality is projected to increase to 0.037 in 2003 and decrease back to 0.032 in 2007. Under FMP 2.2, fishing mortality is projected to decrease to 0.025 in 2003 and decrease further to 0.020 in 2007. These values are well below the F_{MSY} proxy value of 0.102 which is the rate associated with the OFL.

Spatial/Temporal Concentration of Fishing Mortality

Thornyhead catch is approximately evenly divided between longliners and trawlers under status quo management. There is nothing about FMP 2.1 or FMP 2.2 that is expected to change this. Longline catches are spatially dispersed along the continental shelf break throughout the GOA (Figure 4.5-1), and temporally dispersed due to the nature of the IFQ sablefish fishery. For example, longline thornyhead catches in 2000 occurred year round, with peaks in April and September which did not exceed 60 mt per week. Trawler catch has been more concentrated in time, with some catches of 20-40 mt per week happening in late spring and a single large peak of 160 mt per week in 2000 during July, coincident with the rockfish trawl fishery. Between 1997 and 1999, trawl thornyhead catches appear to have become more concentrated in space (Figure 4.5-2). The distribution of thornyheads from surveys did not appear to change over the same time period (Figure 4.5-3). This apparent concentration may be the indirect result of changes in the trawl fisheries for deepwater flatfish and rockfish since thornyheads are not a primary target of trawl fisheries. However, it should be noted that the overall catch of thornyheads is low relative to both the estimated biomass and the ABC, such that this apparent concentration of catch is unlikely to have any adverse population effects.

Status Determination

The GOA thornyhead stock is not overfished. Even at the projected low point under FMP 2.1 of 23,200 mt, spawning stock biomass is expected to be well above both $B_{35\%}$ level (14,681 mt) as well as the $B_{40\%}$ level (16,045 mt), and will remain above $B_{40\%}$ in all projection years under FMP 2.1. At 23,500 mt, spawning stock biomass under FMP 2.2 is also expected to be well above both $B_{35\%}$ level (14,681 mt) as well as the $B_{40\%}$ level (16,045 mt) in the year 2002 and will remain above $B_{40\%}$ in all projection years under FMP 2.2.

Age and Size Composition

Under FMP 2.1, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 9.90 years. Under FMP 2.2, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.15 years. This compares with a mean age in the equilibrium unfished GOA stock of 12.67 years.

Sex Ratio

The sex ratio of GOA thornyheads is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Under FMP 2.1, all current closed areas aside from those related to sea lion habitat would be removed. However, most current closed areas do not extend to deeper waters where thornyheads are found. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next five years under this FMP.

Under FMP 2.2, all current management measures would be maintained. The level of habitat disturbance under FMP 1 (and FMP 2.2) does not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next five years under this alternative.

Prey Availability

In the GOA, shortspine thornyheads prey on benthic invertebrates; according to the AFSC food habits database, much of their diet in the 1990s has been composed of shrimp. Thornyheads are rare in the diets of other groundfish, birds, or marine mammals in the GOA according to the present limited information. Therefore, the effects of FMP 2.1 and FMP 2.2 on trophic interactions involving GOA thornyheads are expected to be minor. The current levels and distribution of groundfish harvest do not appear to impact prey availability for thornyheads such that it affects the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next five years under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Thornyhead Rockfish

The GOA thornyhead stock appears to be healthy and stable under current management, and catches have generally been below the estimated ABCs because thornyheads are taken as bycatch in other directed fisheries. To the best of our knowledge, thornyheads are widely distributed in the deeper habitats of the GOA, where fishing impacts have historically been low. As long as catches remain at or near the currently observed low levels, as predicted under FMP 2.1 and FMP 2.2, we do not expect any significant population effects to thornyheads (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA thornyhead rockfish are summarized in Table 4.5-22.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA thornyhead rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. The removals of thornyhead rockfish that occurred in these fisheries have had a lingering adverse effect on the populations (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of thornyhead rockfish. The IPHC longline fishery is identified as a potential adverse contributor to thornyhead rockfish mortality since they are caught as bycatch in this fishery. However, the State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA thornyhead rockfish and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** FMP 2.1 or FMP 2.2 is expected to have insignificant effects on GOA thornyhead rockfish through the change in biomass levels.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. Past removals by these fisheries have had a lingering adverse effect on the GOA thornyhead rockfish populations (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the thornyhead rockfish biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.23 and 3.10). The IPHC longline fishery is identified as a potential adverse contributor to the thornyhead rockfish biomass level since they are caught as bycatch in this fishery. The State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA thornyhead rockfish and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA thornyhead rockfish. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of GOA thornyhead rockfish. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the thornyhead rockfish stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of thornyhead rockfish due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA thornyhead rockfish. The IPHC longline fishery removals could be sufficiently concentrated as to alter the genetic structure and reproductive success of GOA thornyhead rockfish populations and is therefore identified as a potential adverse contributor. The State of Alaska shrimp fishery is identified as a non-contributing factor since bycatch of thornyhead rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the thornyhead rockfish catch and is ranked as insignificant. The spatial/temporal distribution of thornyhead rockfish catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in prey availability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do effect the availability of some prey species (i.e. shrimp); however, studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor since bycatch of GOA thornyhead rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to prey availability since removal of shrimp, the main prey species of GOA thornyhead rockfish, occurs in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in habitat suitability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA thornyhead rockfish include climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery has been identified as a potential adverse contributor to GOA thornyhead rockfish habitat suitability (see Section 3.6). The State of Alaska shrimp fishery is identified as a non-contributing factor since habitat degradation by the shrimp fishery gear is not expected to occur.

- **Cumulative Effects.** A cumulative effect is identified for GOA thornyhead rockfish habitat suitability and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the thornyhead rockfish stock to sustain itself at or above the MSST is jeopardized.

4.6.1.13 Rockfish

BSAI and GOA rockfish are described in more detail in Sections 3.5.1.12-3.5.1.14 and 3.5.1.24.

BSAI Northern Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Until recently, BSAI northern rockfish were managed under Tier 5; beginning in 2004, northern rockfish will be managed under Tier 3. BSAI northern rockfish were modeled under the Tier 5 category for this analysis.

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for this species.

Fishing Mortality

The catch of BSAI northern rockfish in 2003 was estimated as 6,800 mt. Projected catches from 2003-2008 are shown in Table H.4-15 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to decrease to 4,900 mt in 2005, then increase to 5,200 mt in 2008. The 2003-2008 average catch is 5,400 mt. Under FMP 2.2, model projections indicate that the catch is expected to decrease to 6,400 mt in 2006, then increase to 6,600 mt in 2008. The 2003-2008 average catch is 6,800 mt.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1, model projections indicate that the average harvest of 5,400 mt from 2003-2008 occurs largely in the western Aleutian Islands (3,700 mt, 68 percent), with 800 mt (14 percent) occurring in the EBS and 700 mt (13 percent) occurring in the central Aleutians. The harvest of northern rockfish in the western Aleutian Islands is taken largely in the Atka mackerel fishery, whereas the harvest in the EBS and central Aleutians are taken in the Pacific cod and Pacific ocean perch fisheries, respectively.

Under FMP 2.2, model projections indicate that the average harvest of 6,800 mt from 2003-2008 occurs largely in the eastern Aleutian Islands (4,700 mt, 68 percent), with 1,300 mt (19 percent) occurring in the central Aleutian Islands. The harvest of northern rockfish in the each of these areas is taken largely in the Atka mackerel fishery.

Status Determination

Under FMP 2.1, the ABC for northern rockfish is set equal to the OFL. Under FMP 2.2, the catch rates are below the ABC and OFL values for all years. The MSST cannot be determined for this species.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for this species. The sex ratio of BSAI northern rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – BSAI Northern Rockfish

Under FMP 2.1, the ABC for northern rockfish is set equal to the OFL. An age-structured population model for BSAI northern rockfish is not available, and projections of future OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI northern rockfish are equal to the OFL and the effects of mortality under FMP 2.1 are considered insignificant. Under FMP 2.2, BSAI northern rockfish are fished at less than the ABC and the effects of mortality under FMP 2.2 are considered insignificant. Since the MSST is not able to be calculated, the spatial/temporal distribution of catch and other direct/indirect effects are unknown (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for BSAI northern rockfish are summarized in Table 4.5-23.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI northern rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of northern rockfish. The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI northern rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the northern rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI northern rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI northern rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI northern rockfish (see Section 3.5.1.13 and Section 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of northern rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of northern rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI northern rockfish. The IPHC longline fishery has been identified as a non-contributing factor to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the northern rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI northern rockfish stock. The actual effect of climate changes and regime shifts on northern rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of northern rockfish prey species occurs in this fishery (see Section 3.5.1.13).

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI northern rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in northern rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on northern rockfish species habitat suitability, possibly having disrupted northern rockfish species spawning and/or rearing habitats (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the northern rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt northern rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the northern rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear

BSAI Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Shortraker and rougheye rockfish are currently managed under Tier 5.

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these stocks.

Fishing Mortality

The catch of BSAI shortraker/rougheye rockfish in 2003 was estimated as 900 mt. Projected catches from 2003-2008 are shown in Table H.4-16 of Appendix H. Under FMP 2.1, model projections indicate that the catch is expected to decrease to 800 mt in 2005, then increase to 1,200 mt in 2006 and remain at this level through 2008. The 2003-2008 average catch is 1,000 mt. Under FMP 2.2, the projected catch of BSAI shortraker/rougheye rockfish in each year from 2003 to 2008 was estimated as 1,000 mt.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1,model projections indicate that the average harvest of 1,000 mt from 2003-2008 occurs largely in the central and western Aleutian Islands, with 500 and 300 mt harvested in each of these areas, respectively. The harvest of shortraker/rougheye rockfish in the central Aleutian Islands is taken largely in the Pacific ocean perch fishery, whereas the harvest in the western Aleutian Islands is taken in the Atka mackerel trawl fishery and the sablefish and Pacific cod longline fisheries.

Under FMP 2.2, model projections indicate that the average harvest of 1,000 mt from 2003-2008 occurs largely in the eastern and central Aleutian Islands, with 300 mt in each area. The harvest of shortraker/rougheye rockfish in the eastern Aleutian Islands is taken largely in the Pacific ocean perch trawl fishery, whereas the harvest in the central Aleutian Islands is taken largely in the Pacific cod longline fishery.

Status Determination

Under FMP 2.1, the ABC for shortraker/rougheye rockfish is set equal to the OFL. Under FMP 2.2, the catch rates are below the ABC and OFL values for all years. The MSST cannot be determined for these stocks

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. The sex ratio of BSAI shortraker/rougheye rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 2.1 or FMP 2.2.

Habitat Suitability

Any habitat-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Prey Availability

As with habitat-mediated impacts, any predation-mediated impacts of FMP 2.1 and FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Shortraker/Rougheye Rockfish

Under FMP 2.1, the ABC for shortraker/rougheye rockfish is set equal to the OFL. An age-structured population model for is not available for either shortraker or rougheye rockfish, and projections of future OFL levels were made by carrying over the 2002 baseline values into the future. The projected TAC for shortraker/rougheye rockfish from 2003-2008 is equal to the OFL, and the mortality effects under FMP 2.1 are considered insignificant. Under FMP 2.2, BSAI shortraker/rougheye rockfish are fished at less than the ABC and the effect of mortality under FMP 2.2 is considered insignificant. Since the MSST is not able to be calculated, the spatial/temporal distribution of catch and other direct/indirect effects are unknown (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects of BSAI shortraker/rougheye rockfish are summarized in Table 4.5-24.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI shortraker/rougheye rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI shortraker/rougheye rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as a non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI shortraker/rougheye rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI shortraker/rougheye rockfish (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of shortraker/rougheye rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of shortraker/rougheye rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery have been identified as non-contributing factors to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the shortraker/rougheye rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI shortraker/rougheye rockfish stock. The actual effect of climate changes and regime shifts on shortraker/rougheye rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of shortraker/rougheye rockfish prey species occurs in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to BSAI shortraker/rougheye prey availability since shrimp is on e of the main prey species of rougheye rockfish (see Section 3.5.1.13).

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI shortraker/rougheye rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in shortraker/rougheye rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on shortraker/rougheye rockfish species habitat suitability, possibly having disrupted shortraker/ rougheye rockfish species spawning and/or rearing habitats. The State of Alaska shrimp fishery is identified as a non-contributing factor to shortraker/rougheye rockfish habitat suitability since habitat degradation by shrimp fishery gear is not expected to occur (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the shortraker/rougheye rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt shortraker/rougheye rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the shortraker/rougheye rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

BSAI Other Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

The other rockfish assemblage falls under Tier 5.

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

Under FMP 2.1, the catch of Aleutian Islands other rockfish species in 2003 was estimated as 500 mt, increasing to 800 mt in 2004 before decreasing to 700 mt in 2008; the average catch from 2003-2008 was

700 mt. In the EBS, the projected harvest was 200 mt in 2003, decreasing to 100 mt in 2008; the average catch from 2003-2008 was projected at 100 mt. Under FMP 2.2., the catch of Aleutian Islands other rockfish in each year from 2003 to 2008 was 300 mt, and the projected harvest of EBS other rockfish was 100 mt in each of these years. Projected catches from 2003-2008 are shown in Tables H.4-1.13 and H.4-1.14 of Appendix H.

The 2003 OFL for this species complex is 846 mt and 1,280 mt in the Aleutian Islands and EBS, respectively (Reuter and Spencer 2002). Fishing mortality at projected levels under FMP 2.1 is below the OFL for other rockfish, so FMP 2.1 and FMP 2.2 are not likely to result in any significantly adverse impacts to these stocks.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 2.1, in the Aleutian Islands, 78 percent of the average harvest of 700 mt occurs in the western Aleutian Islands, taken largely in the sablefish longline fishery and Pacific cod trawl fishery. In the EBS, the average catch of 100 mt is taken largely in the Greenland turbot and sablefish longline fisheries and the flathead sole trawl fishery. Information is insufficient to determine whether existing harvest patterns would undergo any significant change under FMP 2.1.

Under FMP 2.2, in the Aleutian Islands, 85 percent of the average harvest of 300 mt occurs in the cental and western Aleutian Islands, taken largely in the Atka mackerel and Pacific cod trawl fisheries and the Pacific cod and sablefish longline fisheries. In the EBS, the average catch of 100 mt is taken largely in the Pacific cod and Greenland turbot bottom trawl fisheries and the sablefish and Greenland turbot longline fisheries. Information is insufficient to determine whether existing harvest patterns would undergo any significant change under FMP 2.2.

Status Determination

The ABC and is set equal to the OFL for this species complex under FMP 2.1. Under FMP 2.2, the fishing the ABC and is set below the OFL value. The fishing mortality rates under both FMPs are below the OFL. The MSST cannot be determined.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. Estimated sex ratios are not available for these species.

Habitat Suitability

Any habitat suitability impacts of FMP 2.1, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing, would be governed by a complex web of direct and indirect interactions that are difficult to quantify at the present time due to insufficient data However, there is the potential for degradation of benthic habitats important to other rockfish species as a result of increased fishing for groundfish. Actions illustrated by FMP 2.1 include the repeal of all current closed areas except for those required to protect Steller sea lions. Areas now opened to groundfish fishing may result in either an increase in Other rockfish catch, or decreases depending on rockfish abundance and location of rockfish habitat. Information is insufficient to conclude at this time whether existing habitat conditions would undergo any significant change under FMP 2.1.

FMP 2.2 would retain existing closures and bycatch restrictions, so the extent that these measures protect habitat, these benefits would continue to accrue to other rockfish stocks. However, information is insufficient to conclude whether existing habitat conditions would undergo any significant change under FMP 2.2.

Prey Availability

As with habitat related impacts, any effects of FMP 2.1 or FMP 2.2 on predator-prey relationships would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that predator-prey relationships would undergo any significant change under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1 and FMP 2.2 – BSAI Other Rockfish

Under FMP 2.1, the ABC for the other rockfish category is set equal to the OFL. An age-structured population model for is not available for either Aleutian Islands or EBS other rockfish, and projections of future OFL levels were made by carrying over the 2002 baseline values into the future. The projected TAC for other rockfish from 2003-2008 is below the OFL, and the direct and indirect effects under FMP 2.1 are considered either insignificant or unknown. The spatial/temporal distribution of catch should have no significant direct impact on stock productivity. There could be adverse effects on rockfish habitat depending on where fishing effort is directed in response to increased TACs, but there currently is insufficient information to determine the significance of these effects.

Under FMP 2.2, other rockfish are fished at less than the ABC and well below current OFL. As a result, the direct and indirect effects under FMP 2.2 are considered either insignificant or unknown. The spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects on BSAI other rockfish are summarized in Table 4.5-25.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those indicated for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other rockfish and is rated as insignificant. Fishing mortality at projected levels is below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those indicated for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
 – Change in Genetic Structure of Population
 – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI other rockfish catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of other rockfish are the same as those indicted for the BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in prey availability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in prey availability are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the change in habitat suitability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in habitat suitability are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability are the same as those indicated for BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is not possible to be determined. It is unknown whether the combined effect will make the other rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear, thus the combined effects are found to be significant.

GOA Northern Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

GOA northern rockfish is currently managed under Tier 3.

Total and Spawning Biomass and Fishing Mortality

FMP 2.1 represents a less precautionary approach of fishery management. An important measure in this bookend that would impact all target species is that ABC would be set equal to overfishing. This would eliminate the buffer between ABC and overfishing that exists in FMP 1. Another measure in FMP 2.1 that could impact GOA northern rockfish is that the eastern GOA trawl closure in FMP 1 would be repealed. Both of these measures in combination would likely result in a larger catch of GOA northern rockfish than has been the case in years past, and increase the risk of overfishing. However, the projection model results for this bookend indicate a decrease in GOA northern rockfish catch instead of an increase. Therefore the projection results do not appear to be reasonable. Average fishing mortality during the years 2003 - 2008 is still expected to be less than or equal to F_{OFL} (0.066) (Table H.4-35 of Appendix H).

According to the description of FMP 2.2, this FMP is much less aggressive in its approach than FMP 2.1. The two particular measures that affected GOA northern rockfish catch in FMP 2.1 (setting ABC equal to overfishing and removing the eastern GOA trawl closures) are not part of FMP 2.2, so catch of GOA northern rockfish in FMP 2.2 should be reduced relative to FMP 2.1 and result in catches similar to those of FMP 1. Instead, the bycatch model results for FMP 2.2 show lower catch for GOA northern rockfish which may be unreasonable. However, average fishing mortality during the years 2003 - 2008 is still expected to be less than F_{OFL} (0.066) (Table H.4-35 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effect of FMP 2.1 on the spatial/temporal concentration of northern rockfish catch is similar to what the baseline situation has been in past years. The inclusion of the eastern GOA as an open trawl zone under FMP 2.1 would not be a major difference relative to the baseline for northern rockfish. Northern rockfish generally do not occur in the eastern GOA and the trawl inclusion in this area would not affect the spatial concentration of fishing. Fishing effort would continue to be compressed into a relatively short open season resulting in an increase risk of possible overfishing. The potential for localized depletion of the stock would also increase under the higher fishing mortality rates if fishing occurs year after year on localized aggregations of northern rockfish.

FMP 2.2 would have similar effects on the spatial/temporal concentration of northern rockfish catch as the baseline fishing. The inclusion of the eastern GOA no-trawl zone is consistent with the baseline situation. ABCs are geographically apportioned among management areas which provides some protection against localized depletion. The northern rockfish fishery would likely be concentrated into a relatively short open season, thereby increasing the risk of possible overfishing because of the difficulty of managing a short, compressed fishery. Under FMP 2.2, the potential for localized depletion of the stock exists if fishing occurs year after year on localized aggregations of northern rockfish.

Status Determination

Under FMP 2.1 and FMP 2.2, the projected B2003 of 42,700 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B2005 of 40,300 mt under FMP 2.1, and of 40,200 mt under FMP 2.2, is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition and Sex Ratio

Under FMP 2.1 and FMP 2.2, the age composition of GOA northern rockfish may be affected by fishing mortality as in FMP 1. No information is available to suggest that sex ratio would change under FMP 2.1 or FMP 2.2, but size composition of GOA northern rockfish might change in proportion to the change in age composition.

Habitat Suitability

Under FMP 2.1 and FMP 2.2, increased damage to epifauna by increased bottom trawl effort may adversely impact juvenile northern rockfish habitat. Bottom trawling or other fishing gear in contact with the ocean floor on the Gulf of Alaska continental shelf or upper slope could adversely impact juvenile northern rockfish habitat. Juvenile northern rockfish tend to live inshore in shallower depths than adults which are captured primarily between 75 - 175m. Juvenile northern rockfish may also be associated with epifauna that provides structural relief such as corals or sponges. If so, damage to this epifauna by bottom trawls may reduce survival of juvenile fish. However, there is insufficient information to conclude that habitat would undergo significant qualitative changes under FMP 2.1 or FMP 2.2.

Prey Availability

The major prey of northern rockfish is euphausiids, and northern rockfish may in turn be preyed upon by large piscivorous fish. There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under FMP 2.1 or FMP 2.2.

Summary of Effects of FMP 2.1and FMP 2.2 – GOA Northern Rockfish

Under FMP 2.1 and FMP 2.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 2.1 and FMP 2.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability are believed to have an insignificant impact on stock sustainability (Table 4.6-1).

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA northern rockfish are summarized in Table 4.5-26.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA northern rockfish stock is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries is identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to northern rockfish mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA northern rockfish and is rated as insignificant. Northern rockfish are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA northern rockfish stock is expected to be insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries is identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to northern rockfish change in biomass levels as a function of change in reproductive success (see below).

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the northern rockfish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.24) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management and is not expected to contribute to changes in genetic structure or reproductive success of northern rockfish. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. The magnitude and direction of the change in reproductive success with water temperatures is currently unknown. Climate changes and regime shifts are not considered to be contributors to change in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** FMP 2.1 and FMP 2.2 would have an insignificant effect on northern rockfish prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on northern rockfish prey species (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since northern rockfish prey species bycatch is not expected to occur. Climate changes and regime shifts are identified as making potential beneficial or adverse contributions on prey availability, although the magnitude and the direction of change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the northern rockfish stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** FMP 2.1and FMP 2.2 would have an insignificant effect on northern rockfish habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA northern rockfish stocks include past foreign, JV, and domestic fisheries, IPHC longline fishery and climate changes and regime shifts (see Section 3.5.1.24). Intense bottom trawling on northern rockfish habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries have also been identified as having adverse effects on northern rockfish habitat, although these effects are not expected to have been as intense as those effects associated with trawl gear see Section 3.6 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both beneficial and adverse effects on northern rockfish habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has been identified as an adverse contributing factor since the fishery gear could disrupt spawning and/or rearing habitats. Although, as state above, the impacts associated with longline gear are not as significant as those associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the GOA northern rockfish stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the northern rockfish stock to sustain itself at or above MSST is jeopardized.

GOA Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

GOA shortraker/rougheye are currently managed under Tier 4 and Tier 5. Direct/indirect effects are summarized in Table 4.6-1.

Total and Spawning Biomass

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter.

Fishing Mortality

FMP 2.1 represents a less precautionary approach of fishery management than what is currently used by the NPFMC. An important measure in this bookend that would affect all target species is that ABC would be set equal to overfishing, which would eliminate the buffer between ABC and overfishing that exists in the baseline situation and FMP 1. Another measure in FMP 2.1 that would particularly impact shortraker/rougheye is that the eastern GOA trawl closure in FMP 1 would be repealed. Both of these measures in combination would likely result in a larger catch of shortraker/rougheye than has been the case in years past, and increase the risk of overfishing these stocks. The bycatch model results for this bookend; however, indicate catches approximately equal to those in past years, and therefore do not appear to be reasonable (Table H.4-34 of Appendix H).

FMP 2.2 is much less aggressive in its approach than FMP 2.1. The two particular measures that affected shortraker/rougheye catch in FMP 2.1 are not part of FMP 2.2, so one would expect that catch and ABC projections for shortraker/rougheye in FMP 2.2 should be nearly identical to those for FMP 1. Indeed, the ABCs for shortraker/rougheye in FMP 2.2 are the same as those in FMP 1, but the projected catches in FMP 2.2 are inexplicably higher than in FMP 1. Therefore, the catch results for shortraker/rougheye in FMP 2.2 do not seem reasonable (Table H.4-34 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 would have major effects on the spatial/temporal concentration of shortraker/rougheye catch compared to the baseline situation in past years. Because the eastern GOA trawl closure would be repealed in FMP 2.1, shortraker/rougheye would almost certainly be taken by bottom trawl again in this region. ABCs; however, would be geographically apportioned between management areas, which would continue to provide some protection against localized depletion of the resource. Because IFQs and fishing cooperatives are not part of this bookend, the trawl fisheries would likely continue to be concentrated into a relatively short open seasons. More importantly, the IFQ longline fisheries would be eliminated, and the longline fisheries would revert back to very compressed "derby" fisheries. This would increase the risk of overfishing shortraker/rougheye because of the difficulty managing these very short, intense fisheries.

FMP 2.2 would have very similar effects on the spatial or temporal concentration of shortraker/rougheye catch as has been the case for the baseline situation in past years. ABCs would be geographically apportioned between management areas, which would continue to provide some protection against localized depletion of the resource. Because IFQs or fishing cooperatives for trawl fisheries are not part of this bookend, any bycatch of shortraker/rougheye taken by trawl fisheries would likely continue to be concentrated into relatively short open seasons. Similar to the baseline, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery. In contrast, FMP 2.2 would retain the IFQ system for longline fisheries, which would reduce the risk of overfishing because IFQs allow the fisheries to be spread out over an eight month season.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL. Under FMP 2.2 the catch rates are below the ABC and OFL values for all years. The MSST cannot be determined for these stocks.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter. There is no information on the sex ratio of shortraker/rougheye, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 2.1 and FMP 2.2 is unknown.

Habitat Suitability

The main impacts of FMP 2.1 on habitat suitability of shortraker/rougheye would be caused by 1) increased bottom trawl activity because the bookend would increase ABCs and catches for all species, and 2) the bookend's repeal of the eastern GOA trawl closure. Increased bottom trawl activity would likely result in more damage to the benthic habitat, which could have a adverse impact on species such as shortraker and rougheye rockfish that have been observed living in association with epifauna such as corals.

Similar to FMP 1 and the baseline situation in past years, FMP 2.2 may impact habitat for shortraker/rougheye because it closes the eastern GOA to trawling. This closure prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of shortraker/rougheye, an undamaged benthic habitat may provide a benefit to these species. For example, observations from a manned submersible in the eastern GOA have found shortraker and/or rougheye rockfish associated with boulders along steep slopes (Krieger and Ito 1999) and with colonies of Primnoa coral (Krieger and Wing 2000). The eastern GOA trawl closure presumably causes a reduction in the alteration or destruction of these habitats, which may have a beneficial effect on shortraker/rougheye in this region.

Prey Availability

Pacific cod and to a lesser extent walleye pollock are species that are known to prey on shrimp, a major prey item of rougheye rockfish, so any changes in their abundance as a result of FMP 2.1 hypothetically could affect the food supply of shortraker/rougheye. Because FMP 2.1 sets ABC equal to the overfishing rate, catches of Pacific cod and walleye pollock would both increase substantially in the GOA, and their abundance would decrease. To protect Steller sea lions, FMP 2.2 has two measures that may reduce the catch and increase the abundance of Pacific cod and walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for two species. However, whether a change in abundance of Pacific cod or walleye pollock would actually affect the food supply for shortraker/rougheye is unknown, as there is no quantitative information on trophic interactions between all these species. Moreover, shortraker and rougheye rockfish reside in deeper depths than Pacific cod or walleye pollock, so they may not be competing for the same spatial aggregations of food.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for GOA shortraker/rougheye rockfish are summarized in Table 4.5-27.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shortraker/rougheye rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery are identified as non-contributing factors since bycatch of rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA shortraker/rougheye rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery and State of Alaska shrimp are identified as non-contributing factors to GOA slope rockfish biomass level since bycatch is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal concentration of catch under FMP 2.1 and FMP 2.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA shortraker/rougheye rockfish; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on shortraker/rougheye rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA shortraker/rougheye rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors to the change in genetic structure and reproductive success of GOA shortraker/rougheye rockfish since bycatch in these fisheries is unlikely to occur.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA shortraker/rougheye rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA shortraker/rougheye rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 2.1 and FMP 2.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on shortraker/rougheye rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery is identified as a non-contributing factor to shortraker/rougheye rockfish prey availability since bycatch of shortraker/rougheye rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since shrimp is a main prey item of rougheye rockfish.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA shortraker/rougheye rockfish; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA shortraker/rougheye rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA shortraker/rougheye rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to shortraker/rougheye rockfish habitat suitability (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery has been identified as a potential adverse contributor to shortraker/rougheye rockfish habitat suitability due to impacts from fishery gear. The State of Alaska shrimp fishery is a non-contributing factor since habitat degradation from shrimp fishery gear is not expected to occur (see Section 3.6).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA shortraker/rougheye rockfish, the effect is currently unknown due to lack of scientific information.

GOA Slope Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Other slope rockfish are managed under Tier 5 and sharpchin rockfish are assessed under Tier 4. Direct/indirect effects are summarized under Table 4.6-1.

Total and Spawning Biomass

No projections are possible for these two parameters, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Fishing Mortality

FMP 2.1 represents a less precautionary approach of fishery management than what is currently used by the NPFMC. An important measure in this bookend that would affect all target species is that ABC would be set equal to overfishing, which would eliminate the buffer between ABC and overfishing that exists in the baseline and FMP 1. An even more important measure in FMP 2.1 concerning slope rockfish is that eastern GOA trawl closure would be repealed. Because slope rockfish mostly reside in the eastern GOA and are predominantly caught by trawl, opening this region to trawling would make most of GOA population of slope rockfish vulnerable to fishing. Both of these measures in combination would result in a larger catch of slope rockfish than has been the case in years past, and increase the risk of overfishing slope rockfish stocks. The model results for this bookend indicate a modest increase in slope rockfish catch of about 300-400 mt compared to the baseline and FMP 1 and recent past catches, but it is likely that if FMP 2.1 actually went into effect, catches of slope rockfish would show even more of an increase (Table H.4-31 of Appendix H).

FMP 2.2 is much less aggressive in its approach than FMP 2.1. The two particular measures that affected slope rockfish catch in FMP 2.1 (removing the eastern GOA trawl closures and setting ABC equal to overfishing) are not part of FMP 2.2, so one would expect that catch and ABC projections for slope rockfish in FMP 2.2 should be nearly identical to those for FMP 1. The model results for FMP 2.2; however, show ABCs for slope rockfish much less than for those FMP1, and the corresponding catch projections are inexplicably similar to FMP 2.1. Thus, ABC and catch results for slope rockfish in the model for FMP 2.2 do not appear reasonable (Table H.4-31 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1 would have substantial effects on the spatial or temporal concentration of slope rockfish catch, especially because the eastern GOA trawl closure would be rescinded. This would allow trawling for rockfish species in the eastern GOA, where most of the GOA population of slope rockfish is located, and greatly increase the chance of localized depletion for some of the slope rockfish species. Because IFQs and fishing cooperatives are not part of this bookend, catches of slope rockfish would likely continue to be concentrated into relatively short open seasons when fishing for rockfish is allowed. Similar to the baseline and FMP 1, this would increase the risk of possible overfishing slope rockfish species because of the difficulty of managing a short, compressed fishery.

FMP 2.2 would have very similar effects on the spatial or temporal concentration of slope rockfish catch as has been the case for the baseline situation in past years. There have been no studies to determine stock structure for any species of slope rockfish, and it is unknown if subpopulations exist. Consequently, there is a possibility that localized depletion may be occurring, despite the effort of geographic apportionment. However, because most of the biomass of slope rockfish occurs in the eastern GOA, which is closed to trawling in this FMP, localized depletion is unlikely under this FMP.

There are no measures in FMP 2.2 for IFQs or cooperatives for rockfish trawlers, who historically have taken most of the catch of slope rockfish in the form of bycatch. Because these measures do not exist in this FMP, it is likely that the rockfish trawl fishery would continue to be compressed into a short open season each year. This would cause a greater risk of possibly overfishing slope rockfish, because it is difficult to manage the fishery within this short time span.

Status Determination

No projections are possible for the fishing mortality rate or MSST, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. There is no information on the sex ratio of slope rockfish, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 2.1 or FMP 2.2 is unknown.

Habitat Suitability

The main impacts of FMP 2.1 on habitat suitability of slope rockfish would be caused by 1) the bookend's repeal of the eastern GOA trawl closure, and 2) increased bottom trawl activity because the bookend would increase ABCs and catches for all species by setting ABC equal to overfishing. The removal of the eastern GOA trawl closure would permit bottom trawlers to catch slope rockfish in the eastern GOA, where most of the slope rockfish biomass is located, and this region would no longer serve as a *de facto* refugium for slope rockfish species. Increased bottom trawl activity would likely result in more damage to benthic habitats, and therefore could have a adverse impact on slope rockfish. The impact could be especially acute for juvenile slope rockfish, which may be particularly dependent on such epifauna.

Similar to FMP 1, FMP 2.2 greatly impacts habitat for slope rockfish because it closes the eastern GOA to trawling. This creates a *de facto* no-take zone or refugium for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species.

Prey Availability

No studies have been done in Alaska to determine the food habits for any of the slope rockfish species. Many of the abundant species, such as sharpchin, harlequin, and redstripe rockfish, are relatively small in size and may be plankton-feeders, but this is conjecture. There is also no documentation of predation on slope rockfish, although larger fishes such as Pacific halibut that are known to prey on other rockfish presumably also prey on slope rockfish. Because of this lack of information, the effect of FMP 2.1 and FMP 2.2 on predator-prey relationships for slope rockfish is unknown.

Cumulative Effects of FMP 2.1 FMP 2.2

Cumulative effects of GOA slope rockfish are summarized in Table 4.5-28.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA other slope rockfish is rated as insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries and State of Alaska groundfish fisheries have been identified as having had a adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of other slope rockfish. The State of Alaska groundfish fisheries is identified as a non-contributing factor since catch and bycatch of slope rockfish species is already accounted for by the domestic groundfish fishery management. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA other slope rockfish and is rated as insignificant. Fishing mortality at projected levels is equal to or below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the other slope rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.24 and 3.10). The State of Alaska groundfish fisheries are identified as non-contributing factors to GOA slope rockfish biomass level. Although catch and bycatch do occur in these fisheries, the removals are already accounted for by the domestic groundfish fishery management.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA other slope rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal concentration of catch under FMP 2.1and FMP 2.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA slope rockfish; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on slope rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA slope rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The State of Alaska groundfish fishery is identified as a non-contributing factor to the change in genetic structure and reproductive success of GOA slope rockfish. Although catch and bycatch of slope rockfish species occurs in these fisheries, they are not expected to contribute to localized depletion such that it leads to a detectable reduction in genetic diversity or reproductive success. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA slope rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA slope rockfish complex.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The change in prey availability under FMP 2.1 and FMP 2.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on slope rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to slope rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to slope rockfish prey availability since bycatch of slope rockfish prey species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA slope rockfish; however, the effect is unknown due to lack of scientific information.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, State of Alaska groundfish fisheries and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA slope rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA slope rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to slope rockfish habitat suitability. The State of Alaska groundfish fishery and the IPHC longline fishery have been identified as potential adverse contributors to slope rockfish habitat suitability due to impacts from fishery gear (see Section 3.6).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA slope rockfish, the effect is currently unknown due to lack of scientific information (Table 4.5-28).

GOA Pelagic Shelf Rockfish – Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Until recently, dusky rockfish fell under Tier 4, while yellowtail and widow rockfish were managed under Tier 5. As of 2004, dusky rockfish will be managed under Tier 3 and the rest of the pelagic rockfish species will continue under Tier 5 until more information becomes available. GOA dusky rockfish were modeled under the Tier 4 category for this analysis. Direct/indirect effects are summarized in Table 4.6-1.

Total and Spawning Biomass

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish.

Fishing Mortality

FMP 2.1 represents a less precautionary approach of fishery management than what is currently used by the NPFMC. An important measure in this bookend that would affect all target species is that ABC would be set equal to overfishing, which would eliminate the buffer between ABC and overfishing that exists in the baseline situation and FMP 1. Another measure in FMP 2.1 that would particularly impact PSR is that the eastern GOA trawl closure in FMP 1 would be repealed. Both of these measures in combination would likely result in a larger catch of PSR than has been the case in years past, and increase the risk of overfishing PSR stocks. The model results for this bookend; however, indicate a decrease in PSR catch, instead of an increase, and therefore do not appear to be reasonable (Table H.4-32 of Appendix H).

According to the description of FMP 2.2, this FMP is much less aggressive in its approach than FMP 2.1. The two particular measures that affected PSR catch in FMP 2.1 (setting ABC equal to overfishing and removing the eastern GOA trawl closures) are not part of FMP 2.2, so one would expect that catch and ABC projections for PSR in FMP 2.2 should be nearly identical to those for FMP 1. Instead, the model results for FMP 2.2 show ABCs for PSR substantially less than for those FMP 1, and the corresponding catch projections are inexplicably similar to FMP 2.1. Thus, catch and ABC results for PSR in the model for FMP 2.2 appear highly unreasonable (Table H.4-32 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 2.1and FMP 2.2 would have very similar effects on the spatial or temporal concentration of PSR catch as has been the case for the baseline situation in past years. ABCs would be geographically apportioned between management areas, which would continue to provide some protection against localized depletion of the resource. Because rockfish IFQs and fishing cooperatives are not part of these bookends, the PSR fishery would likely continue to be concentrated into a relatively short open season. Similar to the baseline and FMP 1, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

Status Determination

Under FMP 2.1, the ABC is set equal to the OFL. Under FMP 2.2, the catch rates are below the ABC and OFL values. The MSST cannot be determined at this time for these stocks.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish. There is no information on the sex ratio of PSR, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 2.1 or FMP 2.2 is unknown.

Habitat Suitability

The main impacts of FMP 2.1 on habitat suitability of PSR would be caused by 1) increased bottom trawl activity because the bookend would increase ABCs and catches for all species, and 2) the bookend's repeal of the eastern GOA trawl closure. Increased bottom trawl activity would likely result in more damage to the benthic habitat, which could have a adverse impact on PSR such as dusky rockfish that may live in association with epifauna such as corals or sponges. The impact could be especially acute for juvenile dusky rockfish, which may be particularly dependent on such epifauna. The removal of the eastern GOA trawl closure would permit bottom trawlers to catch PSR in the eastern GOA, and this region would no longer serve as a *de facto* refugium that could help to replenish PSR stocks in other areas of the GOA.

Similar to FMP 1 and the baseline situation in past years, FMP 2.2 impacts habitat for PSR because it closes the eastern GOA to trawling. This creates a *de facto* no-take zone or refugium for PSR in this area, as trawls are generally the only effective gear for capturing these species. Although biomass estimates from trawl surveys indicate that the trawl closure area in the eastern GOA only contains about 10-15 percent of the Gulfwide biomass of dusky biomass, this is still large enough that it may provide enhanced protection to the dusky rockfish resource.

Prey Availability

The major prey of dusky rockfish appears to be euphausiids, based on the limited food information available for this species (Yang 1993). Euphausiids are also the major prey of walleye pollock, which means dusky rockfish and walleye pollock may be competing for the same food resource. Thus, any measures in FMP 2.1 that affect the commercial catch of walleye pollock could have an subsequent indirect effect on dusky rockfish by increasing or decreasing the amount of euphausiids available to dusky rockfish. Because this bookend sets ABC equal to the overfishing rate, catches of walleye pollock would increase substantially in the GOA. This would decrease the abundance of walleye pollock, and hypothetically increase the number of euphausiids available for consumption by dusky rockfish. To protect Steller sea lions, FMP 2.2 (similar to FMP 1 and the baseline situation in past years) has two measures that may reduce catch of walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for walleye pollock. Hypothetically, these two measures could increase the abundance of walleye pollock, resulting in the consumption of more euphausiids and having an adverse effect on the food supply for dusky rockfish.

However, there is little or no quantitative information on trophic interactions between dusky rockfish and walleye pollock or data on whether they even feed on the same spatial aggregations of euphausiids. Therefore, the effects of FMP 2.1 and FMP 2.2 on GOA PSR is unknown through the change in prey availability.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects for the GOA PSR complex are summarized in Table 4.5-29.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA PSR complex is insignificant under FMP 2.1 and FMP 2.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA PSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR mortality since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA PSR and is rated as insignificant. PSR are expected to be fished at or below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effects of FMP 2.1 and FMP 2.2 on the biomass level are unknown.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery has been identified as a non-contributing factor to GOA PSR biomass levels since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass; however, the effect is unknown since total and spawning biomass levels and MSST are currently unavailable.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The effects of the fisheries on the spatial/temporal characteristics of GOA PSR under FMP 2.1 and FMP 2.2 are unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA PSR; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on PSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery has been identified as a non-contributing factor to GOA PSR genetic structure and reproductive success since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA PSR complex is possible; however, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability under FMP 2.1 and FMP 2.2 is currently unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on PSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a potential adverse contributor to GOA PSR prey availability. The catch of shrimp in the shrimp fishery is expected to continue in the future. Marine pollution is identified as a potential adverse contributor to PSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA PSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in habitat suitability under FMP 2.1 and FMP 2.2 is currently unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries have been identified as having past persisting adverse effects on GOA PSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA PSR habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR habitat suitability since the gear associated with this fishery is not expected to cause a significant impact to the benthic habitat (see Sections 3.5.1.24 and 3.6). Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA PSR, the effect is currently unknown due to lack of scientific information.

GOA Demersal Shelf Rockfish – Direct/Indirect Effects of FMP 2.1

Demersal shelf rockfish are managed under Tier 4. Direct/indirect effects are summarized in Table 4.6-1.

Total and Spawning Biomass

Reliable total and spawning biomass statistics are not available for demersal shelf rockfish species. However, due to the removal of DSR bycatch and halibut IFQ program under this FMP, it is likely that the biomass of DSR will likely tend toward levels that jeopardize the ability of the stock to sustain itself at or above current population levels. Therefore, the direct/indirect effects of FMP 2.1 are ranked as significantly adverse for change in biomass.

Fishing Mortality

The catch (fishing mortality) of DSR in the eastern GOA would reach and likely exceed the DSR OFL, or 540 mt under this example FMP. It is presumed that managers would continue to set TAC below its ABC level to prevent the directed catch and the bycatch of DSR in the halibut fishery to exceed the OFL. It is unknown whether a directed fishery for DSR would be permitted under FMP 2.1 since this management plan would permit the reopening of the eastern GOA to trawl fishing. Historically trawl fisheries in this area have targeted Pacific ocean perch and other pelagic rockfish species. Bycatch of DSR in a trawl fishery is likely but would be difficult to estimate in advance. Mortality approaching 540 mt would raise serious management concerns about the sustainability of the population to withstand such a high exploitation rate. Recent investigations on rockfish exploitation strategies on the west coast of the U.S. suggest that a lower F50 value may be more appropriate for long-lived rockfish stocks than the current F40 rate. (Ralston *et al.* 2002; Ralston (1998); and Dorn (2002). Increasing the mortality level to 540 mt is the equivalent to a F35 exploitation rate. Nearing or exceeding this level would be detrimental to DSR. We conclude that the projected catch of the FMP 2.1 scenario would result in a significantly adverse effect (Table H.4-33 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

In the eastern GOA, most of the DSR harvest is taken in the southeast Outside District with the remainder taken from the east Yakutat Districts (O'Connell *et al.* 2002). We would expect a similar geographic distribution of DSR catch under FMP 2.1. However, as described above, localized deception of DSR stocks could be occurring within these districts. Due to the uncertainty that such localized depletion is occurring on the Fairweather Grounds (or elsewhere), we conclude that management under FMP 2.1 would have a conditionally significant adverse effect on the current environmental condition of DSR stocks in the eastern GOA.

Status Determination

The MSST cannot be determined for this stock complex.

Age and Size Composition and Sex Ratio

Age and size composition data is not available for GOA demersal shelf rockfish species. The sex ratio of GOA demersal shelf rockfish species is unknown.

Habitat Suitability

Any habitat suitability impacts of FMP 2.1, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing, would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, under this example FMP, trawl fisheries would again be permitted to operate in the eastern GOA for the first time in years. Information is insufficient to conclude where these fisheries would occur and whether existing habitat-related impacts would undergo significant change under FMP 2.1. Due to the uncertainty about the intensity of these effects, we have concluded that FMP 2.1 would have a conditionally significant adverse effect on the current environmental condition of DSR habitat.

Prey Availability

Any predator-prey impacts of FMP 2.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify due to inadequate data. Information is insufficient to conclude that predator-prey relationships would undergo any significant change under FMP 2.1. Therefore, the effects of FMP 2.1 on GOA DSR through prey availability are unknown.

Summary of Effects of FMP 2.1 – GOA Demersal Shelf Rockfish

Under FMP 2.1, the ABC for DSR rockfish is set equal to the OFL. An age-structured population model is not used for DSR rockfish and projections of future OFL levels were made by carrying the 2002 baseline values into the future. The projected TAC for DSR rockfish from 2003-2008 will be set below the OFL to prevent overfishing when taking into account any unreported catch, or bycatch mortality. However, combining all estimates of direct mortality raises the risk of overfishing DSR, especially since this FMP would eliminate the DSR bycatch limits in the halibut fishery and authorize renewed trawl operations in the eastern GOA. The uncertainties of the location, magnitude, or bycatch of DSR species in these fisheries has led us to conclude that there would be significantly adverse effects of this FMP on DSR species. Similarly, conditionally significant adverse effects resulting from localized depletion and habitat degradation are possible.

Cumulative Effects of FMP 2.1

Cumulative effects for the DSR complex are summarized in Table 4.5-30.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA DSR complex is significantly adverse under FMP 2.1.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR mortality since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A significantly adverse cumulative effect is identified for mortality of GOA DSR. The elimination of the DSR bycatch limits in the halibut fishery and renewed fishery operations in the eastern GOA increase the risk of overfishing. The combined effect of internal removals and removals due to reasonably foreseeable external events is expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** It is determined the effect of the fisheries on change in biomass level under FMP 2.1 is significantly adverse.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR biomass levels since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A significantly adverse cumulative effect is identified for change in biomass. The elimination of the DSR bycatch limits in the IPHC fishery and the reopening of trawl operations in the eastern GOA could reduce biomass levels. The combined effects of internal and external removals is expected to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA DSR are identified as conditionally significant adverse.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA DSR; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on DSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and IPHC longline fisheries have been identified as non-contributing factors to GOA DSR genetic structure and reproductive success. Catch/bycatch of these fisheries is already accounted for by the domestic groundfish management or is not expected to occur (as in the case of the State of Alaska herring and shrimp fisheries). Marine pollution is identified as a potential adverse contributor to GOA DSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** The concentration of fishing in the Fairweather Grounds and the reopening of the eastern GOA to trawl operations could have significantly adverse effects on the current environmental condition of DSR stocks in the eastern GOA. The combined effects of internal and external removals are likely to jeopardize the ability of the stock complex to maintain current population sizes, therefore a rating of conditionally significant adverse is assigned to change in genetic structure and reproductive success of GOA DSR.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability under FMP 2.1 is currently unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on DSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as potential adverse contributors to GOA DSR prey availability. Catch of herring in the herring fishery and the catch of shrimp in the shrimp fishery are expected to continue in the future. The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to GOA DSR prey availability since bycatch of DSR prey species in not expected to occur. Marine pollution is identified as a potential adverse contributor to DSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA DSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Due to the potential increase in fishing effort as a result of the removal of DSR bycatch limits and the halibut IFQ program, we have determined FMP 2.1 to have a conditionally significant adverse effect on DSR habitat suitability.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries and the IPHC longline fisheries have been identified as having past persisting adverse effects on GOA DSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA DSR habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as non-contributing factors to GOA DSR habitat suitability since the gear associated with these fisheries are not expected to cause a significant impact to the benthic habitat. The State of Alaska groundfish fisheries and the IPHC longline fisheries are identified as potential adverse contributors to DSR habitat suitability (see Sections 3.5.1.24 and 3.6). Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect is identified for change in habitat suitability of the GOA DSR. The reopening of the eastern GOA trawl operations in combination with external removals are likely to jeopardize the capacity of the GOA DSR complex to maintain current populations.

Direct/Indirect Effects of FMP 2.2

Total and Spawning Biomass

Reliable total and spawning biomass statistics are not available for demersal shelf rockfish species. However, due to the removal of the DSR bycatch levels and the removal of the halibut IFQ, the increase in DSR mortality could significantly reduce the DSR biomass to a level at which the capacity of DSR species to maintain current population levels is jeopardized. Thus, FMP 2.2 is rated as conditionally significant adverse for change in biomass.

Fishing Mortality

The projected catch of DSR rockfish would likely be a little lower under this FMP than FMP 2.1. DSR ABC levels would be set below the OFL to prevent overfishing. While a reduced ABC, and in turn a reduced TAC for DSR species would reduce the risk of overfishing, the removal of bycatch limits in the halibut fishery and the addition of trawl fisheries permitted by this FMP would likely offset any benefits of reduced ABCs. As described for FMP 2.1, mortality of DSR species would likely increase above current levels. Mortality approaching 540 mt would raise serious management concerns about the sustainability of the population to withstand such the higher exploitation rate. Recent investigations on rockfish exploitation strategies suggest that a lower F50 value may be more appropriate for long-lived rockfish stocks than the current F40 rate. (Ralston 1998, 2002, and Dorn 2002). Increasing the mortality to 540 mt is the equivalent to a F35 exploitation rate. Nearing or exceeding this level would be detrimental to DSR. We conclude that the projected catch of the FMP 2.2 scenario would result in a significantly adverse effect on DSR species (Table H.4-33 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

In the eastern GOA, most of the DSR harvest is taken in the southeast Outside District with the remainder taken from the east Yakutat District (O'Connell *et al.* 2002). We would expect a similar geographic distribution of DSR catch under FMP 2.2. However, as described previously for FMP 2.1, localized deception of DSR stocks could be occurring within these districts. Due to the uncertainty that such localized depletion is occurring on the Fairweather Grounds (or elsewhere), we conclude that management under FMP 2.2 would have a conditionally significant adverse effect on the current environmental condition of DSR stocks in the eastern GOA.

Status Determination

The MSST cannot be determined for this stock complex.

Age and Size Composition and Sex Ratio

Age and size composition data is not available for GOA demersal shelf rockfish species. The sex ratio of GOA demersal shelf rockfish species is unknown.

Habitat Suitability

Any habitat suitability impacts of FMP 2.2, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing, would be governed by a complex web of direct and indirect interactions that are difficult to quantify due to inadequate data. However, unlike FMP 2.1, the trawl closure currently in place for the eastern GOA would remain, thereby maintaining the current level of habitat protection from this gear type. Due to the uncertainty about the intensity of these effects, we have concluded that FMP 2.2 would have a conditionally significant adverse effect on the current environmental condition of DSR habitat.

Prey Availability

Any effects to predator-prey relationships of FMP 2.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify due to inadequate data. Information is insufficient to conclude that predator-prey relationships would undergo any significant change under FMP 2.2.

Summary of Effects of FMP 2.2 – GOA Demersal Shelf Rockfish

Under FMP 2.2, the ABC for DSR rockfish is set less than the OFL. An age-structured population model is not used for DSR rockfish and projections of future OFL levels were made by carrying the 2002 baseline values into the future. The projected TAC for DSR rockfish from 2003-2008 will be set below the OFL to prevent overfishing when taking into account any unreported catch, or bycatch mortality. However, combining all estimates of direct mortality raises the risk of overfishing DSR, especially since this FMP eliminates bycatch limits in the halibut fishery and would authorize renewed trawl operations in the eastern GOA. The uncertainties of the location, magnitude, or bycatch of DSR species in these fisheries has led us to conclude that there would be conditionally significant adverse effects of this FMP on DSR species. The effects to predator-prey relationships are unknown .

Cumulative Effects of FMP 2.2

Cumulative effects for the GOA DSR complex are summarized in Table 4.5-30.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA DSR complex is significantly adverse under FMP 2.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A significantly adverse cumulative effect is identified for mortality of GOA DSR. The elimination of the DSR bycatch limits in the halibut fishery and increase of fishing effort in the eastern GOA increases the risk of overfishing. The combined effect of internal removals and removals due to reasonably foreseeable external events is expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** FMP 2.2 is rated as conditionally significant adverse for change in biomass levels.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect is identified for change in biomass. If DSR bycatch limits in the IPHC fishery are eliminated, the increase of fishing effort in the eastern GOA could reduce biomass levels. Under those conditions, he combined effects of internal and external removals could jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** FMP 2.2 is rated as conditionally significant adverse for the spatial/temporal characteristics of GOA DSR under FMP 2.2.

- **Persistent Past Effects.** Past effects on the change in reproductive success and genetic structure of the GOA DSR are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in reproductive success and genetic structure of the GOA DSR are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** The concentration of fishing in the Fairweather Grounds and the increased trawl operations in the eastern GOA could have conditionally significant adverse effects on the current environmental condition of DSR stocks in the eastern GOA. The combined effects of internal and external removals are likely to jeopardize the ability of the stock complex to maintain current population sizes, therefore a rating of conditionally significant adverse is assigned to change in genetic structure and reproductive success of GOA DSR.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability under FMP 2.2 is unknown.

- **Persistent Past Effects.** Past effects on the change in prey availability of the GOA DSR are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of the GOA DSR are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA DSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Due to the potential increase in fishing effort as a result of the removal of DSR bycatch limits and the halibut IFQ program, we have determined FMP 2.2 to have a conditionally significant adverse effect on DSR habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability of the GOA DSR are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of the GOA DSR are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect is identified for change in habitat suitability of the GOA DSR. The increased trawling efforts in eastern GOA in combination with external removals are likely to jeopardize the capacity of the GOA DSR complex to maintain current populations.

4.6.2 Prohibited Species Alternative 2 Analysis

4.6.2.1 Pacific Halibut

Pacific halibut are managed by the International Pacific Halibut Commission (IPHC). Halibut bycatch in Federal groundfish fisheries is controlled by the use of PSC limits. IPHC provides for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery.

FMP 2.1 and FMP 2.2 – Direct/Indirect Effects

Direct and indirect effects for Pacific halibut include mortality along with changes in reproductive success and prey availability. These effects, which are associated with changes in catch, are considered insignificant because annual quota setting processes implemented by IPHC account for all removals of halibut including bycatch in other fisheries. Thus, if changes to the baseline condition of the stock occur, they are reflected in the quotas set for the directed fishery. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. Halibut are opportunistic predators with a wide range of prey species, and no significant change to prey structure is expected as a result of FMP 2.1 or 2.2. No evidence of fishery impact to habitat of halibut has been shown, so this effect will not be considered in the cumulative effects analysis that follows.

Under FMP 2.1, halibut PSC caps would be removed. Halibut bycatch mortality in the BSAI and GOA combined would increase from the present 6,800 mt to 12,000-15,000 mt as a result of increases in TAC levels for target groundfish fisheries. Such a scenario would require that the IPHC make a corresponding reduction of 5,000-8,000 mt in halibut catches by the directed fishery, or 10-20 percent of the 2002 level. Thus, even with removal of bycatch restrictions, IPHC would limit total removals of halibut to a level that would protect the resource to avoid adverse impacts to stock status.

Under FMP 2.2, halibut PSC caps would be retained. As a result, there would be no increased halibut mortality above current levels, and no adjustment to the halibut harvest quota by IPHC would be necessary.

FMP 2.1 – Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 2.1 is shown in Table 4.5-31, and a summary of the ratings for all effects is provided in Table 4.6-2. For further information on persistent past effects included in this analysis see Section 3.5.2.1 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 2.1 because current management of halibut by IPHC accounts for all removals of halibut including bycatch in other fisheries when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects.** The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 2.1. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 2.1.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut, since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 2.1. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of FMP 2.1.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of halibut have been identified.

- **Reasonably Foreseeable Future External Effects.** Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1.

FMP 2.2 – Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 2.2 is shown in Table 4.5-31, and a summary of the ratings for all effects is provided in Table 4.6-2. For further information on persistent past effects included in this analysis see Section 3.5.2.1.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 2.2 because current management of halibut by IPHC accounts for all removals of halibut including bycatch in other fisheries when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects.** The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 2.2. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 2.2.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut, since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.2.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 2.2. No significant change to prey structure is expected as a result of FMP 2.2.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of halibut have been identified.

- **Reasonably Foreseeable Future External Effects.** Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability on Pacific halibut resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.2.

4.6.2.2 Pacific Salmon or Steelhead Trout

Pacific salmon are managed by the ADF&G, which also manages the salmon sport fisheries and permitted subsistence harvesting, to ensure that escapement goals are met for the spawning population in order to maintain sustained yields from the stock as a whole. Annual harvest levels are responsive to fluctuations in run sizes. Section 4.5.2.2 provides a detailed summary of current harvest rates and stock status for salmon in Alaska.

ESA-listed Pacific Northwest chinook salmon and steelhead trout were not specifically considered in this cumulative effects analysis as discussed in Section 4.5.2.2, which also presents a summary of assumptions included in the impact analysis of the FMPs.

The cumulative effects analyses were based on two groupings of Alaska salmon in BSAI and GOA: chinook salmon and other salmon. Refer to Section 4.5.2.2 for a list of the assumptions used during the cumulative effects analysis.

FMP 2.1 and FMP 2.2 – Direct/Indirect Effects

Direct and indirect effects for chinook salmon and other salmon in BSAI and GOA include mortality along with changes in prey availability, genetic structure of population, and reproductive success.

<u>BSAI – Chinook Salmon</u>

Under FMP 2.1, chinook salmon bycatch in BSAI varies from approximately 89,000 fish in 2003 down to 51,000 fish in 2007. Assuming 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 30,000 to 62,000 fish during the next six years. This harvest represents approximately 10 to 20 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Under FMP 2.1, chinook salmon bycatch would increase by 17,000 to 44,000 fish. These catch levels represent a significant increase in bycatch (>25 percent increase) and may be detectable in natal streams. This increase may impact subsistence harvests and escapement, especially in years of poor runs such as the year 2000. The bycatch levels predicted under FMP 2.1 could have conditionally significant adverse impacts on the sustainability of individual runs and on the stock as a whole. If combined with increased harvests in the GOA under FMP 2.1, the increased chinook salmon catch would be 25,000 to 50,000 fish for a total catch of 46,000 to 84,000 fish. Such catch levels would be detectable, likely impact subsistence and commercial harvest or escapement, and have a conditionally significant adverse impact on the sustainability of individual runs or the stock as a whole.

Under FMP 2.2, chinook salmon bycatch in the BSAI varies from approximately 38,000 fish in 2003 to 24,000 fish in 2006. Assuming 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 14,000 to 27,000 fish during the next six years. This harvest represents approximately 4.7 to 9.0 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This level of bycatch represents an increase of 1,000 to 9,000 fish, which may be considered significant in some years (greater than [>]25 percent). However, considering this increase across all chinook salmon runs in western Alaska, it is not likely to be detectable in natal streams, nor would it impact subsistence or commercial fisheries and escapement. If combined with increased harvests in GOA, this increase in BSAI catch could adversely impact population sustainability, especially in years of poor runs such as those seen in 2000. Therefore, the effects of mortality on BSAI chinook under FMP 2.2 are considered conditionally significant adverse.

BSAI – Other Salmon

Under FMP 2.1, bycatch of other salmon in BSAI varies from approximately 153,000 fish in 2003 down to a low of 82,000 fish in 2006. Assuming 96 percent of other salmon bycatch is chum salmon and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 16,000 to 29,000 fish during the next six years. This harvest represents approximately 1.5 to 2.6 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. Chum salmon bycatch would increase by 5,000 to 16,000 fish. Such bycatch levels represent a significant increase in harvest (> 25 percent increase), but would likely not be detectable in natal streams and would have little or no effect on subsistence or commercial harvests and escapement. When considered across all chum salmon stocks in western Alaska, this level of bycatch is not likely to significantly impact sustainability of any particular run or the stock as a whole. However, if combined with increased harvests in the GOA under FMP 2.1, chum salmon catches would increase by 11,000 to 24,000 fish. Such an increase could adversely impact population sustainability, especially in years of poor runs such as those in 2000. Therefore, the effects of mortality on BSAI other salmon under FMP 2.1 are considered conditionally significant adverse.

Under FMP 2.2 bycatch of other salmon in the BSAI varies from approximately 108,000 fish in 2003 to a low of 68,000 fish in 2006. Assuming 96 percent of this other salmon bycatch may be chum salmon and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 13,000 to 21,000 fish during the next six years This harvest represents approximately 1.2 to 1.9 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This represents a moderate (10 to 25 percent) to significant (> 25 percent) increase in the bycatch of 2,000 to 9,000 western Alaska chum salmon. When spread across all chum salmon runs in western Alaska, such increases are not detectable in natal streams, would not significantly impact commercial or subsistence harvests or escapement. However, such an increase could have adverse impacts to population sustainability, especially in years of poor runs such as those seen in 2000. Therefore, the effects of mortality on BSAI other salmon under FMP 2.2 are considered conditionally significant adverse.

GOA – Chinook Salmon

Under FMP 2.1, chinook salmon bycatch in GOA varies from approximately 27,000 individuals in 2003 to 38,000 individuals in 2008. Assuming 58 percent of GOA chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 16,000 to 22,000 fish during the next six years. This harvest represents approximately 5.3 to 7.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Chinook salmon bycatch would increase by 6,000 to 8,000 fish. Such catch levels represent a significant increase in bycatch (>25 percent increase). When spread across all the chinook salmon runs of western Alaska, this level of bycatch is not expected to be detectable in natal streams, impact subsistence harvests and escapement, or significantly impact the sustainability of the stock as a whole. However, if combined with increased bycatch in the BSAI under FMP 2.1, the increased chinook salmon catch would be 25,000 to 50,000 fish for a total catch of 46,000 to 84,000 fish. Such catch levels would be detectable, likely impact subsistence and commercial harvest and escapement, and may have a conditionally significant adverse impact on the sustainability of individual runs or the stock as a whole.

Under FMP 2.2, chinook salmon bycatch in the GOA varies from approximately 11,000 fish in 2003 up to 23,000 fish in 2008. Assuming 58 percent of GOA chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 6,000 to 13,000 fish during the next six years. This harvest represents approximately 2 to 4 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Such levels of bycatch are not expected to have a significant impact on the sustainability of the stock. Considering this increase across all chinook salmon runs in western Alaska, it is not likely to be detectable in natal streams, nor would it impact subsistence or commercial fisheries and escapement. However, if combined with increased harvests in BSAI, this increase in GOA bycatch could adversely impact population sustainability, especially in years of poor runs such as those seen in 2000. Therefore, the effects on mortality of GOA chinook salmon under FMP 2.2 are considered conditionally significant adverse.

GOA – Other Salmon

Under FMP 2.1, bycatch of other salmon in the GOA varies from approximately 10,000 fish in 2003 to 13,000 fish in 2008. Assuming 56 percent of this other salmon bycatch is chum salmon, the bycatch could range from 6,000 to 7,000 fish during the next six years. The proportion of these fish from western Alaska is unknown. Assuming that all of these fish were from western Alaska, this harvest represents approximately 0.5 to 0.6 percent of the average western Alaska commercial and subsistence harvest of approximately 900,000 chum salmon from 1998 through 2000. In most cases, such bycatch levels represent a minor to moderate increase in harvest (10 to 25 percent), although in some cases, there may be significant increases in harvest (>25 percent). When considered across all chum salmon runs in western Alaska, such an increase would not be detectable in natal streams and would have no detectable effect on subsistence or commercial harvests and escapement. However, this increase in catch could have a conditionally significant adverse impact to population sustainability, if combined with increased bycatch in BSAI during years of poor runs such as those seen in 2000. Therefore, the effects of mortality on GOA other salmon under FMP 2.1 are considered conditionally significant adverse.

Under FMP 2.2, bycatch of other salmon in the GOA varies from approximately 4,000 fish in 2003 up to 9,000 fish in 2008. Assuming 56 percent of this other salmon bycatch is chum salmon, the bycatch could range from 2,000 to 5,000 fish during the next six years. The proportion of these fish from western Alaska is unknown. Assuming that all of these fish originate in western Alaska, this harvest represents approximately 0.2 to 0.5 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. When spread across all chum salmon runs in western Alaska, these bycatch levels are not detectable in natal streams, would have no detectable impact on subsistence or commercial catches and escapement, and are not expected to significantly impact sustainability of the stock. Therefore, the effects of mortality on GOA other salmon under FMP 2.2 are considered insignificant.

FMP 2.1 – Cumulative Effects Analysis

Summaries of the cumulative effects analysis for chinook and other salmon associated with FMP 2.1 is shown in Tables 4.5-32 and 4.5-33. A summary of the ratings for all effects is provided in Table 4.6-2. For further information on persistent past effects included in this analysis see Section 3.5.2.2.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered conditionally significant adverse based on the predicted increases in catch under FMP 2.1. Such increases in bycatch levels would be detectable, likely impact subsistence and commercial harvest and escapement, and may have a conditionally significant adverse impact on the sustainability of the already depressed individual runs or the stock as a whole.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the following years and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries exert effects on mortality of BSAI and GOA chinook and other salmon populations. The magnitude of these effects cannot be determined. However, current stock status of salmon runs in western Alaska are depressed. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. GOA non-western chinook and salmon stocks are considered stable, but state and commercial fisheries still exert effects on mortality. Similar to western Alaska stocks, the magnitude of these effects cannot be determined. State sport fisheries are not viewed as having significant impacts to salmon stocks in the GOA and are not considered contributing factors to mortality of salmon populations as a whole. Land management practices heavily influence the condition of watersheds used by spawning salmon but are not considered contributing factors in direct mortality of salmon. State hatchery enhancement programs were initiated in GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI and GOA chinook and other salmon resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for FMP 2.1. Combined bycatch potential in the BSAI and GOA fisheries under this FMP could impede successful recovery of depressed stocks. Even for the relatively stable GOA other salmon populations, such an increase in bycatch under FMP 2.1 would not be desirable, and is considered to have a conditionally significant adverse impact due to the uncertainty regarding loss of population sustainability.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 2.1 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of prey and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, a relationship between state commercial, subsistence, and (in the GOA) sport fisheries bycatch of prey and salmon prey availability has not been defined and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. State hatchery enhancement programs occur in GOA, but do not include prey species of salmon. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 2.1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 2.1 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, salmon bycatch composition has not been determined. Potential effects of state commercial and subsistence fisheries, along with sport fisheries in the GOA, on genetic structure of salmon populations are unknown. Land management practices and long-term climate changes and regime shifts are not considered contributing factors to changes in GOA salmon populations. In the GOA, state hatchery enhancement programs focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in the BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 2.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 2.1 on reproductive success for BSAI and GOA chinook and BSAI other salmon are considered conditionally significant adverse since stock status in this region is currently depressed and catch prediction under this FMP would increase significantly. For GOA other salmon stocks, the effects of FMP 2.1 are unknown.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska, it may be inferred that reproductive success has been impacted in certain populations. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may also play a role in the reproductive success of certain salmon populations. Non-western Alaska chinook and other salmon stocks in the GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of increased catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. Non-western chinook and other salmon stocks in GOA are considered stable, so potential effects of state commercial, subsistence, and sport fisheries on reproductive success of these stocks are considered insignificant. Degradation of watersheds used by spawning salmon resulting from poor land management practices could significantly impact the reproductive success of BSAI and GOA salmon stocks. Thus, these practices are considered potentially adverse contributors to possible changes in reproductive success of this population. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska, and are considered potentially beneficial to the reproductive success of salmon.

  Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential in the BSAI and GOA fisheries, the sustainability of BSAI and GOA chinook and BSAI other salmon stocks could be impacted. Thus, increased catch predicted under FMP 2.1 may remove spawning adults destined for spawning grounds, and potential combined effects from internal and external events are considered conditionally significant adverse to the reproductive success of BSAI and GOA chinook and BSAI other salmon. Although current stock status of GOA other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) cannot be determined for GOA other salmon stocks under FMP 2.1.

FMP 2.2 – Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 2.2 is shown in Tables 4.5-32 and 4.5-33. A summary of significance ratings for all effects is provided in Table 4.6-2. For further information on persistent past effects included in this analysis see Section 3.5.2.2.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI chinook and other salmon is considered conditionally significant adverse based on the predicted increases in catch under FMP 2.2. When spread across all chum salmon runs in western Alaska, such increases in bycatch are not detectable in natal streams, and would not significantly impact commercial or subsistence harvests or escapement. However, such an increase could have adverse impacts to population sustainability, especially in years of poor runs. Therefore, the FMP 2.2 is found to have a conditionally significant adverse effect on BSAI salmon mortality. The levels of bycatch predicted for GOA salmon are not expected to have a significant impact on the sustainability of the stock. Therefore, FMP 2.2 is found to have an insignificant effect on mortality of GOA salmon.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the following years and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries exert effects on mortality of chinook and other salmon populations. The magnitude of these effects cannot be determined, however, current stock status of salmon runs in western Alaska are depressed. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. The GOA other salmon stocks are considered stable, thus the predicted catch rates under

FMP 2.2 do not show potential for impacts on stock sustainability and are considered insignificant. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State hatchery enhancement programs were initiated in GOA and have a potentially beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI chinook and other salmon resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for FMP 2.2. Combined bycatch potential in the BSAI fisheries under this FMP could impede successful recovery of depressed stocks in BSAI and impact sustainability of the stock as a whole. Current stock status of salmon in GOA is considered stable and combined effects of mortality on chinook and other salmon in this region resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 2.2 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of salmon prey items and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, a relationship between state commercial, subsistence, and (in the GOA) sport fisheries bycatch of prey and salmon prey availability has not been defined and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. State hatchery enhancement programs that occur in GOA do not include prey species of salmon. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in both the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 2.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 2.2 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, salmon bycatch composition has not been determined, so potential effects of state commercial, subsistence, and sport fisheries on genetic structure of salmon populations are unknown. Land management practices and long-term climate changes and regime shifts are not considered contributing factors to changes in GOA salmon populations. State hatchery enhancement programs focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 2.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 2.2 on reproductive success for BSAI chinook and other salmon are considered conditionally significant adverse since stock status in this region is currently depressed and catch prediction under this FMP would increase significantly. For GOA stocks, the effects of FMP 2.2 are unknown.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska it may be inferred that reproductive success has been impacted in certain populations of BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may also play a role in the reproductive success of certain salmon populations. Stocks in GOA are currently considered stable so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries catch of western chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Alaska chinook and other salmon stocks in GOA are considered stable, so potential effects of state commercial, subsistence, and sport fisheries on reproductive success of these stocks are considered insignificant. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of increased catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potentially adverse contribution to the population as a whole. Degradation of watersheds used by spawning salmon resulting from poor land management practices could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potentially adverse contributions to possible changes in reproductive success of this population. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska and are considered potentially beneficial to the reproductive success of salmon. Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential in the BSAI fisheries, the sustainability of BSAI chinook and other salmon stocks could be impacted. Thus, increased catch predicted under FMP 2.2 may remove spawning adults destined for spawning grounds and potential combined effects from internal and external events is considered conditionally significant adverse to the reproductive success of BSAI salmon. Although current stock status of GOA chinook and other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) cannot be determined for GOA stocks under FMP 2.2.

4.6.2.3 Pacific Herring

Pacific herring are managed by the ADF&G. Harvest policy and allocations among gear (user) groups is established by the Alaska Board of Fisheries. Annual harvest quotas are set by ADF&G under an exploitation rate harvest policy; herring exploitation rates are capped at a maximum level of 20 percent statewide. All directed herring fisheries occur in state waters and are managed by regulatory stocks.

A detailed discussion of the modeling approach used in this analysis is included in Section 4.5.2.3. Given the low herring bycatch levels that are predicted across all FMPs, bycatch removals would not be expected to have significantly different impacts on herring abundance estimates among FMPs.

FMP 2.1 and FMP 2.2 – Direct/Indirect Effects

Direct and indirect effects for Pacific herring include mortality, along with changes in reproductive success, prey availability, and habitat. These effects, which are associated with changes in catch, are considered insignificant for the following reasons: bycatch of herring in the groundfish fisheries is generally low, the fisheries do not target herring prey, and spatial/temporal overlap between the groundfish fisheries and herring habitat is minimal. In addition, annual quota setting processes implemented by ADF&G are responsive to fluctuations in herring biomass.

FMP 2.1 and FMP 2.2 – Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 2 is shown in Table 4.5-34. For further information on persistent past effects included in this analysis see Section 3.5.2.3 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA herring is insignificant under FMP 2.1 and FMP 2.2 because even with the opening of the Herring Savings Areas, current management of herring by ADF&G is responsive to fluctuations in herring biomass. The herring savings areas reduce herring bycatch potential by triggering closures in years when herring are abundant within fishing grounds. Although FMP 2.1 would remove the herring savings areas, it is presumed that the intensive harvest management currently in place with ADF&G would account for any increases in catch or respond accordingly to changes in biomass.

- **Persistent Past Effects.** Domestic herring fisheries became prominent in the early 1900s with peak catches occurring in the 1920s and 1930s. Foreign herring harvests became prominent in the BSAI in the late 1950s, with highs in the late 1960s and early 1970s. Overexploitation of herring likely resulted during these years of high catch. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have impacted herring populations over the long-term. In addition, past federal groundfish fisheries bycatch combined with the directed state fisheries have exceeded the state's herring harvest policy in the past and may still exert lingering effects on current herring populations in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur, but are closely managed by the state (ADF&G). Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. State subsistence catch does not constitute a significant amount of catch compared to the directed fishery and is accounted for in ADF&G herring management plans. These fisheries are not considered contributing factors to changes in herring mortality. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring mortality, especially for those populations that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass and fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. Thus, although some persistent past effects may still be present on certain herring populations in the BSAI and GOA, the combined effects of mortality on Pacific herring resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1 and FMP 2.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on reproductive success of BSAI and GOA herring is insignificant under FMP 2.1 and FMP 2.2, due to the low amounts of estimated herring bycatch, and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in reproductive success occurs, it would most likely be reflected in corresponding changes to biomass, which are incorporated into ADF&G management plans of Pacific herring.

- **Persistent Past Effects.** As discussed in the analysis of cumulative effects on Pacific herring mortality, past federal groundfish fisheries bycatch combined with the directed state fisheries have exceeded the state's herring harvest policy in the past and may still exert lingering effects on current herring populations in the BSAI and GOA. Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. It has been found that this type of contamination exposure to adult and larval herring can result in many adverse effects such as: increased rates of egg mortality, larval deformities, and immune system deficiencies. It is presumed that the effects of EVOS still exist and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur but are closely managed by the state (ADF&G). Fishing quotas are based on variable exploitation rates that account for declines in stock. State subsistence fisheries catch are also accounted for in ADF&G herring management plans. Thus, these fisheries are not considered contributing factors to changes in herring reproductive success. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring reproductive success, especially for those populations that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific herring depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass, and fishing quotas are based on variable exploitation rates that account for declines in stock. Although certain herring populations in the GOA have been impacted by EVOS, the stock as a whole is considered recovering. Thus, some persistent past effects may still be present on certain herring populations in the BSAI and GOA, but the combined effects on Pacific herring reproductive success resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 2.1 and FMP 2.2.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The potential effect of Federal groundfish fisheries on prey availability for BSAI and GOA herring is insignificant under FMP 2.1 and FMP 2.2, because groundfish fisheries do not target herring prey and if current management by ADF&G is responsive to fluctuations in herring biomass regardless of the cause associated with the change. Thus, if a change in prey availability did occur, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of herring have been identified.

- **Reasonably Foreseeable Future External Effects.** Pacific herring prey primarily on zooplankton which is not affected by state directed herring fisheries or state subsistence fisheries. Thus, these fisheries are not considered contributing factors to changes in prey availability for herring. Future acute and chronic marine pollution could occur, but effects on prey such as zooplankton are unknown. Long-term climate change and regime shifts could have impacts to many species that contribute to the prey structure of Pacific herring. The nature of these impacts depends on the direction of the climatic shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** Potential effects of future natural events, such as marine pollution and climatic shifts, on prey availability for Pacific herring are unknown for FMP 2.1 and FMP 2.2.

Change in Habitat

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on habitat of BSAI and GOA herring is insignificant under FMP 2.1 and FMP 2.2, because current management of herring by ADF&G is responsive to fluctuations in herring biomass and spatial/temporal overlap between the fisheries and herring habitat is minimal. However, if a change in important habitat were to occur, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring. In FMP 2.2, the herring savings areas would reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds. Despite the removal of these areas under FMP 2.1, it is presumed that any significant changes to biomass would be accounted for in the harvest management plans set forth by ADF&G.

- **Persistent Past Effects.** Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. The long-term effects of this event to herring habitat are unknown. It is presumed that the effects of EVOS still exist and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** No evidence of fishery impact on habitat of herring exists. Thus, fisheries are not considered contributing factors to changes in herring habitat at this time. Future acute and chronic marine pollution could occur and is considered potentially adverse to some herring habitat, especially those that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts are not expected to significantly change physical habitat of Pacific herring.

- **Cumulative Effects.** Potential impacts of future natural events, such as marine pollution and climatic shifts, in addition to lingering contamination from EVOS on certain habitat of herring in the GOA exist, but effects are not known for FMP 2.1 and FMP 2.2.

4.6.2.4 Crab

Alaska king, bairdi Tanner crab, and opilio Tanner crab (also called snow crab) fisheries are managed by the State of Alaska, with Federal oversight and following guidelines established in the BSAI king and Tanner crab FMP (NPFMC 1989). Section 4.5.2.4 contains further information on current stock status and management of crab in Alaska.

For the cumulative effects analysis, crab stocks in BSAI and GOA will be placed in the following groups: Bairdi Tanner, Opilio Tanner (only BSAI), Red king, Blue king, and Golden king. Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, GOA opilio Tanner crab is not included in this analysis.

Direct/Indirect Effects FMP 2.1 and FMP 2.2

Direct and indirect effects for all species of crab in BSAI and GOA include mortality along with changes in biomass, reproductive success, prey availability, and habitat. These effects may be attributed to fishing activities (both directed and undirected), but may also be linked to natural events such as long-term climatic change and decadal regime shifts. Significance of these effects is based on the likelihood that population-level changes will result from internal events within the groundfish fishery. An effect that is considered insignificant corresponds to a change that is not likely to result in population-level effects on crab or that lies within the range of natural variability for the species. Significance ratings for the individual direct and indirect effects are discussed in the following cumulative effects sections.

Cumulative Effects Analysis FMP 2.1

Summaries of the cumulative effects analyses associated with FMP 2.1 are shown in Tables 4.5-36 through 4.5-42. Table 4.6-2 provides a summary of the significance ratings for all effects on crab. For further information on persistent past effects included in this analysis see Section 3.5.2.4 of this Programmatic SEIS.

The foundation of the cumulative effects analysis is the baseline description for each species that includes population status and trends, if known, and the major human and natural influences that have affected the population in the past and that continue to the present.

For each species, the predicted direct and indirect effects of the groundfish fishery are then analyzed for their contribution to the overall impacts from all sources, including reasonably foreseeable future events resulting from human and natural events external to the fishery. The reasonably foreseeable future events include other U.S. and foreign fisheries, acute and chronic environmental pollution, and natural events such as climatic and oceanographic fluctuations. Cumulative effects are rated according to the same significance criteria as the direct/indirect effects of the fishery and are based on the potential for population-level effects.

<u>Mortality</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Under FMP 2.1, predicted catch of these crab species increases significantly from the current baseline condition, although catch trends do fluctuate throughout the five-year period. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. Increases in crab catch and bycatch by federal fisheries, in addition to removal of protection areas, trawl closures, and PSC limits proposed under this FMP, could significantly impact sustainability and recovery of these already depressed stocks. Thus, FMP 2.1 is rated as significantly adverse to bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI considering that no signs of recovery have been evident for these stocks to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are managed by ADF&G in cooperation with NOAA Fisheries. These fisheries are considered to have a potentially adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect but the population is currently considered depressed. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI still exist and stocks are considered depressed, and in some instances overfished, with no signs of recovery to date. Thus, these combined effects of mortality, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events, are considered significantly adverse to bairdi Tanner, opilio Tanner, red king, and blue king crab populations in BSAI under FMP 2.1.These effects could further impede the recovery of the population, although the driving factor(s) behind the BSAI crab stocks' lack of recovery have not been determined.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Under FMP 2.1, predicted catch rates of golden king crab in BSAI and GOA were combined with those for blue king crab. The BSAI predictions showed slight increases in catch over the next five years when compared to current catch rates. Model projections for GOA catch showed minor decreases in catch compared to current catch in this region. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status. Thus, effects of FMP 2.1 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA are currently unknown. Thus, the potential effects of these fisheries on mortality are not known. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown. Potential increases in crab bycatch and catch, in addition to removal of protection areas, trawl closures, and PSC limits proposed under FMP 2.1, could have significant impacts on the sustainability of these stocks. However, potential combined effects of mortality, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined due to lack of a current baseline condition.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Under FMP 2.1, predicted catch of bairdi Tanner, red king, and blue king crab in GOA showed large increases from current catch levels over the next five years. However, significance of these predicted changes in catch on mortality is unknown. Some stocks of bairdi Tanner crab in GOA show signs of possible recovery while others are still considered depressed. Under FMP 2.1, potential for catch increases and removal of protection areas and trawl closures are proposed. This could have conditionally significant adverse effects on these stocks should lack of recovery continue. GOA red king stocks are severely depressed according to ADF&G survey data and do not show signs of recovery. For the same reasons mentioned above for bairdi Tanner crab, FMP 2.1 is rated as significantly adverse to red king crab stocks. Blue king crab stock status in GOA has not been determined by ADF&G, but it is presumed that these stocks may also be depressed. However, the effects of FMP 2.1 on mortality of blue king crab populations in GOA are unknown, until a baseline condition can be established.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in bottom trawl fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of external fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential combined effects of mortality, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 2.1. Under FMP 2.1, crab catch is expected to increase while protection areas and trawl closures are removed. These factors, in addition to potential effects of mortality on red king stocks in the GOA are considered significantly adverse due to the already severely depressed nature of these stocks, and the lack of recovery that has been observed.

Change in Biomass

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. Increases in crab bycatch by federal fisheries, in addition to removal of protection areas, trawl closures, and PSC limits proposed under this FMP, could significantly impact sustainability and recovery of these already depressed stocks. Thus, FMP 2.1 is rated as significantly adverse to bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI considering that no signs of recovery have been evident for these stocks to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fishing effects could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. These fisheries are considered to have a potentially adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Potential effects of climate change and regime shifts on biomass levels of crab in BSAI have not been determined and depend on the direction of change that occurs.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI still exist and stocks are considered depressed with no signs of recovery to date. Increases in crab bycatch, in addition to removal of protection areas, trawl closures, and PSC limits proposed under FMP 2.1, could significantly impact sustainability and recovery of these stocks. Thus, these combined effects, resulting from past events, direct catch, internal bycatch, and reasonably foreseeable future external events, are considered significantly adverse to changes in biomass and sustainability of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. These effects could further jeopardize the sustainability of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI under FMP 2.1, although the driving factor(s) behind the BSAI crab stocks' lack of recovery have not been determined.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 2.1 on changes to biomass cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. The potential effects of past fishing mortality on biomass of golden king crab stocks in BSAI and GOA cannot be determined because catch composition is unknown, and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA is unknown, and biomass estimates have not been determined. Thus, the potential effects of these fisheries on biomass are not known. Potential effects of long-term climate change and regime shifts on crab biomass levels have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown and biomass estimates have not been determined. Thus, potential effects on biomass of BSAI and GOA golden king crab stocks, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.1.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Some stocks of bairdi Tanner crab in GOA show signs of possible recovery while others are still considered depressed. Under FMP 2.1, potential for catch increases and removal of protection areas and trawl closures are proposed. This could have conditionally significant adverse effects on these stocks should lack of recovery continue. GOA red king stocks are severely depressed according to ADF&G survey data and do not show signs of recovery. For the same reasons mentioned above for bairdi Tanner crab, FMP 2.1 is rated as significantly adverse to red king crab stocks. Blue king crab stock status in GOA has not been determined by ADF&G, but it is presumed that these stocks may also be depressed. The effects of FMP 2.1 on biomass of blue king crab populations in GOA are unknown until a baseline condition can be established.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in bottom trawl fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Adverse effects of past fishing mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in GOA may still exist as recovery of depressed stocks has not occurred.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to be managed by ADF&G in cooperation with NOAA Fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on biomass of bairdi Tanner and blue king crab stocks cannot be determined. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Potential effects of long-term climate change and regime shifts on crab biomass levels have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential effects on biomass of bairdi Tanner and blue king crab in GOA, resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.1. Potential effects on biomass of red king crab in GOA, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events are considered significantly adverse due to the already severely depressed nature of these stocks, lack of signs for recovery, and potential for increases in catch and removal of protection areas under FMP 2.1.The combined effects could further impede the recovery of the population, although the driving factor(s) behind the red king crab stocks' lack of recovery have not been determined.

Change in Reproductive Success

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. Changes in reproductive success within BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causation between spawning-recruitment success and depressed stock status cannot be concluded at this time. Increases in crab bycatch by federal fisheries, in addition to removal of protection areas, trawl closures, and PSC limits proposed under this FMP, could significantly impact sustainability and recovery of these already depressed stocks. Therefore, the potential effects of FMP 2.1 on changes to reproductive success are considered conditionally significant adverse to these stocks.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Directed crab fishing seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. Increases in crab bycatch by federal fisheries, in addition to removal of protection areas, trawl closures, and PSC limits proposed under this FMP, could significantly impact sustainability and recovery of these already depressed stocks. A relationship between spawning-recruitment success and other factors impeding on reproductive potential to depressed stock status cannot be drawn at this time Thus, potential effects reproductive success, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events, are considered conditionally significant adverse under FMP 2.1.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 2.1 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on reproductive success are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA are not known. Potential effects on reproductive success, resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events are unknown for FMP 2.1 until a baseline condition is defined. It should be noted that increased mortality resulting from removal of PSC limits, bycatch restrictions, protection areas, and trawl closures as proposed under this FMP, could significantly impact the reproductive success and sustainability of these stocks.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Changes in reproductive success within GOA crab populations may be an underlying factor in the depressed nature of these stocks. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery while other GOA stocks are still considered depressed. Although, a direct causation between reproductive success and depressed stock status cannot be concluded at this time, the potential for catch increases and removal of protection areas and trawl closures proposed under FMP 2.1, could have conditionally significant adverse effects on these stocks should lack of recovery continue. Red king crab populations in GOA are at historic lows according to ADF&G survey information. For the same reasons mentioned above for bairdi Tanner crab, FMP 2.1 is rated as conditionally significant adverse to red king crab stocks. Blue king crab stock status in GOA has not been determined by ADF&G, but it is presumed that these stocks may also be depressed. The effects of FMP 2.1 on reproductive success of blue king crab populations in GOA are unknown until a baseline condition can be established.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as some of these stocks have not shown signs of recovery to date. Current stock status of GOA blue king crab has not been determined, so potential past effects on reproductive success are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting periods so these fisheries are not considered contributing factors to changes in reproductive success of these stocks. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the GOA may still exist, and some stocks are considered depressed with no signs of recovery to date. Under FMP 2.1, there is a potential for increases in fishing mortality and removal of protection areas. This could have conditionally significant adverse effects on these stocks should lack of recovery continue. Potential effects on reproductive success of bairdi Tanner and blue king crab in GOA, resulting from past events, direct catch, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.1 due to lack of current baseline condition. Potential effects on reproductive success of red king crab in GOA, resulting from past, present, and future events are considered conditionally significant adverse due to the already severely depressed nature of these stocks, lack of signs for recovery, and potential for increases in fishing mortality and removal of protection areas under FMP 2.1.

<u>Change in Prey Availability</u>

Bairdi Tanner, Opilio Tanner, Red King, Blue King, and Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and it is unclear if FMP 2.1 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of FMP 2.1 on changes in prey availability cannot be determined.

- **Persistent Past Effects.** Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past fisheries is minimal. Thus, past effects on crab prey structure and availability in BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and these fisheries are not considered contributing factors to changes in prey availability. Rebuilding plans currently in effect in BSAI do not address crab prey structure and availability and are not considered contributing factors to potential changes in prey availability. Long-term climate change and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the potential effects that these changes may have on crab populations throughout BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined and potential changes to prey structure, resulting from past, present, and future events, cannot be determined for all species of crab in BSAI and GOA.

<u>Change in Habitat</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. However, a direct link between changes to habitat and the depressed stock status of these crab species in the BSAI cannot be concluded at this time. Numerous ADF&G management measures, rebuilding plans, trawl closures, and conservation areas have been implemented to address declining and overfished crab stocks in BSAI. Under FMP 2.1, removal of protection areas and trawl closures throughout BSAI could impede on the recovery of these stocks and significantly impact the sustainability of BSAI crab stock as a whole. Thus, FMP 2.1 is considered significantly adverse to changes in crab habitat.

- **Persistent Past Effects.** The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of trawling and using other types of fishing gear that interact with bottom habitat. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered potentially adverse factors to possible changes in crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock also has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time and offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed, and possible habitat-related effects have not been determined. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors.

- **Cumulative Effects.** Persistent past effects on crab habitat in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. Although some of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, these protection measures would be removed under FMP 2.1. Thus, potential combined effects on BSAI crab habitat, resulting from past, present, and future events, would be considered significantly adverse to sustainability of these stocks due to the proposed removal of protection areas and trawl closures under this FMP.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout BSAI and GOA. Potential effects of FMP 2.1 to crab habitat are unknown.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on essential habitat are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered potentially adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for many of the crab stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors.

- **Cumulative Effects.** It is unclear if persistent past effects on golden king crab habitat in the BSAI and GOA exist. Some GOA golden king crab stocks are considered depressed, although some of the known habitat areas of BSAI and GOA crab are currently protected by no trawl zones and conservation zones. These protection measures would be removed under FMP 2.1; however, it is uncertain how these measures would affect the BSAI and GOA golden king crab stocks due to the lack of a current baseline condition. Thus, potential combined effects on BSAI and GOA golden king crab habitat, resulting from past, present, and future events cannot be determined for FMP 2.1 without first establishing the overall population status of this species. However, it should be noted that removal of protection areas and trawl closures proposed under this FMP could significantly impact the sustainability of this stock if increases in mortality and changes to reproductive success result.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Red king crab stocks are severely depressed in GOA according to ADF&G survey data. Bairdi Tanner crab stocks in the GOA are currently considered depressed while blue king crab stock status is unknown, but presumed to be depressed based on limited survey data. Although, a relationship between changes to habitat and depressed stock status cannot be drawn at this time the removal of protection areas and trawl closures throughout the GOA as proposed under FMP 2.1, could impede the recovery of these stocks and significantly impact the sustainability of GOA crab stock as a whole. Thus, this FMP is considered significantly adverse to changes in crab habitat for the already depressed red king crab stocks in GOA, and conditionally significant adverse for GOA bairdi Tanner crab stocks. This FMP could result in significantly adverse impacts to blue king crab stocks in GOA, but it is difficult to determine how these stocks will react to potential changes in habitat until a baseline condition has been established.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as some of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered potentially adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist, and stocks are considered depressed with no signs of recovery to date. Thus, potential combined effects on GOA red king crab habitat, resulting from past, present, and future events are considered significantly adverse under FMP 2.1. Potential combined effects on GOA bairdi Tanner and blue king crab habitat cannot be determined for FMP 2.1 without first establishing the overall population status of this species. Removal of protection areas and trawl closures proposed under this FMP, could significantly impact the sustainability of these stocks if increases in mortality, and changes to reproductive success result and impede on recovery of currently depressed stocks.

Cumulative Effects Analysis FMP 2.2

Summaries of the cumulative effects analyses for crab associated with FMP 2.2 are shown in Tables 4.5-36 through 4.5-42. Table 4.6-2 provides a summary of significance ratings for all effects (direct, indirect, and cumulative). For further information on persistent past effects included in this analysis (see Section 3.5.2.4).

Mortality

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Under FMP 2.2, predicted bycatch of these crab species are slightly higher than the 2002 bycatch estimates. Blue king and red king crab bycatch are predicted to be the highest under this FMP, largely due to the spatial changes in distribution of the yellowfin sole and rock sole trawl fisheries. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances overfished. Thus, FMP 2.2 is considered to have a conditionally significant adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI due to the predicted increase in bycatch, and because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch, and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered to have potential adverse effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. Thus, these combined effects of mortality resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events are considered conditionally significant adverse for FMP 2.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Under FMP 2.2, predicted catch of golden king crab in BSAI and GOA were combined with predictions for blue king crab. The BSAI predictions showed increases and decreases in catch over the next five years when compared to current catch rates. Model projections for GOA catch showed decreases in catch compared to current catch in this region. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status. Thus, effects of FMP 2.2 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA are currently unknown. Thus, the potential effects of these fisheries on mortality are not known. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown. Thus, potential combined effects of mortality resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Under FMP 2.2, predicted catch of bairdi Tanner, red king, and blue king crab in GOA showed increases and decreases from current baseline for the next five years. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status of bairdi Tanner and blue king crab. Thus, effects of FMP 2.2 on mortality of GOA bairdi Tanner, and blue king crab are unknown. GOA red king crab stocks are severely depressed according to ADF&G survey data and do not show signs of recovery. Although red king crab bycatch is predicted to be slightly below the 2002 level, the effects of mortality could further impede the ability of this stock to recover. Thus, effects of FMP 2.2 on mortality of GOA red king crab are considered conditionally significant adverse.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in bottom trawl fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential combined effects of mortality resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 2.2. Potential combined effects of mortality on red king stocks in the GOA are considered conditionally significant adverse due to the already severely depressed nature of these stocks and apparent lack of recovery.

<u>Change in Biomass</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances overfished. The predicted bycatch levels under FMP 2.2 are expected to be slightly higher than baseline estimates. The bycatch levels predicted for red and blue king crab are the highest under this FMP. Thus, FMP 2.2 is considered to have a conditionally significant adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered to have potential adverse effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, the population is currently considered depressed. Potential effects of long-term climate change and regime shifts on biomass levels have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on crab populations in the BSAI still exist and stocks are considered depressed with no signs of recovery to date. Thus, these combined effects resulting from past events, direct catch, internal bycatch, and reasonably foreseeable future external events are considered conditionally significant adverse to biomass and sustainability of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI for FMP 2.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 2.2 on changes to biomass cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. The potential effects of past fishing mortality on biomass of golden king crab stocks in BSAI and GOA cannot be determined because catch composition is unknown, and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur be managed by ADF&G in cooperation with NOAA

Fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA is unknown and biomass estimates have not been determined. Thus, the potential effects of these fisheries on biomass are not known. Potential effects of long-term climate change and regime shifts on biomass levels has not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on golden king crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown and biomass estimates have not been determined. Thus, potential effects on biomass of BSAI and GOA golden king crab stocks resulting from past events, direct catch, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in GOA, potential effects of FMP 2.2 on biomass of this species is unknown. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery while other GOA stocks are still considered depressed. Thus, potential effects of FMP 2.2 on biomass of GOA bairdi Tanner crab as a whole cannot be determined. Red king crab populations in GOA are at historic lows according to ADF&G survey information. Considering the severely depressed state of this stock as a whole, FMP 2.2 could have conditionally significant adverse effects on the biomass of red king crab populations in GOA, since no signs of recovery have been observed to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Adverse effects of past fishing mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in GOA may still exist, as recovery of depressed stocks has not been determined.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on biomass of bairdi Tanner and blue king crab stocks cannot be determined. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Potential effects of long-term climate change and regime shifts on biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential effects on biomass of bairdi Tanner and blue king crab in GOA resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 2.2. Potential effects on biomass of red king crab in GOA resulting from past events, internal bycatch, and reasonably foreseeable future external events are considered conditionally significant adverse due to the already severely depressed nature of these stocks and apparent lack of recovery observed to date.

Change in Reproductive Success

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances overfished. Changes in reproductive success within BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a relationship between reproductive success and depressed stock status has yet to be determined. Therefore, the potential effects of FMP 2.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist, as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. The current baseline condition for blue king and bairdi Tanner crab is unknown and a direct causation between red king crab reproductive success and depressed stock status cannot be concluded at this time. Therefore the potential effects on reproductive success resulting from past, present, and future events are unknown for all stocks under FMP 2.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 2.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries, but the composition of this catch is unknown. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on reproductive success are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Crab seasons are set as to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA are not known. Potential effects on reproductive success resulting from past, present, and future events are unknown for FMP 2.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in GOA, potential effects of FMP 2.2 on changes to reproductive success cannot be determined. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery while other GOA stocks are still considered depressed. Red king crab populations in GOA are at historic lows according to ADF&G survey information. Changes in reproductive success within GOA crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causation between reproductive success and depressed stock status cannot be concluded at this time. Potential effects of FMP 2.2 on changes to reproductive success cannot be determined for bairdi Tanner and red king crab populations in GOA.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting period so these fisheries are not considered contributing factors to changes in reproductive success of these stocks. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Although crab seasons are set to avoid mating and molting periods, persistent past effects on crab populations in the GOA may still exist, and some stocks are considered depressed with no signs of recovery to date. Thus, potential effects on reproductive success resulting from past, present, and future events are unknown for FMP 2.2.

<u>Change in Prey Availability</u>

Bairdi Tanner, Opilio Tanner, Red King, Blue King, and Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and it is unclear if FMP 2.2 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of FMP 2.2 on changes in prey availability cannot be determined.

- **Persistent Past Effects.** Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past groundfish fisheries is minimal. Thus, past effects on crab prey structure and availability in BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Competition for prey species of crab resulting from fisheries' catch has not been shown and is not considered a contributing factor to changes in prey availability. Rebuilding plans currently in effect in BSAI do not address crab prey structure and availability and are not considered contributing factors to potential changes in prey availability. Long-term climate change and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the effects that these changes may have on crab populations throughout BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined and potential changes to prey structure, resulting from direct catch, bycatch, and other future events cannot be determined for all species of crab in BSAI and GOA for FMP 2.2.

Change in Habitat

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. However, a direct causation between habitat and depressed stock status cannot be concluded at this time. Numerous ADF&G management measures, rebuilding plans, trawl closures, and conservation areas have been implemented to address declining and overfished crab stocks in the BSAI. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks. Potential effects of FMP 2.2 on changes to habitat are considered insignificant.

- **Persistent Past Effects.** The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat areas, as a result of trawling and using other types of fishing gear that interact with bottom habitat. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. These fisheries are considered potentially adverse factors in changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing . These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time and offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed, and possible habitat-related effects have not been determined. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors.

- **Cumulative Effects.** Persistent past effects on crab habitat in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. Although some of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. Thus, potential effects on crab habitat resulting from past, present, and future events cannot be determined for FMP 2.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout BSAI and GOA. Potential effects of FMP 2.2 to crab habitat are unknown.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on essential habitat are also unknown.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur and are considered potentially adverse factors in changes to crab habitat based on the lack of recovery that has been observed for many of the crab stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors.

- **Cumulative Effects.** It is unclear if persistent past effects on golden king crab habitat in the BSAI and GOA exist, and some GOA golden king crab stocks are considered depressed. Although some of the known habitat areas of BSAI and GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. Thus, potential effects on golden king crab habitat resulting from past, present, and future events cannot be determined for FMP 2.2 without first establishing the population status of this species.

Bairdi Tanner, Red King, and Blue King Crab in GOA

- **Direct/Indirect Effects.** Red king and bairdi Tanner stocks in the GOA are currently considered depressed. Blue king crab stock status is unknown, but presumed to be depressed based on limited survey data. Although a relationship between changes in habitat and depressed stock status has not been determined, numerous ADF&G management measures, rebuilding plans, trawl closures, and conservation areas have been implemented to address declining crab stocks in the GOA. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks. Therefore, the potential effects of FMP 2.2 on changes to habitat for bairdi Tanner, red king, and blue king crab stocks in GOA are considered insignificant.

- **Persistent Past Effects.** The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist, as some of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur and are considered potentially adverse factors in changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist and stocks are considered depressed with no signs of recovery to date. Although some of the known habitat areas of GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. Thus, potential effects on GOA bairdi Tanner, red king, and blue king crab habitat, resulting from past, present, and future events, cannot be determined for FMP 2.2.

4.6.3 Other Species Alternative 2 Analysis

The other species category consists of the following species:

- Squid (order Teuthoidea).
- Sculpin (family Cottidae).
- Shark (*Somniosus pacificus, Squalus acanthias, Lamna ditropis*).
- Skate (genera *Bathyraja and Raja*).
- Octopi (*Octopus dofleini,Opistholeutis california,* and *Octopus leioderma*).

An aggregate TAC limits the catch of species in this category. Within the other species category, only shark are identified to the species level by fishery observers. Furthermore, accuracy of catch estimates depends on the level of coverage in each fishery. Estimates of observer coverage in the BSAI is 70-80 percent, whereas the GOA has only approximately 30 percent observer coverage. Coverage can also vary for certain target fisheries and vessel sizes (Gaichas 2002). Further description of this management is described in detail in Section 3.5.3.

Formal stock assessments for other species are not currently conducted in the BSAI and GOA and biomass estimates for the species included in this category are limited and often unreliable. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. There are numerous direct and indirect effects that may impact the current and future status of individual species within this group and/or this group as a whole. These effects are summarized in the section that follows.

Direct/Indirect Effects FMP 2.1 – Other Species

Direct and indirect effects for other species include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 2.1 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 2.1, total catch of BSAI squid and other species is predicted to increase by several thousand tons per year. Catch of GOA other species is predicted to triple. This is due to predicted increases in catches of the target species that other species are caught with. Most of this increase is predicted in the catch of sculpin in the BSAI and skate in the GOA. Catch projections for specific groups within BSAI and GOA other species are presented below.

Squid

In the BSAI, squid catch is predicted to double initially and then decrease to just above the current level over the five projection years, likely following trends in the pollock fishery. The 2003 catch exceeds the historical OFL set for squid based on Tier 6 criteria, and might result in additional management measures being applied relative to those modeled if these were actual catches and if the same OFL were set in the future. Squid catch is predicted to triple over the five-year projection period in the GOA, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so tripling may not cause different population impacts than current catch levels.

Sculpin

Catches of BSAI sculpin are predicted to double, increasing from the current level of 7,000 mt per year to 13,000-15,000 mt per year. While this seems substantial, the effects on any of the approximately 50 different species of sculpin in this group are unpredictable because the effects of current levels of catch are unknown and species composition is currently unknown as well.

GOA sculpin catch is predicted to double over the projection period, reaching approximately 1,000 mt.

Shark

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of sleeper shark are predicted to double initially and then decrease to roughly current levels, as are catches of salmon shark and other shark. Dogfish catches, which are low in the BSAI under current management, are predicted to decrease and then increase to current levels during the five year projection period under FMP 2.1. As in the BSAI, shark catches in the GOA are partitioned into Pacific sleeper shark, salmon shark, dogfish, and other shark. While all shark catch in the GOA is predicted to be relatively low, catches of other shark are predicted to increase by an order of magnitude. Catches of salmon shark are predicted to decrease slightly, and catches of sleeper shark and dogfish will increase relative to current levels.

Skate

Skate currently make up the largest portion of bycatch for the other species complex. The catch of BSAI skate is predicted to decrease by nearly 3,000 mt initially within the first three projection years, and return to current levels by the end of the modeled period. GOA Skate catch is predicted to more than double to over 4,300 mt; an increase which could warrant increased management attention.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the target species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined big and longnose skates in the central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway and improved collection of data is expected under this amendment.

Octopi

Octopus catch in the BSAI is predicted to remain stable at 200-300 mt per year. However, observed GOA octopus catch has been low historically, so potential increases may not cause different population impacts than current catch levels. The trace amounts of octopus catch reported in the GOA are predicted to increase over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 2, FMP 2.1 is shown in Table 4.5-43. Table 4.6-2 provides a summary of the significance ratings for all effects. For further information on persistent past effects included in this analysis see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA other species is unknown under Alternative 2, FMP 2.1. The current baseline condition is unknown and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA other species are unknown under Alternative 2, FMP 2.1. The current baseline condition is unknown and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. This possible overexploitation could have impacts to reproductive success, if sex-ratios of these species are significantly altered, or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since the current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in BSAI and GOA are unknown under Alternative 2, FMP 2.1. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the other species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA other species is unknown under Alternative 2, FMP 2.1. The current baseline condition is unknown and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries. Formal stock assessments are not conducted for other species, and most biomass estimates for BSAI and GOA other species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species is unknown under Alternative 2, FMP 2.1. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the other species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species also have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Direct/Indirect Effects FMP 2.2 – Other Species

Direct and indirect effects for Other species include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 2.2 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 2.2, total catch of BSAI squid and other species and GOA other species is predicted to increase by several thousand tons per year. This is due to predicted increases in catches of the target species that other species are caught with. Most of this increase is predicted in the catch of skate and sculpin in both areas. Catch projections for specific groups within BSAI and GOA other species are presented below.

Squid

In the BSAI, squid catch is predicted to nearly double and then decrease to just above the current level over the five projection years, likely following trends in the pollock fishery. Squid catch is predicted to slowly increase to double its current magnitude over the five year projection period in the GOA, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so doubling may not cause different population impacts than current catch levels.

Sculpin

Catches of BSAI sculpin are predicted to increase by about 1,000 mt relative to current catches. GOA sculpin catch is predicted to increase by 200 mt per year over the projection period.

Shark

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of all of these species are predicted to increase slightly and then decrease to close to current levels under FMP 2.2. As in the BSAI, shark catches are partitioned into Pacific sleeper shark, salmon shark, dogfish, and other shark. While all shark catch in the GOA is predicted to be relatively low, catches of other shark are predicted to increase by an order of magnitude. Catches of Pacific sleeper shark and salmon shark are predicted to decrease slightly, and catches of dogfish will remain relatively similar to current levels.

Skate

The catch of BSAI skate is predicted to increase by nearly 2,000 mt to over 21,000 mt for all projection years. The increased catch of skates may reflect increased catches in both longline fisheries for Pacific cod and in bottom trawl fisheries for cod and flatfish. Skate catch in GOA is predicted to increase by about 1,000 mt, which is the same order of magnitude as current catches and may warrant increased management attention if it actually happened.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the target species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined big and longnose skates in the Central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway and improved collection of data is expected under this amendment.

Octopi

Octopus catch in the BSAI is predicted to remain stable at about 500 mt per year. The trace amounts of octopus catch reported in the GOA are predicted to decrease slightly over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 2, FMP 2.2 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis see Section 3.5.3.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA other species is unknown under Alternative 2, FMP 2.2. The current baseline condition is unknown and species-specific catch information is lacking for this complex since species identification does not occur in the fisheries.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success of BSAI and GOA other species are unknown under Alternative 2, FMP 2.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in BSAI and GOA are unknown under Alternative 2, FMP 2.2. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the other species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA other species is unknown under Alternative 2, FMP 2.2. The current baseline condition is unknown and species-specific catch information is lacking for this complex since species identification does not occur in the fisheries. Formal stock assessments are not conducted for other species, and most biomass estimates for BSAI and GOA other species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and nonspecified species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species is unknown under Alternative 2, FMP 2.2. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the other species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species also have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

4.6.4 Forage Fish Alternative 2 Analysis

The BSAI and GOA FMPs were amended in 1998 to establish a forage species category to prevent the development of directed fisheries on these ecologically important non-target species. Forage fish are described in more detail in Section 3.5.4.

Direct/Indirect Effects of FMP 2.1 – BSAI and GOA Forage Fish

Total Biomass

Total biomass of BSAI and GOA forage fish is unknown at this time. Under FMP 2.1, the ban on a directed fishery on forage fish would be repealed. If an intensive, directed fishery for forage fish were developed, it is possible to envision an adverse impact on forage fish populations. On the large scale, due to economic and biological factors, it is unlikely that a fishery with enough intensity would be able to develop to reduce forage fish populations to below a sustainable level. However, it is possible that a local fishery could develop and create localized forage fish depletions that could place competitive strains on predator populations (seabirds, marine mammals, groundfish). Without the development of a forage fish fishery, the effect of FMP 2.1 on the total biomass of forage fish is thought to be insignificant.

Spawning Biomass

Spawning biomass of BSAI and GOA forage fish is unknown at this time. Under FMP 2.1, it is possible for a fishery to develop on forage fish. If a fishery were developed, the spawning biomass could decrease from their current levels due to increased fishing effort. However, unless the fishery was extremely intensive it would most likely not significantly affect the spawning biomass.

Catch/Fishing Mortality

Under FMP 2.1, the ban on a directed fishery on forage species would be lifted. It is impossible to predict how the fishery would react to this. Even with a lifting of the ban, due to economic reasons a fishery for forage species would not necessarily commence. Therefore, the model can only forecast incidental catch rates of forage fish.

Forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (> 90 percent most years) of the forage fish bycatch is made up of smelt species (Osmeridae) from the pollock fishery. In the BSAI region, model projections for FMP 2.1 indicate incidental catch of forage fish would increase considerably above the current level (Table H.4-22 in Appendix H). Over the next 5 years the pollock catch in the GOA is projected to grow rapidly under FMP 2.1 (Table H.4-41 in Appendix H). This increased pollock catch under this FMP is expected to lead to greater, yet still relatively low, incidental catches of forage fish.

Fishing mortality of BSAI and GOA forage fish is unknown at this time. Under FMP 2.1, an increase in forage fish bycatch, and hence fishing mortality, would be expected. If a directed fishery for forage fish developed under FMP 2.1, fishing mortality would increase.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. It would be hypothetically possible for a directed fishery under FMP 2.1 to create localized depletions in forage fish creating competitive forces on other predator species (marine mammals, sea birds, groundfish). However, it is unknown if this type of fishery would develop for economic reasons.

Status Determination

The MSST of forage fish species is unknown at this time, but it is highly unlikely that management practices under FMP 2.1 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. It is unknown how FMP 2.1 would change the age and size composition of the forage fish species. The sex ratio of forage fish is currently assumed to be 50:50. There is no information available that would suggest this would change under FMP 2.1.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the given data, it would be extremely difficult to accurately assess the predator-prey impacts of FMP 2.1.

Summary of Effects of FMP 2.1 – BSAI and GOA Forage Fish

Information on forage fish species is very limited. Total biomass, spawning biomass and fishing mortality are not estimated in the model used for this analysis. Therefore, only qualitative assessment of this FMP's effects on these measures can be described.

A directed fishery for forage fish is currently prohibited by Amendment 36 and 39 in the BSAI and GOA FMP. Under FMP 2.1 this ban would be lifted. Direct effects of FMP 2.1 would include incidental take of forage fish in other fisheries and any direct take from a fishery that may develop. It is impossible to predict how, or even if, a forage fish fishery would develop under FMP 2.1. Even with a lifting of the ban, due to economic reasons a fishery for forage species would not necessarily commence. Therefore, the model can only forecast incidental catch rates for forage fish.

The model is able to estimate future bycatch of forage fish by averaging the 1997-2001 bycatch matrix. Model output for forage fish bycatch is closely linked to pollock catch. Smelts make up the vast majority of the forage fish bycatch in the BSAI and GOA. The bulk of the smelt bycatch comes from the pollock fishery. Therefore, the projected level of incidental catch of forage fish is highly correlated with the pollock TAC set for the FMP. Under FMP 2.1 the pollock TAC is set to a more aggressive level. Pollock catch, and hence forage fish bycatch, is forecast to increase appreciably in the BSAI (Table H.4-22 in Appendix H). In the GOA the catch of pollock is also modeled to increase considerably in the next 5 years. Assuming the bycatch rate of forage fish stays constant, a large increase in the total forage fish bycatch is predicted (Table H.4-41 in Appendix H). Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 2.1 is thought to be a relatively small fraction of the biomass, and unlikely to affect the abundance of the stock in either the BSAI or GOA.

As stated above, FMP 2.1 removes the ban on a directed forage fish fishery. If a fishery were to be developed, for biological and economic reasons the most likely forage species group to be exploited would be the smelts (Osmeridae). If an intensive, directed fishery for smelt was developed, it is possible to envision an adverse impact on forage fish populations. On the large scale, due to economic factors, it is unlikely that a fishery with enough intensity would be able to develop to reduce forage fish populations to below a sustainable level. However, it is possible that a fishery could create localized forage fish depletions that could place competitive stress on predator populations (seabirds, marine mammals, groundfish).

Indirect effects of FMP 2.1 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 2.1.

Cumulative Effects Analysis of FMP 2.1 – BSAI and GOA Forage Fish

Tables 4.5-44 and 4.5-45 summarize the cumulative effects associated with FMP 2.1.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 2.1.

- **Persistent Past Effects** have not been identified for fishing mortality in the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on mortality are indicated due to potentially adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts are not considered to be contributing factors, since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of forage fish (see Sections 3.5.4 and 3.10). Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish mortality; however, the removal of these species is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The change in biomass level under FMP 2.1 is rated as unknown.

- **Persistent Past Effects** have not been identified for the change in biomass in the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on the change in biomass are indicated due to the potentially adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts have been identified as having potentially beneficial or adverse contributions on the forage fish biomass level. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment (see Sections 3.5.4 and 3.10). The Alaska subsistence and personal use fisheries have been identified as a potentially adverse contributor to the change in biomass level of BSAI and GOA forage fish. Subsistence and personal use fisheries concentrate mostly on the smelt species; however, it is unlikely that these fisheries would have a population level effect.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 2.1, the effect of the spatial/temporal concentration of catch is unknown.

- **Persistent Past Effects** are not identified for the genetic structure of the BSAI and GOA forage fish. Climate changes and regime shifts are identified as influencing the reproductive success of BSAI and GOA forage fish. For example, some Osmeridae species have shown a decline in recruitment since the late 1970s, coinciding with the increase water temperature.

- **Reasonably Foreseeable Future External Effects** on the reproductive success of forage fish due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has been identified as a potentially adverse contributor, since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI and GOA forage fish. The Alaska subsistence and personal use fisheries are identified as having potentially adverse contributions to the genetic structure and reproductive success of BSAI and GOA forage species. As stated above, these fisheries mainly target smelt species. However, it is unlikely the removals in these fisheries would sufficiently large and localized, such that they would jeopardize the capacity of the stocks to maintain current population levels.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect is unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** are identified for the change in prey availability of the BSAI and GOA forage fish stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** of the climate changes and regime shifts on the BSAI and GOA forage fish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse contributor, since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. Alaska subsistence and personal use fisheries are identified as potentially adverse contributors to the prey availability of BSAI and GOA forage fish. However, the catch/bycatch of these species is expected to be minimal and unlikely to have a population level impact.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.1, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for BSAI and GOA forage fish include climate changes and regime shifts (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** of the climate changes and regime shifts on the BSAI and GOA forage fish stock are potentially beneficial or adverse. Marine pollution has also been identified as having a potentially adverse contribution, since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Alaska subsistence and personal use fisheries are identified as potentially adverse contributors to forage fish habitat suitability (see Section 3.6).

- **Cumulative Effects.** A cumulative effect is identified for BSAI and GOA forage fish habitat suitability; however, this effect is unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

Direct/Indirect Effects of FMP 2.2 – BSAI and GOA Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. The incidental catch rates predicted for FMP 2.2 is not expected to affect biomass.

Catch/Fishing Mortality

A directed fishery on forage species is prohibited by Amendment 36 and 39 in the BSAI and GOA FMPs. However, forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (>90 percent most years) of the forage fish bycatch is made up of smelt species (Osmeridae) from the pollock fishery. In the BSAI region, model projections for FMP 2.2 indicate incidental catch of forage fish would increase considerably above the current level (Table H.4-22 in Appendix H). Over the next 5 years the pollock catch in the GOA is projected to grow rapidly under FMP 2.2 (Table H.4-41 in Appendix H). This increased pollock catch under this FMP is expected to lead to greater, yet still small, incidental catches of forage fish.

Fishing mortality of BSAI and GOA forage fish is unknown at this time. As described above, forage fish bycatch and hence fishing mortality would increase under FMP 2.2. Currently, fishing mortality of forage fish is thought to be small, and the predicted increase is thought to be trivial.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. It is unknown how the spatial or temporal concentration of fishing effort is expected to change under FMP 2.2.

Status Determination

The MSST of forage fish species is unknown at this time, but it is unlikely that management practices under FMP 2.2 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. It is assumed that the age and size composition of forage fish would not change under FMP 2.2. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest this would change under FMP 2.2.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the given data, it would be extremely difficult to accurately assess the predator-prey impacts of FMP 2.2.

Summary of Effects of FMP 2.2 – BSAI and GOA Forage Fish

Information on forage fish species is very limited. Total biomass, spawning biomass and fishing mortality are not estimated in the model used for this analysis. Therefore, only qualitative assessment of the FMPs effects on these measures can be described.

A directed fishery for forage fish is prohibited by Amendment 36 and 39 in the BSAI and GOA FMPs. Therefore, the only direct effect of FMP 2.2 is incidental take of forage fish in other fisheries.

The model is able to estimate future bycatch of forage fish by averaging the 1997-2001 bycatch matrix. Model output for forage fish bycatch is closely linked to pollock catch. Smelts make up the vast majority of the forage fish bycatch in the BSAI and GOA. The bulk of the smelt bycatch comes from the pollock fishery. Therefore, the projected level of incidental catch of forage fish is highly correlated with the pollock TAC set for the FMP. Under FMP 2.2 the pollock TAC is set to a more aggressive level. Pollock catch, and hence forage fish bycatch, is projected to increase appreciably in the BSAI (Table H.4-22 in Appendix H). In the GOA the catch of pollock is modeled to increase considerably in the next 5 years (Table H.4-41 in Appendix H). Assuming the bycatch rate of forage fish stays constant, a significant increase in the total forage fish bycatch will result. Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 2.2 is thought to be a relatively small fraction of the biomass and unlikely to affect the abundance of the stock in the BSAI or GOA.

Indirect effects of FMP 2.2 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 2.2 (Tables 4.5-87 and 4.5-88).

Cumulative Effects Analysis of FMP 2.2 – BSAI and GOA Forage Fish

Tables 4.5-44 and 4.5-45 summarize the cumulative effects of FMP 2.2 on BSAI and GOA forage fish.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 2.2.
- **Persistent Past Effects** have not been identified for fishing mortality in the BSAI or GOA forage fish stock.
- **Reasonably Foreseeable Future External Effects** on mortality are the same as those indicated under FMP 2.1.
- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.
- **Persistent Past Effects** have not been identified for the change in biomass in the BSAI and GOA forage fish stock.
- **Reasonably Foreseeable Future External Effects** on the change in biomass are the same as those indicated under FMP 2.1.
- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 2.2 the effect of the spatial/temporal concentration of catch is unknown.
- **Persistent Past Effects** identified for the change in reproductive success and genetic structure of the BSAI and GOA forage fish are the same as those indicated under FMP 2.1.
- **Reasonably Foreseeable Future External Effects** identified for the change in reproductive success and genetic structure of the BSAI and GOA forage fish are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 2.2, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for the change in prey availability are the same as those indicated under FMP 2.1.

- **Reasonably Foreseeable Future External Effects** identified for the change in prey availability are the same as those indicated under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, however, this effect is unknown. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 2.2, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for the change in habitat suitability are the same as those described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects** identified for the change in habitat suitability are the same as those described under FMP 2.1.

- **Cumulative Effects.** A cumulative effect is identified for BSAI and GOA forage fish habitat suitability; however, this effect unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

4.6.5 Non-Specified Species Alternative 2 Analysis

Grenadiers have been chosen to illustrate potential effects to non-specified species because they are currently the major catch in the non-specified FMP category. Non-specified species is a huge and diverse category encompassing every species not listed in the current FMP as a target, prohibited, forage, or other species. Considering a single species group from this category, such as grenadier, cannot possibly represent the diverse effects to all species in the category. However, because information is lacking for nearly all of these groups, and they are caught in small or unknown amounts (due to a lack of reporting requirements in this category), only potential effects to grenadier are discussed.

Formal stock assessments are not conducted for grenadiers. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. Changes in bycatch of grenadiers were predicted based on modeled changes in target species catches and population trajectories (sablefish target fisheries have the most grenadier bycatch). While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact grenadier populations, or whether these impacts might be adverse, beneficial, or neutral.

Direct/Indirect Effects FMP 2.1 – Non-Specified Species

Direct and indirect effects for grenadier include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown. Information on stock status is lacking, but is needed in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 2.1 are relatively small, such that diverse alternatives may have similar (but unknown) effects on each stock.

Under FMP 2.1, catch of grenadiers in both the BSAI and GOA is predicted to increase. In the BSAI, catches are double the currently observed level for most projection years. In the GOA, catches increase from about 11,000 mt to over 18,000 mt, a level which might warrant management attention if it were actually observed. However, even this level of catch has unknown population impacts because we do not know the species composition of the catch or the life history of any grenadier species in Alaskan waters to assess whether there would be population impacts.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 2, FMP 2.1 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 2.1. The current baseline condition is unknown. Catch information is lacking for all members of the non-specified category, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier, and all other species included in the non-specified category, in the BSAI and GOA, could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA, and mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** For grenadiers and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on grenadiers, and other species with the non-specified complex, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success of BSAI and GOA grenadier, and presumably all other species within the non-specified complex, are unknown under FMP 2.1. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. This possible overexploitation could have impacts on reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts on the reproductive success of grenadiers (and other non-specified species) depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadiers, and all other members of the non-specified category, will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadiers, and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on grenadiers and other non-specified species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier, and other species within the non-specified complex, populations in BSAI and GOA are unknown under FMP 2.1. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex have not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited. However, stock status remains unknown. This possible overexploitation could have impacts on the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For grenadiers, and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.1.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadiers is unknown under FMP 2.1. The current baseline condition is unknown for all members of the non-specified complex, and species-specific catch information is lacking since species identification does not occur in the fisheries. Formal stock assessments are not conducted and biomass estimates in the BSAI and GOA for grenadiers, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier, and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. The current non-management of grenadiers could mask declines in individual grenadier species, and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadiers, and all other members of the non-specified group, depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadiers, and all other species in the non-specified group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.1.

Direct/Indirect Effects FMP 2.2 – Non-Specified Species

Direct and indirect effects for grenadier include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 2.2 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 2.2, catch of grenadiers in both the BSAI and GOA is predicted to remain within or slightly above the currently observed range. In both areas, grenadier catch is predicted to increase slightly initially and then decrease, following trends in the sablefish fishery.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 2, FMP 2.2 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 2.2. The current baseline condition is unknown. Catch information is lacking for all members of the non-specified category, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA, and mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** For grenadiers and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex, as a whole are unknown. The combined effects of mortality on grenadiers, and other species with the non-specified complex, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier, and presumably all other species within the non-specified complex, are unknown under FMP 2.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of grenadiers (and other non-specified species) depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadiers, and all other members of the non-specified category, will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadiers, and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes on reproductive success of grenadiers and other non-specified species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier and other species within the non-specified complex populations in BSAI and GOA are unknown under

FMP 2.2. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. This possible overexploitation could have impacts on the genetic structure of the population, if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, their potential impacts on genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For grenadiers, and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex is unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.2.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadiers is unknown under FMP 2.2. The current baseline condition is unknown for all members of the non-specified complex. Species-specific catch information is lacking, since species identification does not occur in the fisheries. Formal stock assessments are not conducted, and biomass estimates in the BSAI and GOA for grenadiers, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited. However, stock status remains unknown. The current non-management of grenadiers could mask declines in individual grenadier species, and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fishery continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadiers, and all other members of the non-specified group, depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadiers, and all other species in the non-specified group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 2.2.

4.6.6 Habitat Alternative 2 Analysis

Alternative 2 seeks to maximize biological and economic yield from the groundfish fisheries by adopting a more aggressive harvest policy for groundfish stocks. Since this policy would result in increased fishing effort, more disturbance to benthic habitat is expected.

Direct/Indirect Effects of FMP 2.1

In addition to having a more aggressive harvest policy, FMP 2.1 illustrates a scenario where the agency repeals the various closure areas currently in place, with the exception of those required to protect Steller sea lions. Figure 4.2-2 illustrates the year-round closures in the BSAI and GOA management areas. In this FMP scenario, the fishery would be returned to an open access regime, where closures, gear restrictions, and PSC limits are repealed.

Direct and indirect effects of the FMP on habitat are discussed under the topics of changes to living habitat through direct mortality or benthic organisms and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to differences in habitat type, the BSAI and GOA are rated and discussed separately.

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

In the GOA, based on the multi-species model, the catch of most living habitats is projected to increase under FMP 2.1 (Table 4.5-48). However, catch of coral in the GOA is projected to decrease. This decrease in the model projection for coral is due to a constraint in the aggregated rockfish fishery catch (Jim Ianelli, AFSC, personal communication). In the baseline, bycatch of corals is highest in the aggregated rockfish fishery. As with FMP 1, we believe a more realistic prediction is that bycatch levels under FMP 2.1 would be about the same or would increase due to increases in groundfish TACs relative to the baseline. In the BSAI, some bycatch levels of coral increased and others decreased in the model projections. A more realistic prediction under FMP 2.1 is that bycatch levels would be about the same or would perhaps increase relative to the baseline. Reliable abundance estimates are not available for most living substrates, and the level of abundance of living habitat species needed to sustain their functional role as habitat for groundfish is not known. Some of these organisms have life-history traits that make them especially sensitive to fishing removals. The long-lived nature of corals and perhaps some sponges, in particular, makes them susceptible to permanent eradication in fished areas. Continued bycatch and damage at increased levels in FMP 2.1 could have long-term negative consequences to habitat quality.

Conceptual deductions from the habitat impacts model yield the following inferences:

- **Bering Sea.** Whether opening up new areas to fishing will result in an increased mean impact level, E, depends on habitat sensitivity parameters q, q_H, and densities of target species and habitat. The model indicates that for lower values of q and q_H (longer recovery times) catch changes faster than the equilibrium impact level for a given change in effort than at higher (short habitat recovery time) values for these parameters. Lower values for sensitivity also result in a greater impact E for a given effort level. Therefore, if sensitivity values are low, opening new areas will likely result in an increase in mean impact level, and the impact will be high. For shorter recovery times, impacts will be less severe, while there is more chance of a decrease in mean impact level with the opening of new areas. A decrease in mean impact level is beneficial, and impact severity may not be high enough to be of concern. In the former case, higher mean impact levels in combination with more severe impacts will result in detrimental impacts of concern. In addition, increased TACs as projected for FMP 2.1 will lead to greater fishing effort, which would increase impact level. Based on these results, we conclude that there would be significantly adverse change in mortality and damage to living habitat as a result of FMP 2.1.

- **Aleutian Islands.** The same situation exists in the Aleutian Islands as described above for the Bering Sea. However, a detrimental scenario is more probable in this region due to a greater likelihood of slow recovering organisms impacted. Based on these results, we conclude that there would be significantly adverse change in mortality and damage to living habitat as a result of FMP 2.1.

- **GOA.** The situation in the GOA is intermediate to the situations in the Bering Sea and in the Aleutian Islands in regard to likelihood of detrimental impacts to slow recovering organisms. It is concluded that there would be significantly adverse change on mortality and damage to living habitat as a result of FMP 2.1.

Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection

- **Bering Sea.** Baseline closed areas are eliminated in example FMP 2.1. Table 4.5-49 shows that of the Bering Sea fishable area, 7.6 percent is closed to bottom trawling under FMP 2.1. Figure 4.6-1 shows areas closed to trawling only at various times of the year under this FMP, while Figure 4.6-2 depicts those areas closed to fixed gear only. The eliminated closure areas were adjacent to areas (e.g., historic cluster) of intermediate fishing intensity and, therefore, provided some diversity of impact in the habitat found along the boundary. They also protected crab, halibut, and other prohibited species habitat. Thus, the predicted effect of FMP 2.1 on benthic community diversity is significantly adverse relative to the existing baseline due to eliminating the closed areas. The effects of FMP 2.1 on geographic diversity of impacts are predicted to be conditionally significant adverse.

- **Aleutian Islands.** Under FMP 2.1, similar to the baseline, there are no significant notable marine reserves except for shallow areas near sea lion rookeries, which remain closed in this FMP. As shown on Table 4.5-49, about 43 percent of the fishable area in the Aleutians is closed to bottom trawling at one time or another during the year under this FMP. Less than one percent of the deep area is closed to bottom trawling. Figures 4.6-1 and 4.6-2 show the closure areas under FMP 2.1 broken down by gear type, bottom trawl, and fixed gear. As seen on the figures, closure areas in the Aleutians are the same as those shown and discussed for FMP 1 and the baseline. As such, there is little diversity in protection. The Aleutian Islands bathymetry and habitat is distributed on a fine scale, with fishing effort that is patchy and in small clusters. Based on these observations as relative to the baseline, the predicted effects of FMP 2.1 on benthic community diversity are considered conditionally significantly adverse due to the predicted increase in concentrated fishing effort. The geographic diversity of impacts are considered insignificant due to the similarity in closed areas under the baseline condition.

- **GOA.** As shown on Table 4.5-49 and Figures 4.6-1 and 4.6-2, FMP 2.1 closes nearly 22 percent of the fishable area in the GOA to trawling at one time or another during the year. However, the FMP eliminates the baseline closed area that was adjacent to an area of intermediate fishing intensity, which provided some diversity of impact in habitat found along the boundary. Therefore, the predicted effect of FMP 2.1 on benthic community diversity is significantly adverse relative to the existing baseline due to the opening of these closed areas. The predicted effects of FMP 2.1 on geographic diversity of impacts is conditionally significant adverse, also due to the opening of these closed areas.

Cumulative Effects of FMP 2.1

Cumulative effects on habitat for FMP 2.1 are summarized on Table 4.5-50. The following discussion of cumulative effects as presented on the table is broken down by geographic area.

Bering Sea

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Mortality of species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts that include mortality due to smothering and reduced oxygen are expected to be more prevalent in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use are possible at several locations in the Bering Sea area, including Port Moller, Port Heiden, Dillingham, St. Paul and St. George. Again, the impacts include mortality due to smothering and/or burying, would only affect nearshore zones and bays. Marine pollution is also identified as having a reasonably foreseeable, potentially adverse effect since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Again, areas most likely to be impacted would be nearer to shore. Natural events such as storm surges and waves also have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Cumulative effects on mortality of Bering Sea benthic organisms are judged to be significantly adverse under FMP 2.1. Additional external factors would not improve conditions and could add to the mortality of benthic organisms.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution all have the potential to cause changes to benthic community structure. If the effect is long-term, as in the case of changes in weather patterns, wind-induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed under changes to living habitat, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with ENSO and La Nina events have been identified as having impacts on both the physical and biological systems in the North Pacific. These changes could have either beneficial or adverse effects on the benthic community (see Sections 3.6 and 3.10).

- **Cumulative Effects.** Cumulative effects on benthic community structure of the Bering Sea are judged to be significantly adverse under FMP 2.1. Additional external factors would not improve conditions, and could add to adverse changes in the benthic community.

<u>Geographic Diversity of Impacts and Protection</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6 this effect is judged to result in a conditionally significant adverse change from baseline conditions, and as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 illustrate the spatial measures that were in effect before 1980 or were later established by regulations following publication of the Final Groundfish SEIS in November of 1980. As discussed in Section 3.6, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most of the restricted areas were implemented to spatially and temporarily restrict the foreign fishery. This was done to prevent conflicts between domestic and foreign fisheries over bycatch of species important to U.S. fishermen or grounds preemption and gear conflicts. Most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that, in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. This was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 almost 9 percent of the fishable area in the Bering Sea was closed to trawling, with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion, and marine pollution all have the potential to change geographic diversity and impacts protection. As existing ports in the Bering Sea are expanded and new ports created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, the opening of new ports may allow vessels of all sizes to access new or relatively unfished areas. On the other hand, depending on distribution, fishing pressure in heavily fished areas may be eased as access to other areas becomes available. Closed areas proposed to continue under this FMP would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects**. Cumulative effects on changes in distribution of fishing effort are judged to be conditionally significant adverse. The maps and statistics discussed under persistent past effects show that FMP 2.1 would protect slightly less benthic habitat from trawl gear in the future (7.6 percent) than was protected in 1980 (8.6 percent). This FMP opens many crab and halibut habitat protection areas that are presently closed. Additional external effects are not expected to improve the internal FMP rating.

Aleutian Islands

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutians. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. However, mobile epibenthic predators are not likely to exhibit lingering effects since they can move into non-fished areas (see Section 3.6). The areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering,with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Dredging for scallop fisheries and/or navigation can occur in localized areas (often in conjunction with port development) and can cause burial or smothering of benthic fauna. Damage to living substrates by longline and pot fisheries (see Section 3.6) has been documented and is expected to continue in those heavily fished areas. Offal discharge can occur from offshore catcher processors and onshore processors, causing mortality in nearshore areas. However, improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use is possible at several locations in the Aleutian Islands including Atkutan, Adak, Unalaska, Cold Bay Dutch Harbor, and King Cove. Again, the impacts include mortality due to smothering and/or burying, and would only affect nearshore zones and bays. Marine pollution is also identified as having a reasonably foreseeable potentially adverse impact since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events, such as storm surges and waves, also have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Cumulative effects on mortality of Aleutian Islands benthic organisms are judged to be significantly adverse. Additional external factors would not improve conditions, and could add to the mortality of benthic organisms.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above in previously in 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected in heavily fished areas of the Aleutians. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline and pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause changes to benthic communities. If the effects is long-term, as in the case of changes to weather patterns, wind induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed under changes to living habitat, all of these impacts are more likely to be observed in nearshore areas. Regime shifts and large-scale environmental fluctuations associated with ENSO and La Nina events have been identified as having impacts on both the physical and biological systems in the North Pacific (see Sections 3.6 and 3.10). These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Cumulative effects on in benthic community structure of the Aleutians are judged to be significantly adverse. Additional external factors would not improve conditions, and could add to adverse changes in the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.6.6, this effect is judged to result in an insignificant change to the baseline, and as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed previously for the Bering Sea, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species; most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that, back in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries, in order to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 about 31 percent of the fishable area in the Aleutians was closed to trawling with about 6 percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future external effects include other fisheries, port expansion and the potential resultant changes to offal discharge, and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As with the Bering Sea, existing ports in the Aleutians will be expanded and new ports created, and additional dock space for harboring the fishing fleet will be made available. While the fleet might not necessarily expand, the distribution of fishing effort is likely to change, and previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged to be conditionally significant adverse. The maps and statistics discussed above under persistent past effects show that FMP 2.1 would protect more benthic habitat from trawl gear in the future (43 percent) than was protected in 1980 (31 percent). However, the spatial distribution of the closed areas under the current FMPs may not protect the full range of habitat types. Additional external impacts do not provide any protection and could add to lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 2.1 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished, and impacts would occur in areas not previously impacted.

GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As described for the BSAI, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Port expansion and increased use is possible at several locations in the GOA, including Kodiak, Sand Point, Chignik, Port Lions, Ouzinkie, Valdez, and Seward. Impacts include mortality due to smothering and/or burying, and would likely only affect nearshore zones and bays. Marine pollution is also identified as having a reasonably foreseeable potentially adverse effect since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events, such as storm surges and waves, also have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organism.

- **Cumulative Effects.** Cumulative effects on mortality of GOA benthic organisms are judged to be significantly adverse. The additional external factors would not improve conditions, and could add to the mortality of benthic organisms.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a significantly adverse change from baseline conditions, and, as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As with the other regions, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to GOA benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Cumulative effects on changes in benthic community structure of the GOA are judged to be significantly adverse. The additional external factors would not improve conditions, and could add to adverse changes in the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in a conditionally significant adverse change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed for the other regions, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring, and there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries (Figures 3.6-6 and 3.6-7). Table 4.5-51 shows that in 1980 about 5 percent of the fishable area in the GOA was closed to trawling, with about 7 percent closed to all fishing. The largest closures in the GOA were for longline fishing, where almost 61 percent of the fishable area was closed to longlining. Therefore in 1980, about 73 percent of the fishable area in the GOA was closed to fishing of one type or another sometime during the year.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future external effects include other fisheries, port expansion and the potential resultant changes to offal discharge, and marine pollution. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As existing ports in the GOA are expanded and new ports created, additional dock space for harboring the fishing fleet is made available, and changes in the distribution of fishing effort could result. Depending on the distribution of fishing effort, previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case. Closed areas proposed to continue under this FMP would not be affected by the redistribution of home ports.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged to be conditionally significant adverse. The maps and statistics discussed under persistent past effects show that FMP 2.1 would protect more benthic habitat from trawl gear in the future (22 percent) than was protected in 1980 (16 percent). However, the spatial distribution of the closed areas under FMP 2.1 may not protect the full range of habitat types and crab and halibut habitat protection areas that are presently closed would be opened under this scenario. Also, in 1980 more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under FMP 2.1 (<1 percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. Therefore, the additional past and external effects are not expected to improve the internal FMP rating.

Direct/Indirect Effects of FMP 2.2

Example FMP 2.2 is identical to FMP 1 for habitat impacts. Figure 4.2-3 (bookend) illustrates the suite of year-round closures in the BSAI and GOA management areas.

Direct and indirect effects of FMP 2.2 on habitat are discussed for changes to living habitat through direct mortality or benthic organisms and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to their differences in habitat type, the BSAI and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

In the GOA, the multi-species model results indicate that catch of most living habitats will decline under FMP 2.2. (Table 4.5-48). In the BSAI, bycatch levels are predicted to be within approximately 20 percent of the baseline. The model projections for the GOA are unrealistically low relative to the baseline. This is because the model framework artificially constrained specific fisheries, such as rockfish, that historically have had a high bycatch rate of living substrates (Jim Ianelli, AFSC, personal communication 2003). Based on past performance, it is doubtful that such constraints will severely curtail the rockfish fishery. . Therefore, a more realistic prediction is that bycatch levels would be about the same as the baseline.

The habitat impacts model predicts the following effects for FMP 2.2 on biostructure relative to the baseline:

- **Bering Sea.** There is no predictable difference in impacts to habitat between FMP 2.2 and baseline conditions. For both, mean impacts are low when averaged over the entire fishable EEZ; impacts to biostructure ranged from 1.8 to 9.3 percent of the fishable EEZ and from 8.2 to 41.9 percent of the fished area. A large area in the Bering Sea (8,000 sq mi) that is subject to high fishing intensity potentially causes an 83 percent reduction in equilibrium biostructure level when a 15 year recovery rate is modeled. Based on these results, we conclude that there would be an insignificant change to mortality and damage to living habitat as a result of FMP 2.2.

- **Aleutian Islands.** There is no predictable difference in impacts to habitat between FMP 2.2 and from baseline conditions. For both, meaan impacts ranged from 1.1 to 6.8 percent of the fishable EEZ and from 5.4 to 32.6 percent of the fished areas. Therefore, we rate the change resulting from FMP 2.2 relative to the baseline as insignificant. However, prevalence of long-lived species of coral in the bycatch is a particular concern in the Aleutian Islands under FMP 2.2. With a recovery rate for red tree coral possibly as low as $\rho = 0.005$ (200 years) and sensitivity $q_H = 0.27$, the habitat impact model indicates that fishing intensity as low as $f = 0.10$ (total area swept once every 10 years) results in an equilibrium level reduction of 85 percent relative to the unfished level. About 9 percent of the area (3,590 sq mi) is estimated to be fished at $f = 0.10$ or greater. Thus, continued bycatch and damage to living habitat at FMP 2.2 bycatch levels may have negative consequences on habitat quality.

- **GOA.** There is no predictable difference in impacts too habitat between FMP 2.2 and baseline conditions. For both, mean impact on biostructure ranged from 0.9 to 6.9 percent of the fishable EEZ and from 3.8 to 29.0 percent of the fished areas. Only 2 percent of the fishable EEZ (2,418 sq mi) is potentially impacted to below 32 percent of unfished levels when a 15 year recovery rate is used. Therefore, for FMP 2.2, we rate this change in mortality and damage to living habitat as insignificant.

Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection

- **Bering Sea.** Identical to the baseline and FMP 1, FMP 2.2 closures in the Bering Sea are mostly concentrated on sand substrate (Table 4.5-47). Only 27 percent of the geographical habitat zones have at least 20 percent of their area closed to bottom trawling. Figure 4.1-10 shows that the amount of large contiguous areas of high fishing intensity—that is, areas that are swept at least once each year with bottom trawls—exceeds 8,000 sq mi (Table 4.1-26). Table 4.5-49 shows that, of the Bering Sea fishable area, 19.3 percent is closed to bottom trawling under FMP 2.2. However, very little geographic diversity of fishing impacts occurs within the closed habitats because the closed areas do not represent diverse closures of habitat (i.e., they are concentrated on sand substrate). In addition, very few of the closures are year-round. Figure 4.5-4 shows areas closed to trawling only at various times of the year under this FMP, while Figure 4.5-5 depicts just those areas closed to fixed gear only.

Application of the habitat impacts model indicated that, depending on plausible sensitivity and recovery parameters, fishing of this intensity could reduce the amount of biostructure in the area by 13 to 75 percent of its unfished equilibrium level (Table 4.5-48). Such biostructure includes sponges, soft corals, tunicates, and anemones (Heifetz 2002, Malecha *et al.* 2003). There are no existing closure areas adjacent to these intensely fished areas to provide a diverse level of impact. While existing closures tend to be large and cover all of a particular habitat, they provide little diversity in fishing impacts. The primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear; therefore, the closures do not necessarily cross a wide range of habitat types. Some of the trawl closures are in effect year-round while others are seasonal (see Section 3.6). Compared to the existing baseline, the predicted effects of FMP 2.2 on benthic community diversity is insignificant. Similarly, the predicted effects of FMP 2.2 on geographic diversity of impacts is also predicted to be insignificant.

- **Aleutian Islands.** Identical to the baseline and FMP 1, FMP 2.2 closures in the Aleutian Islands are concentrated in shallow water, where only 4 percent of the area is closed to bottom trawling year-round for all species. However, as shown on Table 4.5-49, about 43 percent of the fishable area in the Aleutians is closed to bottom trawling at one time or another during the year under FMP 2.2. These closures are associated with sea lion rookeries. As in the baseline, there is very little diversity in protection. Less than one percent of the deep area is closed to bottom trawling. Figure 4.1-10 shows that none of the closure areas extend over any blocks of significant fishing effort. Figures 4.5-4 and 4.5-5 show the closure areas under FMP 2.2 broken down by gear type, bottom trawl and fixed gear, respectively. The Aleutian Islands bathymetry and habitat is distributed on a fine scale, with fishing effort that is patchy and in small clusters. Based on these observations relative to the baseline, the predicted effects of FMP 2.2 on benthic community diversity and geographic diversity of impacts are insignificant.

- **GOA.** Figure 4.5-6 shows that, as in the baseline, minimal geographic diversity of impact or protection results from the current suite of closed areas. Except for the southeast trawl closure, which covers several entire habitat types, all other closures are inshore (see Figure 4.5-6). As shown on Table 4.5-49 and Figures 4.5-4 and 4.5-5, FMP 2.2 closes nearly 46 percent of the fishable area in the GOA to trawling at one time or another during the year. The inshore closure areas tend to be large relative to the size of bathymetric and habitat resolution scale and thus tend to encompass a large portion of a bathymetric feature. Based on these results, the predicted effect of FMP 2.2 on benthic community diversity and geographic diversity of impacts is insignificant.

Cumulative Effects of FMP 2.2

Cumulative effects on habitat for FMP 2.2 are summarized on Table 4.5-50. The following discussion of the cumulative effects as presented on the table is broken down by geographic area.

Bering Sea

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. These effects include persistent mortality of long-lived species such as tree corals and other sessile epifauna (see the cumulative effects discussion for FMP 2.1).

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat (see the cumulative effects discussion for FMP 2.1).

- **Cumulative Effects.** Cumulative effects on mortality of Bering Sea benthic organisms are judged to be conditionally significant adverse. Additional external impacts will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though FMP 2.2 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue to negatively impact benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. (See the cumulative effects discussion for FMP 2.1 for additional information.) Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may be recovered or recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities as described for FMP 2.1. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Cumulative effects on changes in benthic community structure of the Bering Sea are judged to be conditionally significant adverse. Additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though FMP 2.2 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue to negatively impact benthic living habitat.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 almost 9 percent of the fishable area in the Bering Sea was closed to trawling, with 2.2 percent closed to all fishing. The cumulative effects section for FMP 2.1 provides additional discussion regarding past effects.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future external effects include port expansion and the potential resultant changes to fishing effort, offal discharge, and marine pollution episodes (see discussion for FMP 2.1). Depending on the distribution of fishing effort, previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged to be conditionally significant adverse. The maps and statistics discussed under persistent past effects show that FMP 2.2 would protect more benthic habitat from trawl gear in the future (19 percent) than was protected in 1980 (8.6 percent). However, the spatial distribution of the closed areas under FMP 2.2 will not protect the full range of habitat types, or provide for a diversity of impacts within fished areas. Existing closures tend to be large and cover all of a particular habitat, and they provide little diversity in fishing impacts since the primary focus of past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear (see Direct/Indirect Effects discussion and baseline description in Section 3.6). Additional external impacts do not provide any protection and could add to the lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 2.2 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished, and impacts would occur in areas not previously impacted.

Aleutian Islands

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutians. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. See the FMP 2.1 cumulative effects discussion for additional information on these impacts.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat. See the FMP 2.1 discussion of cumulative impacts in the Aleutian Islands for additional details.

- **Cumulative Effects.** Cumulative effects on mortality of Aleutian Islands benthic organisms are judged to be conditionally significant adverse. Long-lived species, such as tree coral, are more prevalent in the Aleutian Islands. Additional external impacts will add to lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though FMP 2.2 is rated as insignificant, bycatch and damage to living habitat will continue to negatively impact benthic living habitat in the Aleutian Islands.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutians. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1, dredging, longline and pot fisheries, offal discharge, port expansion and use, natural events, and marine pollution all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Cumulative effects on changes in benthic community structure of the Aleutians are judged to be conditionally significant adverse. Additional external impacts will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 2.2 are rated as insignificant, continued bycatch and damage to living habitat will increase negative impacts on the benthic community.

<u>Geographic Diversity of Impacts and Protection</u>

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 31 percent of the fishable area in the Aleutians was closed to trawling, with about 6 percent closed to all fishing. There were no longline-only closures in the

Aleutian Islands at that time. The cumulative effects section for FMP 2.1 provides additional discussion regarding these past effects.

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and the potential resultant changes to fishing effort, offal discharge, and marine pollution episodes. See the discussion for cumulative effects of FMP 2.1 for additional details.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged conditionally significant adverse. The maps and statistics discussed udner persistent past effects show that FMP 2.2 would protect more benthic habitat from trawl gear in the future (43 percent) than was protected in 1980 (31 percent). However, the spatial distribution of the closed areas under the current FMPs may not protect the full range of habitat types.

GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, and as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see discussion for FMP 2.1).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 cumulative effects, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat.

- **Cumulative Effects.** Cumulative effects on mortality of GOA benthic organisms are judged to be conditionally significant adverse. Additional external impacts will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 2.2 are rated as insignificant, bycatch and damage to living habitat will continue in the GOA and will negatively impact benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 2.1 in the GOA, dredging, longline and pot fisheries, offal discharge, port expansion and use, natural events, and marine pollution all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the community.

- **Cumulative Effects.** Cumulative effects on changes in benthic community structure of the GOA are judged to be conditionally significant adverse. Additional external impacts will add to the lingering past impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 2.2 are rated as insignificant, bycatch and damage to living habitat in the GOA will continue to negatively impact the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described previously in Section 4.6.6, this effect is judged to result in an insignificant change from baseline conditions, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 5 percent of the fishable area in the GOA was closed to trawling, with about 7 percent closed to all fishing. The largest closures in the GOA were for longline fishing, where almost 61 percent of the fishable area was closed to longlining. Therefore, in 1980, about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at some time during the year (see discussion for FMP 2.1).

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future external effects include other fisheries, port expansion and the potential resultant changes to fishing effort, offal discharge, and marine pollution episodes (see the FMP 2.1 cumulative effects discussion for the GOA). Depending on the distribution of fishing effort, previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Cumulative effects on changes in distribution of fishing effort are judged conditionally significant adverse. The maps and statistics discussed under persistent past effects show that FMP 2.2 would protect much more benthic habitat from trawl gear in the future (46 percent) than was protected in 1980 (16 percent). However, the spatial distribution of the closed areas under the FMP 2.2 may not protect the full range of habitat types. Also, in 1980 more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under FMP 2.2 (<1 percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. The additional external impacts will add to the lingering impacts and contribute to impacts that are already evident.

4.6.7 Seabirds Alternative 2 Analysis

4.6.7.1 Short-Tailed Albatross

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Incidental Take

The seabird protection measures for longline vessels under FMP 2.1 and FMP 2.2 would be the same as those that exist under the baseline conditions unless the USFWS requires a change in regulations under Section 7 of the ESA to protect the short-tailed albatross. For this analysis, it is assumed that the regulations will remain in effect as they were in 2002 (Section 3.7.1). Statistical analysis of the effectiveness of the baseline regulations in preventing incidental take of short-tailed albatross on longlines is problematic given the rarity of encounters. The issue would be even more difficult to resolve if observer coverage of fishing effort was decreased as proposed in FMP 2.1. It is clear, however, that the existing regulations have not eliminated the incidental take of short-tailed albatross. The fact that two short-tailed albatross were caught in one month in 1998 by vessels that were technically in compliance with the regulations indicates that the threat remains. The lack of performance standards in the existing regulations is considered a major limitation in the overall effectiveness of the techniques. Although education programs for fishermen in proper deployment methods could improve this situation, FMP 2.1 defines a very "hands-off" approach to fishery management where such training programs would be unlikely to occur. Using information from the projection model on Pacific cod TAC and qualitative assumptions about gear allocation within a basically unregulated fishery, the longline fishing effort in the BSAI under FMP 2.1 is predicted to be similar to the baseline longline effort, despite a major increase in overall groundfish harvest.

Longline effort in the GOA is predicted to almost double from the baseline effort under FMP 2.1. However, the baseline effort in the GOA is about seven times less than in the BSAI, and accounts for almost 20 times fewer birds taken incidentally. For these reasons, FMP 2.1 is considered to present the same or slightly increased risk of incidental take of short-tailed albatross on longlines as the baseline condition. Under FMP 2.2, longline effort is predicted to be about the same as under the baseline condition. The risk of incidental take of short-tailed albatross on longlines would therefore continue at the estimated rate of two birds per year under both FMP 2.1 and FMP 2.2; a rate that does not jeopardize the existence of the species but may slow its recovery (USFWS 1997).

There are presently no regulations that require any mitigation of seabird incidental take in either the trawl or pot sectors of the groundfish fleet, and no restrictions on these sectors would be implemented under FMP 2.1 or 2.2. Although no short-tailed albatross have been observed or reported to be taken in groundfish trawl gear, Laysan albatross are known to be taken in trawls, so the potential for taking the similar short-tailed albatross exists. In addition, NOAA Fisheries and USFWS are currently investigating whether collisions with trawl third wires pose a threat to short-tailed albatross, as these wires are known to cause mortality of other albatross. The level of bottom and pelagic trawl effort under FMP 2.1 is predicted to increase by 200 to 300 percent in the BSAI and remain about the same in the GOA (although there would be a shift of effort from bottom trawls to pelagic trawls). If the amount of trawl effort is directly proportional to the risk of taking albatross either in trawl gear or through vessel strikes, an assumption that has not yet been tested, this substantial increase in trawl effort under FMP 2.1 could pose an increased risk of taking short-tailed albatross. Such a change in the nature of the fishery would likely prompt a new Section 7 consultation with the USFWS. If USFWS determines that the trawl sector is likely to cause mortality of this endangered species, in addition to the mortality that is assumed and observed to occur in the longline fisheries, the combined incidental take in the groundfish fisheries could exceed the mortality threshold of four birds per two year period that was established in the last BiOp (USFWS 1997) and would likely be considered significant at the population level. Given the conjectural nature of these conditions occurring, FMP 2.1 is considered to be conditionally significant adverse for incidental take of short-tailed albatross from the groundfish fishery.

Under FMP 2.2, trawl effort is expected to increase by approximately 25 percent over the baseline condition. As with all matters concerning fishery interactions with this endangered species, the USFWS would have the responsibility under Section 7 of the ESA to review the proposed structure of the fishery and determine if the changes pose a significant risk to the continued existence of the species. While the outcome of those complex deliberations cannot be predicted at this time, it will be assumed that the modest increase in trawl effort proposed under FMP 2.2 would not be considered a substantial increase in risk for incidental take of the species. FMP 2.2 would therefore be considered to have insignificant effects on short-tailed albatross through incidental take.

Change in Food Availability

Short-tailed albatross forage over vast areas of ocean and are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 2.1 or 2.2, even if a directed forage fish fishery was developed. FMP 2.1 and FMP 2.2 are therefore considered to have insignificant effects on short-tailed albatross through availability of food.

Benthic Habitat

Short-tailed albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1 or FMP 2.2. FMP 2.1 and FMP 2.2 are therefore considered to have no effects on short-tailed albatross through benthic habitat.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on short-tailed albatross are described in Section 3.7.4 (Table 3.7-12) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for this species would be dominated by factors external to the groundfish fisheries and are summarized below.

Mortality

- **Direct/Indirect Effects.** Under FMP 2.1, the risk of incidental take on longlines would be about the same or slightly greater than the baseline conditions. Risk of incidental take on trawl gear, however, would increase substantially. The overall risk of incidental take of short-tailed albatross is therefore considered conditionally significant adverse under FMP 2.1. Under FMP 2.2, the risk of incidental take would be the same or negligibly higher than the baseline conditions. Therefore, the overall risk of incidental take of short-tailed albatross is considered insignificant under FMP 2.2.

- **Persistent Past Effects.** The most important persistent influence on the short-tailed albatross population is their near extinction due to commercial feather hunting. Conservation efforts have allowed the population to recover at or near to its biologically maximum rate. The total fishery-related mortality of short-tailed albatross is unknown but it does not appear to be having an overriding effect on the population growth rate.

- **Reasonably Foreseeable Future External Effects.** The short-tailed albatross population may be substantially affected by several natural and human-caused mortality factors that may or may not occur in the future, including volcanic eruptions on their main breeding site, Torishima Island, and increased rates of incidental take in fisheries throughout their range. If the species experiences a substantial increase in mortality that threatens its recovery, it may lead to further efforts to protect the species from fishery interactions.

- **Cumulative Effects.** Since the population of short-tailed albatross is susceptible to several natural and human-caused mortality factors that may or may not occur in the future, including incidental take in the groundfish fisheries, the cumulative effect on short-tailed albatross is considered to be conditionally significant adverse at the population level through mortality for FMP 2.1 and FMP 2.2..

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under FMP 2.1 and FMP 2.2 and an unknown amount of forage fish under a potential directed fishery. This effect is considered insignificant at the population level for short-tailed albatross.

- **Persistent Past Effects.** Short-tailed albatross primarily prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to natural fluctuations in primary productivity and oceanographic factors. Pollution from a variety of land and marine sources have potentially affected short-tailed albatross prey in the past but specific toxicological effects are unknown.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on short-tailed albatross prey availability. Pollution is likely to affect short-tailed albatross prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to short-tailed albatross, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of short-tailed albatross prey is considered to be insignificant at the population level.

Benthic Habitat

Since short-tailed albatross feed at the surface and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for short-tailed albatross.

4.6.7.2 Laysan Albatross and Black-Footed Albatross

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Incidental Take

As described in Section 4.6.7.1, longline effort in the BSAI is expected to be about the same as under the baseline condition and is expected to almost double in the GOA under FMP 2.1. Incidental take of albatross on longlines is therefore expected to be the same as the baseline condition in the BSAI. Since there is not a strong correlation between fishing effort and incidental take of any species besides fulmars, the increased longline effort in the GOA may translate into similar or slightly increased levels of albatross take as the baseline condition. These levels of incidental take are considered insignificant at the population level for both species (see Section 4.5.7.2). FMP 2.1 is also expected to increase incidental take in trawl gear and vessel strikes due to a major increase in trawl effort. It is not known whether there is a direct proportional relationship between trawl effort and incidental take of albatross. However, if we assume that take levels would increase 300 percent in direct response to the increased level of trawl effort, take of Laysan albatross in trawls would average about 270 birds per year (Table 3.7-4, using the mean of low and high estimates). No black-footed albatross have been recorded as being taken in the combined trawl fisheries. Combining the expected increase in trawl mortality with the baseline level of longline take, the expected total take of Laysan albatross under FMP 2.1 would average approximately 1050 birds per year. This would represent an estimated 0.04 percent of their population (2.4 million birds) and is therefore considered insignificant on the population level. FMP 2.1 is therefore considered to have insignificant effects on both albatross species through overall incidental take.

Under FMP 2.2, the seabird protection measures, and level of effort for longline vessels would be the same as under the baseline condition. The predicted level of incidental take of both albatross species on longlines would therefore approximate the baseline levels described in Section 4.5.7.2, which are considered insignificant at the population level. Trawl effort is expected to increase under FMP 2.2 by approximately 25 percent over the baseline condition. If it is assumed that this increase in effort will result in a corresponding increase in incidental take, take of Laysan albatross in trawls would average about 112 birds per year (Table 3.7-4, using the mean of low and high estimates). This level of take is very small relative to the abundance of this species and is therefore considered to be insignificant at the population level. The overall effect of FMP 2.2 on both albatross species is therefore considered to be insignificant through incidental take.

Changes in Food Availability

Albatross forage over vast areas of ocean and are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 2.1 or 2.2, even if a directed forage fish fishery develops. FMP 2.1 and FMP 2.2 are therefore considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1 or FMP 2.2. FMP 2.1 and FMP 2.2 are therefore considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on these albatross species are described in Sections 3.7.2 and 3.7.3 (Tables 3.7-6 and 3.7-7) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.5-53) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under this alternative, the same seabird protection measures that are described in the baseline conditions (see Section 3.7.1) would be maintained. The predicted level of incidental take from all gear types is considered insignificant at the population level for both albatross species.

- **Persistent Past Effects.** For black-footed and Laysan albatross, past mortality factors include large contributions from foreign longline fisheries and Hawaiian pelagic longline fisheries, a smaller contribution from the BSAI/GOA longline fisheries, and an unknown contribution from other longline fisheries, trawl fisheries, and vessel collisions throughout their range. Both species have been experiencing population declines over the past decade. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown for both albatross species.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets and are expected to reduce take of albatross in those fisheries . Incidental take of black-footed and Laysan albatross in foreign longline fisheries is expected to remain high and continue to exceed the threshold for population level effects.

- **Cumulative Effects.** Since the populations of black-footed and Laysan albatross are undergoing measurable declines and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries under FMP 2.1 and FMP 2.2, the cumulative effects on black-footed and Laysan albatross are considered to be significantly adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under FMP 2.1 and FMP 2.2 and an unknown amount of forage fish in a potential directed fishery under FMP 2.1. This effect is considered insignificant at the population level for both albatross species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on albatross prey populations can not be assessed at this time.

- **Persistent Past Effects.** Albatross primarily prey on squid species and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since albatross can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources have potentially affected albatross prey in the past. However, very little is known about the specific toxicological effects on species important to these seabirds or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on albatross prey availability. Pollution is likely to affect albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to albatross, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of albatross prey is considered to be insignificant at the population level for all species.

Benthic Habitat

Since albatross feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on albatross prey. Therefore, no cumulative effect is identified for these species.

4.6.7.3 Shearwaters

Direct/Indirect Effects of FMP 2.1 and 2.2

Incidental Take

As described in Section 4.6.7.1, longline effort in the BSAI is expected to be about the same as under the baseline condition, and is expected to almost double in the GOA under FMP 2.1. Incidental take of shearwaters on longlines is therefore expected to be the same as the baseline condition in the BSAI. Since there is not a strong correlation between fishing effort and incidental take of any species besides fulmars, the increased longline effort in the GOA may translate into similar or slightly increased levels of shearwater take as the baseline condition. These levels of incidental take are considered insignificant at the population level for both species (see Section 4.5.7.2). FMP 2.1 is also expected to increase incidental take in trawl gear and vessel strikes due to a major increase in trawl effort. It is not known whether there is a direct proportional relationship between trawl effort and incidental take of shearwaters. However, if we assume that take levels would increase 300 percent in direct response to the increased level of trawl effort, take of shearwaters in trawls would average about 2,400 birds per year (Table 3.7-4, using the mean of low and high estimates). These levels of take are very small relative to the abundance of these species (estimated at a combined 54 million birds) and are therefore considered to be insignificant at the population level. FMP 2.1 is therefore considered to have insignificant effects on these species through overall incidental take.

Under FMP 2.2, the seabird protection measures for longline vessels would be the same as the baseline condition and longline effort is predicted to be about the same as under the baseline condition. The predicted level of incidental take of these shearwater species on longlines would therefore approximate the baseline levels described in Section 4.5.7.2, which are considered insignificant at the population level. Trawl effort is expected to increase under FMP 2.2 by approximately 25 percent over the baseline condition. If it is assumed that this increase in effort will result in a corresponding increase in incidental take, take of shearwaters in trawls would average about 1000 birds per year (Table 3.7-4, using the mean of low and high estimates). This level of take is very small relative to the abundance of these species and is therefore considered to be insignificant at the population level. The overall effect of FMP 2.2 on these species is therefore considered to be insignificant through incidental take.

Changes in Food Availability

Shearwaters forage over vast areas of ocean and are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 2.1 or FMP 2.2, even if a directed forage fish fishery develops. FMP 2.1 and FMP 2.2 are therefore considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Shearwaters are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1 or FMP 2.2. FMP 2.1 and FMP 2.2 are therefore considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on these shearwater species are described in Section 3.7.6 (Table 3.7-14) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described above (Table 4.5-54). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.5-54) and summarized below.

Mortality

- **Direct/Indirect Effects**. Under this alternative, the same seabird protection measures that are described in the baseline conditions (see Section 3.7.1) would be maintained. The predicted level of incidental take from all gear types is considered insignificant at the population level for both species in this group.

- **Persistent Past Effects.** For sooty and short-tailed shearwaters, mortality factors include large contributions from subsistence and commercial harvest of chicks on the nesting grounds as well as climatic and oceanic fluctuations that cause periodic mass starvation, substantial contributions from foreign, Hawaiian, and BSAI/GOA groundfish longline and trawl fisheries, and a smaller contribution from vessel collisions throughout their range. It is difficult to assess the population trends in these abundant and widespread species but there is some indications that both species may be declining. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets but they are not expected to reduce take of shearwaters in those fisheries. Incidental take of shearwaters in foreign fisheries will likely continue as in the past unless longline and trawl deterrence techniques are developed and applied that are effective for diving species.

- **Cumulative Effects.** Since the populations of shearwaters may be undergoing declines, and several human-caused mortality factors have been identified that are expected to continue in the future, including contributions from the groundfish fisheries under FMP 2.1 and FMP 2.2, the cumulative effects on sooty and short-tailed shearwaters are considered to be conditionally significant adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid as bycatch under FMP 2.1 and FMP 2.2, even with a potential directed forage fish fishery under FMP 2.1. This effect is considered insignificant at the population level for both species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on shearwater prey populations can not be assessed at this time.

- **Persistent Past Effects.** Short-tailed and sooty shearwaters are susceptible to periodic widespread food shortages that have caused massive die-offs in Alaskan waters. Natural fluctuations in primary productivity and oceanographic factors are considered to be the driving forces that determine the abundance of their main prey (euphausiids), rather than competitive interactions with other predators. Since shearwaters can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected shearwater prey in the past. However, very little is known about the specific toxicological effects on species important to these seabirds or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on shearwater prey availability. Pollution is likely to affect shearwater prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to shearwaters, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of shearwater prey is considered to be insignificant at the population level for both species.

Benthic Habitat

Since shearwaters feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.6.7.4 Northern Fulmar

Direct/Indirect Effects of FMP 2.1

Incidental Take

Mortality of northern fulmars on longline gear accounts for the majority of all birds taken incidentally in the groundfish fisheries under the baseline conditions. Under FMP 2.1, incidental take on longlines is predicted to remain similar to its present level because of similar effort and avoidance measures as the baseline condition (see Section 4.5.7.3). Incidental take in trawl gear and by vessel strikes (about 3150 fulmars per year under baseline conditions) is expected to increase by an unknown amount with the predicted 200 to 300 percent increase in trawl effort under FMP 2.1. Even if we assumed a direct relationship with trawl effort that resulted in a 300 percent increase in fulmar take, the overall numbers of fulmars taken in the groundfish fishery would still be small relative to their abundance in the BSAI/GOA (close to one percent of their estimated 2 million population). Fulmar population dynamics, and the potential effects of different levels of mortality or mortality of adults versus subadults, have not been explored with mathematical modeling. Given the fact that fulmar population trends are presently measured only on the Pribilofs and not on their largest colonies, it is unlikely that anthropogenic mortality equal to an estimated one percent of their population would have a detectable effect on the overall population. However, concern for a colony level effect would be intensified (see Section 4.5.7.3), especially since the existing fishing restrictions around the Pribilof Islands would be lifted under FMP 2.1. If trawl and longline effort increased substantially around the Pribilofs during the breeding season and a high percentage of the incidentally taken fulmars came from the Pribilof colony, incidental take of fulmars under FMP 2.1 could be significant at the colony level. Given the conjectural nature of these conditions occurring, FMP 2.1 is considered to be conditionally significant adverse for incidental take of fulmars.

Changes in Availability of Food

Fulmars forage over vast areas of ocean and are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 2.1, even if a directed forage fish fishery develops. FMP 2.1 is therefore considered to have insignificant effects on fulmars through availability of food.

Benthic Habitat

Fulmars are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1. FMP 2.1 is therefore considered to have no effects on fulmars through benthic habitat.

Cumulative Effects of FMP 2.1

The past/present effects on northern fulmars are described in Section 3.7.5 (Table 3.7-13) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.6-4 and summarized below.

Mortality

- **Direct/Indirect Effects.** Under FMP 2.1, the same seabird protection measures for the longline fleet that are described in the baseline conditions (section 3.7.1) would be maintained. The incidental take of fulmars under FMP 2.1 is expected to be similar to the baseline level in the longline sector, and much higher in the trawl sector due to increased effort. The overall effect of the fishery on fulmar mortality is considered conditionally significant adverse because of increased concern for colony level effects.

- **Persistent Past Effects.** For northern fulmars, past mortality factors include large contributions from the BSAI/GOA groundfish fisheries and other net and longline fisheries in the North Pacific and Bering Sea. There is no indication of an area-wide population decline, but there is some concern that particular colonies may be experiencing declines related to the groundfish fisheries. Other potential mortality factors that have been identified include acute and chronic effects of pollution, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation) due climatic and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Incidental take of fulmars is expected to continue in all offshore fisheries in the BSAI/GOA. The IPHC fisheries will be subject to new seabird avoidance measures, so incidental take from the halibut and sablefish fleet is expected to decline substantially. Future oil spills and other incidents of pollution are likely, but their effects on fulmars will depend on many factors that can not be predicted.

- **Cumulative Effects.** Incidental take in the groundfish fishery under FMP 2.1 is expected to be the primary human-caused mortality factor for fulmars. Because fishing intensity is expected to increase substantially around the Pribilof Islands, the cumulative effect on fulmar mortality is considered conditionally significant adverse because of increased concern for colony level effects.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch under FMP 2.1, and an unknown amount of these prey if a directed forage fish fishery developed. This effect is considered insignificant at the population level for northern fulmars. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on fulmar prey populations can not be assessed at this time.

- **Persistent Past Effects.** Fulmars prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since fulmars can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources have potentially affected fulmar prey in the past. However, very little is known about the specific toxicological effects on species important to fulmars or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on fulmar prey availability. Pollution is likely to affect fulmar prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to fulmars, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of fulmar prey is considered to be insignificant at the population level.

Benthic Habitat

Since fulmars feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernible effect on their prey. Therefore, no cumulative effect is identified for this species.

Direct/Indirect Effects of FMP 2.2

Incidental Take

For the reasons described above, the incidental take of fulmars on longlines under FMP 2.2 would be expected to be approximately the same as described under the baseline conditions (Section 4.5.7.3). This level is considered insignificant at the population level for fulmars. Trawl effort is expected to increase under FMP 2.2 by approximately 25 percent over the baseline condition. If we assume that this increase in effort will result in a corresponding increase in incidental take, take of fulmars in trawls and vessel strikes would average about 4,000 birds per year. The combined take from longlines and trawls would be approximately 16,000 birds per year (see Section 4.5.7.3) which is less than one percent of the estimated BSAI/GOA population of 2 million birds.

This level of take would be considered insignificant at the population level. However, there would still be concern about potential colony level effects and the USGS/BRD would likely continue to investigate the issue. The existing trawl restrictions around the Pribilof Islands would be maintained under FMP 2.2 so the increase in trawl effort would not be concentrated near the fulmar colony. While these investigations continue, it will be assumed for this analysis that FMP 2.2 would not lead to a disproportionate take of fulmars from any one colony. The overall effect of FMP 2.2 on fulmars is therefore considered to be insignificant through incidental take.

Changes in Availability of Food

FMP 2.2 would have the same insignificant effects on fulmar food availability as described above for FMP 2.1

Benthic Habitat

FMP 2.2 would have no effects on fulmar benthic habitat as described above for FMP 2.1.

Cumulative Effects – FMP 2.2

Mortality

- **Direct/Indirect Effects.** The seabird protection measures under FMP 2.2 would be the same as described above for FMP 2.1. However, the structure and intensity of the fisheries would be substantially different than FMP 2.1. Although concern for colony level effects remain, the effect of the fishery under FMP 2.2 is considered insignificant at the population level.

- **Persistent Past Effects and Reasonably Foreseeable Future External Effects.** These effects would be the same as described above for FMP 2.1.

- **Cumulative Effects.** Incidental take in the groundfish fishery under FMP 2.2 is expected to be the primary human-caused mortality factor for fulmars. Incidental take in the IPHC fisheries is expected to decrease, and at least partially compensate for, the small increase in take expected in the groundfish fishery. The cumulative effect on fulmar mortality is therefore considered insignificant at the population level.

Changes in Food Availability and Benthic Habitat

These effects would be the same as described above for FMP 2.1.

4.6.7.5 Species of Management Concern (Red-Legged Kittiwakes, Marbled and Kittlitz's Murrelets)

Direct/Indirect Effects of FMP 2.1

Incidental Take

The seabird avoidance measures under FMP 2.1 would be the same as under the baseline conditions and would be limited to the longline fleet. Under the baseline conditions, no red-legged kittiwakes have been observed to be taken in any of the BSAI/GOA fisheries since data began to be collected in 1993. Under FMP 2.1, longline effort would remain about the same as the baseline in the BSAI, while trawling would increase substantially. The Pribilof Habitat Conservation Area, which covers a large area around the largest red-legged kittiwake colony on St. George Island, would be eliminated along with many other fishery closures. The elimination of this closed area would result in an increased potential for incidental take of red-legged kittiwakes around the Pribilof Islands. However, since incidental take approaches zero under the current conditions, it appears that the species is not very susceptible to being taken in any gear, perhaps because they can not compete for offal with the larger gulls or are more agile in avoiding entanglement. It seems most likely that these birds will continue to be able to successfully avoid being taken on a regular basis, even with increased fishing effort. The effect of FMP 2.1 on incidental take of red-legged kittiwakes is therefore considered insignificant at the population level.

Murrelets, due to their small size and feeding strategy, are more susceptible to being taken in trawls than in either longline or pot fisheries. The 200 to 300 percent increase in trawling under FMP 2.1 would result in an increased potential for incidental take of these species. However, since murrelets prefer to forage in waters inshore of the groundfish fisheries, and the incidental take of murrelets under the baseline conditions already approaches zero, the potential increase in take would likely be very small. The effect of FMP 2.1 on incidental take of marbled and Kittlitz's murrelets is therefore considered insignificant at the population level.

Changes in Food Availability

Given the wide variety of foods used by kittiwakes and the extensive areas over which they forage, it seems unlikely, even with the substantial increased trawling activity, that they would be susceptible to localized depletion of prey during the non-breeding season. However, while nesting, kittiwakes are more dependent on high-quality forage fish for raising chicks and are more susceptible to potential localized depletions of prey around their colonies. Elimination of the Pribilof Habitat Conservation Area fishery closure would likely result in increased trawling around the largest red-legged kittiwake colony, St. George Island. More importantly than trawl bycatch, the existing ban on the development of a directed forage fish fishery would be lifted under FMP 2.1. It is not clear how such a fishery would be structured or how extensive it would become (see Section 4.6.4), but if such a fishery developed around the Pribilofs it could have serious repercussions on the availability of prey to red-legged kittiwakes and could have population level effects. Because of the conjectural nature of this situation developing, the potential effect of the fishery through prey availability is rated conditionally significant adverse.

The groundfish fisheries have very little spatial overlap with murrelet foraging areas, but they do depend on forage fish schools that likely spend part of their time in waters of the EEZ. If a directed forage fish fishery developed near murrelet habitats in southeast Alaska and the GOA, forage fish populations may be affected on a regional level and could potentially affect murrelet reproductive success. As described above for kittiwakes, the potential effect of the fishery through prey availability is rated conditionally significant adverse for marbled and Kittlitz's murrelets.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles. However, benthic habitats in their nearshore foraging areas would not be affected directly by groundfish trawls under FMP 2.1, as these take place further offshore. FMP 2.1 is therefore considered to have insignificant effects on murrelets through benthic habitat, and no effects on red-legged kittiwakes.

Cumulative Effects of FMP 2.1

The past/present effects on red-legged kittiwakes, marbled murrelets, and Kittlitz's murrelets are described in Sections 3.7.13 and 3.7.17 (Tables 3.7-22 and 3.7-26) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above (Table 4.6-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.6-4) and summarized below.

Mortality

- **Direct/Indirect Effects.** The incidental take of red-legged kittiwakes and both murrelets species is expected to be rare and therefore insignificant at the population level under FMP 2.1.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging (red-legged kittiwakes), incidental take in coastal salmon gillnet and other net fisheries (murrelets), oil spills (murrelets), and logging of nest trees (marbled murrelets). Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed very little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. For red-legged kittiwakes, the introduction of nest predators or a large oil spill around the Pribilof Islands in nesting season could have significant effects on mortality. For the murrelet species, oil spills in nearshore habitats and incidental take in salmon and other net fisheries are likely to remain the largest factors in the future. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality. If the Kittlitz's murrelet population continues to decline and the species is listed under the ESA, new regulations may be placed on the various nearshore net fisheries to monitor and reduce incidental take of the species. These measures would also benefit marbled murrelets.

- **Cumulative Effects.** The three species in this group have all experienced substantial population declines in the recent past, and are all susceptible to future human-caused mortality factors, including potentially small contributions from the groundfish fishery. The decline of red-legged kittiwakes on the Pribilofs may have been reversed recently, but it is not clear if their recovery will continue in the future. The cumulative effect for red-legged kittiwakes is therefore considered conditionally significant adverse at the population level through mortality. Both murrelet species continue to decline in their core areas, and are thus considered to have significantly adverse cumulative effects at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** A directed forage fish fishery could develop under this FMP that could lead to population level effects on all three species. The effect of FMP 2.1 is therefore considered conditionally significant adverse at the population level for all three species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All three species prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources, including the EVOS, have likely affected the prey of these species in the past. Since murrelets are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded murrelets from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is also likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The dynamic interaction of natural and human-caused events, including fisheries and pollution, on the availability of forage fish and invertebrate prey to seabirds is only beginning to be explored with directed research. However, the potential of the groundfish fisheries under FMP 2.1 to have a significantly adverse effect on prey availability leads to a cumulative effects rating of conditionally significant adverse for these three species.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery. Therefore, no cumulative effect is identified for red-legged kittiwakes. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles, but they forage in shallow waters that are inshore of the groundfish fishery. Since the groundfish fishery would have minor contributions to potential effects on benthic habitats important to murrelets, the cumulative effects for these species are considered insignificant.

Direct/Indirect Effects of FMP 2.2

Incidental Take

Under FMP 2.2, longline fishing effort would be similar to the baseline in both the BSAI and GOA. Incidental take of red-legged kittiwake would therefore be similar to the baseline, which approaches zero. Trawl effort would increase by a modest amount under FMP 2.2 but, as described above for FMP 2.1, would not be expected to substantially increase incidental take of murrelets or kittiwakes. The effect of FMP 2.2 on incidental take of these species is therefore considered insignificant at the population level.

Availability of Food

As described in Section 4.5.7.4, the potential effects of the groundfish fishery on kittiwake and murrelet prey availability are considered to be insignificant under the baseline conditions. Although trawl effort is predicted to increase by 25 percent under FMP 2.2, it is unlikely that the attendant increase in bycatch of forage fish would affect prey availability enough to cause population level effects on these species (see Sections 4.6.4 and 4.6.10). The existing ban on the development of a directed forage fish fishery would remain in effect under FMP 2.2. The overall effect of FMP 2.2 on the availability of food for species of management concern is therefore considered insignificant at the population level.

Benthic Habitat

There are no effects on these species through benthic habitat under FMP 2.2, as described above for FMP 2.1.

Cumulative Effects of FMP 2.2

The seabird protection measures under FMP 2.2 would be the same as described above for FMP 2.1. The cumulative effects for mortality of these species are dominated by factors external to the fishery and would lead to the same conclusions as described above for FMP 2.1. Without the potential for a directed forage fish fishery, the potential effects of FMP 2.2 on prey availability are unknown, and lead to a cumulative effects rating of unknown. The groundfish fishery only makes a minor contribution to effects on benthic habitat, so insignificant cumulative effects are identified for murrelet species. No cumulative effect is identified for red-legged kittiwakes because they are not benthic feeders (Table 4.5-56).

4.6.7.6 Other Piscivorous Species (Most Alcids, Gulls, and Cormorants)

Direct/Indirect Effects of FMP 2.1

Incidental Take

The incidental take of piscivorous seabirds on longlines under FMP 2.1 would be expected to be similar to the baseline levels which are considered insignificant at the population level for these species (see Section 4.5.7.5). Incidental take in trawls would be expected to increase from baseline conditions due to increased trawl effort, but would not be expected to have population level effects for any species in this group because of the very low levels of take relative to the populations of these abundant species. For these reasons, FMP 2.1 is considered to have insignificant effects on piscivorous species through incidental take.

Changes in Food Availability

As described in Section 4.5.7.5, the potential effect of the groundfish fishery on piscivore prey availability is considered to be insignificant under the baseline conditions. The availability of food in the form of fishery discards would be expected to increase substantially with the overall increase in TAC under FMP 2.1. Some species of large gulls may benefit on the population level from this increase in supplemental food supplies while other species, like kittiwakes and murres, experience an adverse effect from increased predation pressure from the large gulls. The net beneficial or adverse effects of fishery wastes to the different species in this group are unknown.

Although trawl effort is predicted to increase substantially under FMP 2.1, bycatch of forage fish and pelagic invertebrates in groundfish trawls is not expected to affect the abundance and distribution of forage fish enough to cause population level effects on piscivores (see Sections 4.6.4 and 4.6.10). However, the existing ban on the development of a directed forage fish fishery would be lifted under FMP 2.1. It is not clear how such a fishery would be structured or how extensive it would become. Under certain conditions, such a fishery could result in localized depletions of forage fish important to seabirds that could have population level effects, especially if they occurred near breeding colonies during chick-rearing season. Because of the conjectural nature of this situation developing, the potential effect of the fishery through prey availability is rated conditionally significant adverse.

Benthic Habitat

Cormorants and alcids sometimes feed in the demersal zone, and some of their prey depend on benthic habitats during various life cycle stages. Bottom trawling and pelagic trawling that makes contact with the ocean bottom have the greatest potential to indirectly affect these diving seabirds via physical changes to the complexity and productivity of benthic habitats that may affect their prey base (NRC 2002). Although area-specific effects of trawling on seabird prey species (through habitat change rather than by direct take) are poorly known, overall trawl effort in the BSAI/GOA under FMP 2.1 is predicted to increase 200 to 300 percent relative to the baseline condition and, since the effects of repeated trawling are cumulative, benthic habitat important to diving seabirds could be affected substantially over time. The overall effects of increased trawling under FMP 2.1 are therefore considered conditionally significant adverse on piscivorous seabirds.

Cumulative Effects of FMP 2.1

The past/present effects on the species in this group, including most alcids, gulls, and cormorants, are described in the species accounts of Section 3.7 (Tables 3.7-16 and 3.7-20) and the predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.6-4 and summarized below.

Mortality

- **Direct/Indirect Effects.** Although incidental take of alcids is expected to increase under FMP 2.1 due to increased trawl effort, the incidental take of all species in this group is expected to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging, incidental take in a variety of foreign and U.S. coastal and pelagic fisheries, oil spills and other pollution (including huge losses at some colonies from the EVOS, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. Conservation concerns focus on preventing potential impacts around breeding colonies during the nesting season since populations are concentrated in time and space. For some species, human impacts in nearshore habitats will likely have a much greater effect on their populations than offshore fisheries. The contribution from chronic sources of pollution, from both terrestrial and marine sources, may also contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are therefore considered insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** Because of the potential development of directed forage fish fisheries, the effect of FMP 2.1 on the abundance and distribution of seabird prey species is considered conditionally significant adverse at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All species in this group prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources have likely affected the prey of these species in the past. Since some of the alcids are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded them from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries, as well as other net fisheries that take forage fish as bycatch, may have an effect on prey availability for these species. Pollution is also likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** Since the groundfish fisheries under FMP 2.1 may include a directed fishery on forage fish, the effects of which are potentially adverse under certain conditions, the cumulative effects on prey availability are considered to be conditionally significant adverse for these species.

Benthic Habitat

- **Direct/Indirect Effects.** Trawl effort would increase substantially under FMP 2.1, and would have the potential to modify benthic habitats and have indirect effects on the food web of diving piscivorous species. The overall effects of FMP 2.1 on piscivorous seabirds through potential changes in benthic habitat are considered conditionally significant adverse.

- **Persistent Past Effects.** Benthic habitats important to the diving species in this group have been affected by various foreign and U.S. fisheries for many years, and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to seabirds. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may also have persistent effects in certain areas.

- **Reasonably Foreseeable Future External Effects.** All future fisheries in the BSAI/GOA that use bottom contact fishing gear are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will also continue.

- **Cumulative Effects.** Since the groundfish fisheries under FMP 2.1 will contribute in a potentially significant way to the many human-caused and natural factors that may alter benthic habitats, the cumulative effects of these changes as they relate to the food web important to piscivorous seabirds are considered conditionally significant adverse.

Direct/Indirect Effects of FMP 2.2

Incidental Take

The incidental take of piscivorous seabirds under FMP 2.2 would be expected to remain approximately the same as the baseline levels which are considered insignificant at the population level for these species (see Section 4.5.7.5).

Changes in Food Availability

As described in Section 4.5.7.5, the potential effects of the groundfish fishery on piscivore prey availability are considered to be insignificant under the baseline conditions. The availability of food in the form of fishery discards would be expected to increase in proportion to the overall increase in TAC under FMP 2.2. Some species of large gulls may benefit on the population level from this increase in supplemental food supplies while other species, like kittiwakes and murres, experience an adverse effect from increased predation pressure from the large gulls. The net beneficial or adverse effects of fishery wastes to the different species in this group are unknown.

Although trawl effort is predicted to increase by 25 percent under FMP 2.2, the attendant increase in bycatch of forage fish and pelagic invertebrates is not expected to affect prey availability enough to cause population level effects on piscivores (see Sections 4.6.4 and 4.6.10). The existing ban on the development of a directed forage fish fishery would remain in effect under FMP 2.2. The overall effect of FMP 2.2 on the availability of food for piscivorous species is therefore considered insignificant on the population level.

Benthic Habitat

Trawl effort in the BSAI/GOA is predicted to increase by 25 percent under FMP 2.2 relative to the baseline condition. This level of increase is not expected to produce a substantial change in the nature or intensity of trawl impacts relative to the baseline. The effect of FMP 2.2 on benthic habitat important to piscivorous seabirds is therefore considered insignificant.

Cumulative Effects of FMP 2.2

The only factors of the cumulative effects analysis for FMP 2.2 that would vary from those described above for FMP 2.1 are the contributions of the groundfish fishery. The contributions of the fishery to direct mortality, prey availability, and benthic habitat are all considered insignificant at the population level under FMP 2.2. Since the combination of past events have not resulted in population level effects, and no foreseeable future events are likely to change the situation, the cumulative effects of mortality, prey availability, and benthic habitat under FMP 2.2 are considered insignificant (Table 4.5-57).

4.6.7.7 Other Planktivorous Species (Storm-Petrels and Most Auklets)

Direct/Indirect Effects of FMP 2.1 and 2.2

Incidental Take

As described in Section 4.5.7.6, the incidental take of planktivorous species is very small under the baseline conditions relative to their abundance in the BSAI/GOA. Under FMP 2.1 and FMP 2.2, trawl effort would increase while longline effort is predicted to remain similar to the baseline level. Since very few storm-petrels or auklets are taken in either the longline or trawl fisheries, the predicted changes in fishing effort would be unlikely to result in substantial changes in take from the baseline conditions. The increased trawl effort could lead to an increase in bird mortality from vessel strikes, but it is unlikely that this would have population level effects given the infrequent nature of the events and relatively small numbers of birds involved (Section 4.5.7.6). The overall effect of FMP 2.1 or FMP 2.2 on the incidental take of planktivorous species is therefore considered insignificant at the population level.

Changes in Food Availability

The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch under FMP 2.1 and FMP 2.2. FMP 2.1 would also remove the ban on development of directed forage fish fisheries. Although it is not known whether such a fishery would actually develop or what its structure and intensity would be, it would likely take a higher rate of seabird prey as bycatch than other target fisheries. However, it is unlikely that a forage fish fishery would have more than a negligible effect on the availability of prey to planktivorous seabirds.

One potential connection between the groundfish fishery and the abundance of planktonic prey for these seabird species is described in Section 4.5.7.6. The groundfish fisheries could indirectly affect the availability of zooplankton and small schooling fish to seabirds through changes in the abundance and distribution of target fish species that also prey on small fish and zooplankton. For example, since young pollock are planktivores, it could be argued that changes in fishery management that led to decreased abundance of pollock populations (e.g., greater fishing effort) would decrease competition for prey and hence improve the carrying capacity for storm-petrels and auklets. However, zooplankton and juvenile fish abundance and distribution are thought to be influenced much more by primary productivity and oceanographic fluctuations than predator/prey relationships (see 3.7.1). The effects of the fisheries on prey availability for planktivorous seabird species, as managed under FMP 2.1 or FMP 2.2, are therefore expected to be insignificant on the population level for these seabird species.

Benthic Habitat

Storm-petrels and auklets are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 2.1 or FMP 2.2. Therefore, both FMPs are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on the species in this group are described in Sections 3.7.7 and 3.7.18 (Tables 3.7-15 and 3.7-27) and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-58 and summarized below.

Mortality

- **Direct/Indirect Effects.** Although incidental take of alcids is expected to increase due to increased trawl effort, the incidental take of all species in this group is expected to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in foreign and U.S. coastal and pelagic fisheries, oil spills and other marine pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are therefore considered insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** FMP 2.1 would remove the ban on development of directed forage fish fisheries. Although it is not known whether such a fishery would actually develop or what its structure and intensity would be, it would likely take a higher rate of seabird prey as bycatch than other target fisheries. However, it is considered unlikely that a forage fish fishery would have more than a negligible effect on the availability of prey to planktivorous seabirds. Indirect effects on zooplankton and juvenile fish abundance through changes in the abundance of target fish predators is considered minor compared to seasonal changes in primary productivity and oceanographic factors. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group.

- **Persistent Past Effects.** Factors that have affected the abundance and distribution of zooplankton and juvenile fish include bycatch in squid and forage fish fisheries, marine pollution, and the decimation of planktivorous whales by commercial whaling. These effects are considered minor compared to seasonal and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have minimal effects on prey availability for these species. Pollution is also likely to affect prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute in an indirect way to human influences on planktonic prey availability, which are considered minimal compared to natural fluctuations. These cumulative effects are considered insignificant on the population level for all species in this group.

Benthic Habitat

Since these planktivorous seabirds feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effects are identified for these species.

4.6.7.8 Spectacled Eiders and Steller's Eiders

Direct/Indirect Effects of FMP 2.1 and 2.2

Incidental Take

Spectacled eiders interact very little, if at all, with the groundfish fisheries under the baseline conditions (see Section 4.5.7.7). There are no changes in the fishery under FMP 2.1 or FMP 2.2 that would be expected to affect this situation. The groundfish fisheries are therefore expected to have incidental take of spectacled eiders approaching zero under FMP 2.1 and FMP 2.2.

Steller's eider have very little overlap between their foraging areas and the groundfish fisheries, and have thus been taken very rarely under the baseline conditions (see Section 4.5.7.7). In the one area that overlaps with the groundfish fishery, Kuskokwim Shoals, the fishery has not been restricted in the past but has been limited by its distance from ports of delivery and lack of interest by the fleet. An increase in the overall TAC is therefore not likely to lead to a proportional increase in effort in Kuskokwim Shoals. Incidental take of Steller's eider is therefore expected to continue to be very rare under FMP 2.1 and FMP 2.2, and is considered to have insignificant effects on their population levels.

Changes in Food Availability

The groundfish fisheries are not expected to overlap in space or time with spectacled eider critical habitat under FMP 2.1 or FMP 2.2. Therefore, no effects on spectacled eider food availability have been identified. Since there would be very little overlap between groundfish fisheries and critical habitat for Steller's eiders under FMP 2.1 or 2.2, the effects of the groundfish fisheries on prey abundance and availability are considered insignificant at the population level.

Benthic Habitat

As discussed in Section 4.5.7.7, there has been no overlap between the groundfish trawl fisheries and spectacled eider habitat. Neither FMP 2.1 nor FMP 2.2 are expected to change this situation, and are therefore considered to have no effects on spectacled eiders through benthic habitat changes.

For Steller's eiders, potential trawl effort in their critical habitat is limited to Kuskokwim Bay. Since the fishery in this area is not restricted under the baseline conditions and has been apparently limited only by lack of interest from the fleet, no changes in management under FMP 2.1 or FMP 2.2 would promote an increase use of this area. Potential effects are therefore likely to remain similar to the baseline condition and are considered insignificant.

Cumulative Effects of FMP 2.1 and FMP 2.2

The past/present effects on spectacled and Steller's eiders are described in Sections 3.7.9 and 3.7.10 (Tables 3.7-17 and 3.7-18) and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-59 and summarized below.

Mortality

- **Direct/Indirect Effects.** Although incidental take of diving seabirds is expected to increase under FMP 2.1 and FMP 2.2 due to a major increase in trawl effort, this additional fishing is not expected to take place in areas important to eiders. Incidental take of spectacled eider is predicted to remain at or near zero. Incidental take of Steller's eider is expected to be very rare under FMP 2.1 and FMP 2.2, and is therefore considered to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include sport hunting and subsistence harvest in Russia and Alaska, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution that causes physiological stress and reduces survival rates, lead shot poisoning on the nesting grounds, and collisions with vessels and other structures. Incidental take in the BSAI/GOA groundfish fisheries appears to have been very rare for Steller's eider. Both species have been afforded protection through the ESA.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. Conservation concerns focus on preventing potential impacts in critical habitat areas.

- **Cumulative Effects.** The groundfish fisheries do not contribute to direct mortality of spectacled eiders, so no cumulative effect is identified for that species. Decreased adult survival rates appear to have driven the past population decline of Steller's eiders. Known sources of direct human-caused mortality of Steller's eider, including very rare incidental take in the groundfish fisheries, do not appear to account for the past population decline in Alaska. However, several indirect factors may be contributing to decreased adult survival rates, including climate-induced changes in habitat, concentration of predators around nesting areas due to nearby human habitation, and pollution of nearshore waters from chronic and periodic sources of petroleum products (USFWS 2003a). Since the Alaska breeding population of Steller's eiders has declined dramatically in the past and has not recovered, and because several human-induced sources of mortality have been identified as potential contributing factors to this decline, including the potential for contributions to pollution and vessel collisions from the groundfish fisheries as managed under FMP 2.1 and FMP 2.2, the cumulative effects of mortality on Steller's eiders are considered significant adverse at the population level.

Changes in Food Availability

The abundance of marine invertebrate species important to Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. Although other factors external to the fisheries may influence the abundance and distribution of eider prey, the groundfish fisheries only contribute minimally to these potential effects. Therefore, an insignificant cumulative effect on prey availability is identified for Steller’s eiders. There is no overlap predicted between the groundfish fisheries and spectacled eider critical habitat, therefore, no cumulative effect has been identified for spectacled eider food availability.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, disrupt benthic habitats that support the prey of eiders. Under FMP 2.1 and FMP 2.2, the groundfish fishery is not expected to occur in spectacled eider critical habitat or any other area that they typically use. A limited amount of bottom trawling is expected to overlap with Steller’s eider critical habitat. The overall effects of FMP 2.1 and FMP 2.2 on Steller’s eiders through potential changes in benthic habitat are considered insignificant at the population level.

- **Persistent Past Effects.** Benthic habitats important to spectacled and Steller’s eiders have been affected by various trawl and pot fisheries for many years, and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to eiders. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may also have persistent effects in certain areas. Climate change and ocean temperature fluctuations may also play a role in altering the benthic environment.

- **Reasonably Foreseeable Future External Effects.** All future fisheries that use bottom contact fishing gear in areas used by eiders are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will also continue.

- **Cumulative Effects.** There is no overlap predicted between spectacled eider critical habitat and the groundfish fisheries under FMP 2.1 and FMP 2.2, therefore no cumulative effect on benthic habitat has been identified for this species. While the groundfish fisheries are predicted to have little spatial overlap with Steller’s eider habitat under FMP 2.1 or FMP 2.2, the interaction of human-caused and natural disturbances of benthic habitat important to Steller’s eiders has not been examined with respect to their population declines in the past. The cumulative effects of benthic habitat disruptions over the years as they relate to the food web important to eiders are therefore considered to be unknown.

4.6.8 Marine Mammals Alternative 2 Analysis

4.6.8.1 Western Distinct Population Segment of Steller Sea Lions

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

The analysis used to determine changes in the level of incidental takes described in Section 4.5.8 was applied to establish the significance of incidental take and entanglement of marine mammals expected to occur under FMP 2.1. With regard to incidental take, FMP 2.1 is not likely to result in significant changes to the population trajectory of the western distinct population segment (western population) of Steller sea lions. An average of 8.4 Steller sea lions from the western population was estimated to have been taken incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al.* 2001) (Table 4.5-60). The ratio of observed takes of Steller sea lions to observed groundfish catch (from 1995 to 1999) was multiplied by the new projected groundfish catch (all fisheries combined) to estimate incidental takes expected to occur over the next six years under this FMP. The estimated annual incidental take of Steller sea lions under FMP 2.1 in all areas combined is expected to be less than 14 based on expected catch under FMP 2.1, or about one sea lion per 220,000 mt of groundfish harvested.

The MMPA requires NOAA Fisheries (NMFS Office of Protected Resources) to assess whether human-caused mortality threatens the stability or recovery of any species of marine mammal. The MMPA defines a measurement tool for this purpose, the PBR, that is a calculated value of the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. This calculation takes into consideration the most recent population estimates, historic population trends, status of the stock in relation to historic levels (i.e., whether it is depressed or not), and potential rates of recovery. According to the most recent stock assessment, PBR for the western population of Steller sea lions is 208 animals per year (Angliss and Lodge 2002). Mortality from incidental take and entanglement in marine debris is likely to continue under FMP 2.1 at levels that are small (less than 10%) relative to PBR and is therefore considered insignificant according to the criteria set for significance (Table 4.1-6).

Fisheries Harvest of Prey Species

Changes in the fishing mortality rate for Steller sea lion prey species were calculated using output from the targeted species model which projected catch rates for the various FMPs. The estimated fishing mortality rates expected to occur under each FMP were compared to the baseline fishing mortality rate in order to apply the significance criteria established in Table 4.1-6 for determining the effects on marine mammal populations. The baseline fishing mortality rates for the individual BSAI and GOA groundfish fisheries, the fishing mortality rates projected to occur under each FMP, and the relative difference between the baseline and alternative fishing mortality rates are shown in Table 4.5-61.

Under FMP 2.1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 140 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key Steller sea lion prey species is rated significantly adverse. It is worth noting that the harvest rate of pollock in the EBS was particularly low in 2002. Due to the high abundance of EBS pollock in recent years, model predictions project a decreased pollock catch corresponding with an increasing F in subsequent years under FMP 2.1. The harvest of EBS pollock under FMP 2.1 meets the criteria of a significantly adverse impact to Steller sea lions.

The fishing mortality rate of GOA pollock is expected to increase by an average of 100 percent relative to the comparative baseline over the next five years under FMP 2.1. This change in F is significant at the population level for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline conditions. FMP 2.1 allows for the recommencement of an Aleutian Islands pollock fishery and would result in changes to the fishing mortality rate that would be rated as significantly adverse under the criteria established in Table 4.1-6.

Under FMP 2.1, the BSAI Pacific cod fishing mortality rate is expected to increase by 79 percent. This change is determined to be significantly adverse to Steller sea lions according to the criteria established in Table 4.1-6. Under FMP 2.1, the GOA Pacific cod fishing mortality rate is expected to increase by 64 percent. This change is determined to be significantly adverse to Steller sea lions. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to Steller sea lions with a 124 percent increase in F under FMP 2.1 relative to the baseline.

Little difference is expected relative to the baseline and among FMPs for harvest of other, non-target species that are prey for Steller sea lions (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 2.1 is expected to result in population level effects that are, therefore, significantly adverse to Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The spatial/temporal measures for Steller sea lions in FMP 1 (and retained throughout all of the FMPs) were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for Other Species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where Steller sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as “global controls.” Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the western population of Steller sea lions.

Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of environmental components other than with the objective to protect Steller sea lions are repealed. Opening up these areas reduces the protection of prey resources in nearshore areas which have been shown to be used by foraging Steller sea lions. Such openings could plausibly result in adverse impacts to Steller sea lions due to removal of fish in these areas where harvest did not occur under the baseline condition. Significantly higher harvest levels of Steller sea lion prey species are expected to result under FMP 2.1, which would increase the potential for competitive interactions with Steller sea lions in offshore foraging areas where Steller sea lion/fishery interactions are reduced through lower overall harvest limits under the baseline condition. Thus the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are determined to be significantly adverse to the western population of Steller sea lions.

Disturbance

FMP 2.1 repeals closure areas established for the protection of environmental components other than Steller sea lions such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Increased harvest levels expected to occur under FMP 2.1 may result in increased disturbance to Steller sea lions. Disturbance to Steller sea lions may increase due to the increase in the amount of fishable area coupled with increases in TAC. The level of increased disturbance to Steller sea lions, though likely, cannot be estimated, and is therefore determined to result in conditionally significantly adverse effects if disturbance were to increase to a level where population level effects would be a likely result.

Cumulative Effects

The past/present effects on the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above (Table 4.6-5). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.6-1).

Mortality

- **Direct/Indirect Effects.** The estimated annual incidental take of Steller sea lions under FMP 2.1 in all areas of the BSAI and GOA combined is expected to be less than 14 based on expected catch under this FMP. Therefore, mortality from incidental take and entanglement in marine debris under FMP 2.1 is considered insignificant.

- **Persistent Past Effects.** Substantial mortality of Steller sea lions did not occur in the fisheries until after the 1950s. The take of Steller sea lions was substantial after this time with over 20,000 animals believed to have been incidentally killed in the foreign and JV groundfish fisheries from 1966 to 1988, although data from this period are not complete (Perez and Loughlin 1991). In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 per year in the early 1990s to an average of 7.8 sea lions per year from 1996 to 2000. The number of Steller sea lions incidentally taken in state-managed nearshore salmon gillnet fisheries and halibut longline fisheries is estimated at 14.5 sea lions per year in the PWS drift gillnet fisheries (Wynne *et al.* 1992). It is thought that shooting used to be a significant source of mortality prior listing the Steller sea lion as endangered under the ESA. Two cases of illegal shooting were prosecuted in the Kodiak area in 1998 involving two Steller sea lions from the western stock (Angliss *et al.* 2001). The subsistence harvest of the western population has decreased over the last ten years from 547 to 171 animals per year (1992-1998) (Angliss and Lodge 2002). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). Predation by transient killer whales and sharks has always contributed to the natural mortality of Steller sea lions but the numbers of sea lions taken and the relative contribution of this factor to the recent population decline and lack of recovery is currently under investigation (Matkin *et al.* 2001, Matkin *et al.* 2003, Springer *et al.* 2003).

- **Reasonable Foreseeable Future Effects.** Incidental take in the State-managed fisheries such as salmon gillnet fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely be relatively low (fewer than 10 per year). Entanglement in fishing gear and intentional shootings would also be expected to continue at a level similar to the baseline condition. Predation will continue to contribute to natural mortality but climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** Effects of mortality are based on the contribution of the internal effects of the groundfish fishery and external mortality. These effects are considered significantly adverse since the overall human-caused mortality exceeds the PBR for this population and the species is listed as endangered under the ESA due to the severe decline of the species. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and, under the baseline conditions, has been considered to not cause jeopardy under the ESA (NMFS 2001a).

<u>Prey Availability</u>

- **Direct/Indirect Effects.** The combined harvest of Steller sea lion prey species under FMP 2.1 is expected to result in significantly adverse population level effects to Steller sea lions.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in State waters, and partial overlap with other State-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s and one hypothesis is that the combined fisheries, perhaps in conjunction with climate and oceanographic fluctuations, greatly reduced the availability of forage fish to Steller sea lions. NMFS issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of Steller sea lion populations or causing adverse impacts to their critical habitat but most of the focus was on the western population. The most recent BiOp and EIS (NMFS 2001b and 2001c) explores this subject in great depth.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a generally similar manner to the baseline conditions. New fisheries in State or Federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects of availability of prey but the direction or magnitude of these changes is difficult to predict. Climate-induced change has been suspected in the decline of the western population Steller sea lion.

- **Cumulative Effects.** Effects on prey availability were found to be cumulative based on both internal and external effects on prey. Based on significantly adverse internal effects on prey availability under this FMP, when added to the past effects from foreign, JV, and domestic groundfish fisheries, and the state-managed salmon and herring fisheries, the cumulative effect is considered significantly adverse.

Spatial/Temporal Effects of Harvest

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of other environmental components would be reopened to fishing. Therefore, the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are determined to be significantly adverse to the western population of Steller sea lions.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of the Steller sea lion protection measures, which remain in effect under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** The only reasonably foreseeable future factors external to the groundfish fisheries that affect the spatial/temporal harvest of Steller sea lion prey would be the state-managed salmon and herring fisheries, which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to continue to be managed in a similar manner to recent years. No new state or federal fisheries are anticipated at this time.

- **Cumulative Effects.** Effects of the spatial/temporal harvest of prey were based on both internal effects of the FMP, external effects of the groundfish fishery, and state-managed fisheries and future fisheries. The cumulative effect is considered significantly adverse based on the significantly adverse internal effects of FMP 2.1 on spatial temporal harvest of prey with the additional external effects.

Disturbance

- **Direct/Indirect Effects.** Although increased disturbance to Steller sea lions is likely, the level of that disturbance cannot be estimated and therefore, results in conditionally significant adverse effects; conditional on whether disturbance would result in population level effects.

- **Persistent Past Effects.** Past effects of disturbance were identified from foreign, JV, and domestic groundfish fisheries in the BSAI and GOA and state-managed fisheries. Past disturbances were also identified from commercial harvest, intentional shooting and subsistence harvest. General vessel traffic and disturbance to prey fields from gear have also regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects.** Future disturbance was identified for state-managed salmon and herring fisheries as well as general fishing and non-fishing vessel traffic in Steller Sea lion foraging areas. Subsistence harvest was also identified as a continuing source of disturbance to Steller sea lions. Levels of external disturbance are expected to be similar to baseline conditions.

- **Cumulative Effects.** Disturbance to Steller sea lions is from both internal and external effects and is considered conditionally significant adverse. This determination is conditional on the actual location and timing of additional disturbance and whether it could increase over baseline conditions to a level where population-level effects occur.

Direct/Indirect Effects FMP 2.2

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under FMP 2.1 and are considered insignificant.

Fisheries Harvest of Prey Species

Under FMP 2.2, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 69 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in the harvest of this key Steller sea lion prey species is rated significant. Please see the discussion regarding the unusually low fishing mortality rate in 2002 (which served as the comparative baseline) in Section 4.5.8.1. The harvest of EBS pollock under FMP 2.2 management regime meets the criteria of a significantly adverse impact to Steller sea lions.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 13 percent under FMP 2.2. This change in F is insignificant under the FMP 2.2 scenario at the population level for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there is no directed Aleutian Islands pollock fishery under the baseline condition. There is no change in the projected catch of Aleutian Islands pollock between the baseline and FMP 2.2 and therefore effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level.

Under FMP 2.2, the BSAI Pacific cod fishing mortality rate is expected to increase by 28 percent which is considered significantly adverse to Steller sea lions according to the criteria established in Table 4.6-1. The GOA Pacific cod fishing mortality rate is expected to increase by 19 percent under the FMP 2.2 scenario which was determined to be insignificant to Steller sea lions at the population-level. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to Steller sea lions with a 64 percent increase in F under alternative FMP 2.2 relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions.

Ratings for harvest of individual prey species range from insignificant to significantly adverse. The combined harvest of Steller sea lion prey species under FMP 2.2 is rated significantly adverse overall (Table 4.6-5) as there are more prey species that will be adversely affected than those that will not and the overall effect on prey is likely to have population-level effects on the western population of Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 2.2 are rated insignificant to Steller sea lions as they do not deviate from the spatial/temporal measures under the baseline conditions.

Disturbance

FMP 2.2 retains the area closures contained in the comparative baseline. Disturbance of Steller sea lions under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore rated insignificant.

Cumulative Effects

The past/present effects on the western population of Steller sea lions are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.2 are described above (Table 4.6-5). The effects considered in this analysis are listed in Table 4.6-5. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Effects of incidental take and entanglement under FMP 2.2 for the western population of the Steller sea lion are insignificant as discussed under FMP 2.1.

- **Persistent Past Effects.** Persistent past effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of mortality on the western population of the Steller sea lion are significantly adverse as described under FMP 2.1.

Prey Availability

- **Direct/Indirect Effects.** Effects on prey availability under FMP 2.2 for the western population of the Steller sea lion would be significantly adverse as discussed under FMP 2.1.

- **Persistent Past Effects.** Persistent past effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of prey availability on the western population of the Steller sea lion are significantly adverse as described under FMP 2.1.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey is based on past and future effects of the groundfish fisheries and State-managed fisheries and is considered conditionally significant adverse. Although there are several hypotheses regarding the decline and lack of recovery of Steller sea lions, localized depletion of prey due to commercial fishing is a plausible mechanism for population level effects. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine to cause localized depletion of prey in key areas such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the western population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** Disturbance to Steller sea lions both internal and external effects is considered insignificant because it is similar to the baseline condition, and population-level effects are unlikely.

4.6.8.2 Eastern Distinct Population Segment of Steller Sea Lions

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 2.1 is not likely to result in significant changes to the population trajectory of the eastern distinct population segment (eastern population) of Steller sea lions. No Steller sea lions from the eastern population have been taken incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al.* 2001) (Table 4.5-60). In this context, incidental take refers to animals which are deceased or have injuries that are expected to result in the death of the animal. Because no animals from the eastern population have been taken incidental to groundfish fisheries under the baseline conditions, increases in fishing effort under FMP 2.1 are not expected to result in a substantial increase in the level of incidental takes.

Entanglement of Steller sea lions from the eastern population in derelict fishing gear or other materials seems to occur at frequencies that do not have significant effects upon or represent a significant threat to the population. In conclusion, incidental take and entanglement in marine debris under FMP 2.1 are expected to be similar to the baseline conditions and are considered insignificant according to the criteria set for significance (Table 4.1-6).

Fisheries Harvest of Prey Species

The BSAI groundfish fisheries are not likely to have large impacts on prey availability for the eastern population of Steller sea lions as there is little overlap between this population and fisheries that harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to have an effect on the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock and Pacific cod under FMP 2.1 are expected to increase by 100 percent and 64 percent, respectively, relative to the comparative baseline over the next five years. The changes in the fishing mortality rates expected to occur under FMP 2.1 are rated significantly adverse at the population level for the eastern population of Steller sea lions.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species in the GOA under FMP 2.1 is expected to result in significantly adverse population level effects on the eastern population of Steller sea lions (Table 4.6-5).

Spatial/Temporal Concentration of the Fishery

The criteria used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations assume that the FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population level effects would occur. The spatial/temporal measures under the baseline conditions were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Under the baseline condition, groundfish fisheries have been dispersed in time and space such that the competitive interactions with Steller sea lions are thought to be mitigated to an insignificant level. Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of environmental components other than Steller sea lions are repealed. Opening up these areas reduces the protection of prey resources in nearshore areas that have been shown to be used by foraging Steller sea lions and could plausibly result in adverse impacts to Steller sea lions due to removal of fish in these areas where harvest did not occur under the baseline condition. Thus, the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are determined to be conditionally significant adverse to Steller sea lions, contingent on the actual concentration of the fisheries reducing prey to a level that results in a population-level effect.

Disturbance

FMP 2.1 repeals closure areas established for the protection of environmental components other than Steller sea lions such as the Pribiliof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. The area that is of specific concern for the eastern population of Steller sea lions under FMP 2.1 is the trawl exclusion zone in the eastern GOA which would be open to trawling under this FMP. Disturbance of the eastern population of Steller sea lions is expected to increase under the FMP 2.1 management regime if trawling activity occurs in this previously closed area. Catch of fishery target species is also projected to increase under FMP 2.1 relative to the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase above the baseline conditions to the level that population level effects could occur and is therefore determined to be conditionally significant adverse to the eastern population of Steller sea lions.

Cumulative Effects

The past/present effects on the eastern population of the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1are described above (Table 4.6-5). The effects considered in this analysis are listed in Table 4.6-5. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.6-1).

Mortality

- **Direct/Indirect Effect.** With regard to incidental take and entanglement, FMP 2.1 is not likely to result in significant changes to the population trajectory of the eastern population of Steller sea lions, and is therefore considered insignificant.

- **Persistent Past Effects.** It is thought that shooting used to be a significant source of mortality prior to listing the Steller sea lion as "threatened" under the ESA. NMFS Alaska Enforcement Division has successfully prosecuted two cases of illegal shooting involving four sea lions from the eastern population (Angliss *et al.* 2001). It is not known to what extent illegal shooting continues in the eastern population but stranding of sea lions with bullet holes still occurs. Predator control programs associated with mariculture facilities in British Columbia account for a mean of 44 animals killed per year from the eastern population (Angliss and Lodge 2002). The subsistence harvest of the eastern population is subject to an average of only two sea lions taken per year from southeast Alaska (1992 to 1997) (Angliss *et al.* 2001). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). The proportion of these from the eastern population of Steller sea lions is unknown. Intentional shooting of Steller sea lions, other than in subsistence hunts, became illegal after the species was listed as threatened under the ESA in 1990. It is thought that shooting was a significant source of mortality prior to that time. Steller sea lions are incidentally taken in low numbers by commercial fisheries other than groundfish fisheries, including some state-managed salmon drift and set gillnet fisheries, and the salmon troll fishery in southeast Alaska (mean of 1.25 and 0.2 respectively) (Angliss and Lodge 2002). Small numbers of Steller sea lions from the eastern population are also taken outside of southeast Alaska in groundfish fisheries (0.45 per year in Washington, Oregon, and California) and set gillnet fisheries in Northern Washington state (0.2 per year) (Angliss and Lodge 2002). The PBR for this population is 1,396 and current human caused mortality is 45.5, substantially less than 10 percent of the PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillnet and troll fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely be relatively low (<10 per year). Groundfish fisheries in Washington, Oregon and California and salmon set gillnet fisheries will continue to take small numbers from this population. Entanglement and intentional shootings would also be expected to continue. Pollution is likely more of a factor for this population due to its proximity to human population centers. Climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** Effects of mortality are based on the contribution of internal effect of the groundfish fishery and external mortality effects. These effects are considered insignificant since the overall human-caused mortality does not exceed the PBR for this population. Although this population is listed as threatened under the ESA, this population has been increasing over the last 20 years. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and has been determined to not cause jeopardy under the ESA (NMFS 2001a).

Effects of Prey Availability

- **Direct/Indirect Effect.** Due to major increases in the projected harvest of target and non-target species under FMP 2.1, the effect on prey availability was determined to be significantly adverse to Steller sea lions.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in state waters, and partial overlap with other state-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a similar manner to the baseline condition. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects on availability of prey but the direction or magnitude of these changes is difficult to predict. Climate induced change has been suspected in the decline of the western population Steller sea lion, but effects of climate change or regime shifts on the eastern population of the Steller sea lion are largely unknown.

- **Cumulative Effects.** Effects on prey availability were found to be cumulative based on both internal and external effects on prey. The significantly adverse contribution of the groundfish fishery under FMP 2.1 may or may not lead to adverse population level effects, conditional on whether future food availability limits population growth. The cumulative effect is thus considered conditionally significant adverse.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of other environmental components would be reopened to fishing. The effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are determined to be conditionally significant adverse to the eastern population of Steller sea lions.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring.

Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of the Steller sea lion protection measures, which remain in effect under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** The only reasonably foreseeable future factors external to the groundfish fisheries that affect the spatial/temporal harvest of Steller sea lion prey would be the state-managed salmon and herring fisheries, which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to continue to be managed in a similar manner to recent years. No new state or federal fisheries are anticipated at this time.

- **Cumulative Effects.** Cumulative effects of the spatial/temporal harvest of prey from both internal effects of the groundfish fishery and state-managed fisheries would be substantially greater than the baseline condition and are considered conditionally significant adverse. This rating is conditional on whether the combined spatial/temporal patterns of prey removal from all fisheries in the range of the eastern population of Steller sea lions actually creates localized depletion of prey such that adverse population level effects occur.

Disturbance

- **Direct/Indirect Effects.** Disturbance of Steller sea lions under FMP 2.1 may increase substantially above the baseline conditions and is therefore determined to be conditionally significant adverse. This rating is conditional on whether changes in disturbance patterns would actually result in population level effects.

- **Persistent Past Effects.** Past effects of disturbance were identified from foreign, JV, and domestic groundfish fisheries in the BSAI and GOA and State-managed fisheries. Past disturbances were also identified from commercial harvest, intentional shooting and subsistence harvest. General vessel traffic and disturbance to prey fields from gear have also regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects.** Future disturbance was identified for state-managed salmon and herring fisheries as well as general fishing and non-fishing vessel traffic in Steller Sea lion foraging areas. Subsistence harvest was also identified as a continuing source of disturbance to Steller sea lions. Levels of external disturbance are expected to be similar to baseline conditions.

- **Cumulative Effects.** The cumulative effects of disturbance to the eastern population of Steller sea lions from both internal and external effects are considered conditionally significant adverse, conditional on location and time period of additional disturbance and whether it would result in population-level effects.

Direct/Indirect Effects FMP 2.2

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under FMP 2.1 and are considered insignificant.

Fisheries Harvest of Prey Species

Average fishing mortality rates of GOA pollock under FMP 2.2 are expected to decrease by 13 percent relative to the comparative baseline over the next five years. Average fishing mortality rates of GOA Pacific cod under FMP 2.2 are expected to increase by 19 percent relative to the comparative baseline over the next five years. The changes in the fishing mortality rates expected to occur under FMP 2.2 are insignificant relative to the baseline for GOA pollock and Pacific cod harvests.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 2.2 is expected to be similar to the baseline condition and to insignificant effects on the eastern population of Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant to Steller sea lions as they do not deviate from the spatial/temporal measures under the baseline condition.

Disturbance

FMP 2.2 retains the area closures set forth under the baseline. Disturbance of Steller sea lions under the 2.2 management regime is not expected to increase relative to the baseline and is therefore rated insignificant.

Cumulative Effects

The past/present effects on the eastern population of Steller sea lions in southeast Alaska are described in Section 3.8.1 (Table 3.8-1). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Effects of incidental take and entanglement under FMP 2.2 for the eastern population of the Steller sea lion would be insignificant.

- **Persistent Past Effects.** Persistent past effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of mortality on the eastern population of the Steller sea lion would be insignificant, as described under FMP 2.1.

Prey Availability

- **Direct/Indirect Effects.** The combined harvest of Steller sea lion prey species under FMP 2.2 is expected to result in insignificant population-level effects on Steller sea lions.

- **Persistent Past Effects.** Persistent past effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** Effects on prey availability are based on both internal and external effects on prey but since the eastern population has been increasing over the last 20 years, the availability of prey is not considered a major issue with this population. The cumulative effects are not expected to result in population-level effects and are considered insignificant for this population in southeast Alaska.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** Cumulative effects of the spatial/temporal concentration of harvest of prey from internal past effects of the groundfish fishery and state-managed fisheries are likely to remain similar to the baseline condition, under which the eastern population has increased steadily, and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the eastern population of the Steller sea lion are the same as described under FMP 2.1.

- **Cumulative Effects.** Disturbance to Steller sea lions from both internal and external effects is considered insignificant because it is similar to the baseline condition, and population-level effects are unlikely.

4.6.8.3 Northern Fur Seals

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, takes and entanglements of northern fur seals expected to occur incidental to groundfish fisheries under FMP 2.1 are not expected to result in population level effects. Increased harvest rates under this management alternative are not large enough for expected take levels to increase relative to the baseline. Therefore, this effect is expected to be insignificant under FMP 2.1.

Fisheries Harvest of Prey Species

Under FMP 2.1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 140 percent relative to the comparative baseline. This change in the harvest of adult pollock, which is a key prey species of northern fur seals in the EBS, is rated significantly adverse. Various nearshore areas that were closed under the baseline conditions would be repealed in FMP 2.1. Opening these nearshore areas could potentially result in a shift in the species and age composition of groundfish harvests such that prey species of northern fur seals would be more susceptible to harvest under this management regime relative to the baseline conditions. Therefore, the harvest of northern fur seal prey species was determined to be conditionally significant adverse. Population level effects are plausible but the rating is conditional on whether the increased level of pollock harvest under FMP 2.1 results in limited prey resources and if the fishery further encroaches into nearshore fur seal foraging areas in the groundfish fisheries.

Spatial/Temporal Concentration of the Fishery

The criterion used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations is that the alternative FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population level effects would be expected to occur. Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of environmental components other than Steller sea lions are repealed. Opening these areas to fishing may reduce the protection of prey resources in nearshore areas that have been shown to be used by foraging northern fur seals and could plausibly result in adverse impacts to northern fur seals due to removal of fish in these areas where harvest did not occur under the baseline conditions. FMP 2.1 is less precautionary for northern fur seals as areas such as the Pribilof Habitat Conservation area would be open to fishing. The effect on northern fur seals of fishing in these areas that were closed under the baseline is unknown. In addition to an overall projected increase in harvest of adult pollock under FMP 2.1, harvest of juvenile target species that are a large portion of the northern fur seal diet may increase if fisheries were to move into these nearshore areas. Such harvests are likely to have a greater effect on the species than harvest under the baseline conditions. Thus the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are rated conditionally significantly adverse to northern fur seals. The rating is conditional based on whether repeal of baseline protection measures actually increases concentration of harvest in fur seal foraging areas and such harvest has population-level effects.

Disturbance

The potential for disturbance effects caused by vessel traffic, fishing gear or noise appears limited for northern fur seals. Kajimura (1984) (in Johnson *et al.* 1989) reported no response by fur seals when approached by ships, and NOAA Fisheries observers onboard Japanese driftnet vessels regularly reported fur seals in close proximity to both the gear and fishing vessels (INPFC reports from the 1980s). Interactions with other types of fishing gear, such as trawl nets, also appear to be limited, based on the rare incidence of takes in groundfish fisheries and limited overlap between northern fur seal prey preferences and fisheries targets.

The FMP 2.1 bookend repeals closure areas established for the protection of environmental components other than Steller sea lions such as the Pribiliof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Disturbance of northern fur seals is expected to increase under the FMP 2.1 management regime if trawling activity occurs in this previously closed area. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to the level that population level effects could occur and is, therefore, determined to be conditionally significant adverse to northern fur seals. The rating is conditional based on whether disturbance increases substantially around fur seal rookeries in the Pribilof Islands and whether it actually causes population-level effects.

Cumulative Effects

A summary of the effects of the past/present with regards to the northern fur seal is presented in Section 3.8.2. (Table 3.8-2). The predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above (Table 4.6-5). Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial/temporal concentration of the fisheries (Table 4.6-5).

Mortality

- **Direct/Indirect Effects.** Under FMP 2.1, effects of incidental take and entanglement are not expected to have population-level effects and are considered insignificant.

- **Persistent Past Effects.** Effects of past mortality on fur seal population include commercial harvest of young males up to 1985, harvest of females between 1956 and 1968, incidental take in the JV fisheries, foreign fisheries, and annual subsistence harvest on the Pribilof Islands. Commercial harvest of fur seals peaked in 1961 with over 126,000 animals but was halted in 1985. The harvest of female fur seal on the Pribilof Islands, as many as 300,000 between 1956 and 1968, likely contributed to the decline of the population in the late 1970s and early 1980s (York and Kozloff 1987). This precipitous decline resulted in its depleted status under the MMPA. Entanglements may have contributed significantly to declining trends of the population during the late 1970's (Fowler 1987). Since the cessation of commercial harvest in 1985, fur seal number have steadily declined (NMFS 1993, Angliss and Lodge 2002). The contribution of the earlier harvest of fur seal to the subsequent declines uncertain since it has been nearly 20 years since commercial harvest was ended. Subsistence harvest have been one of the major contributors to fur seal mortality in recent years. From 1986 to 1996, the average annual subsistence take was 1,605 from St. Paul and St. George

Islands. From 1995 to 2000 this average take dropped to 1,340 seals per year, which represents about 8 percent of the PBR for this species.

- **Reasonably Foreseeable Future External Effects.** These effects include incidental take from foreign fisheries outside the EEZ where fur seals are widely dispersed. State-managed fisheries take small numbers of fur seal including the PWS drift gillnet fishery, Alaska Peninsula and Aleutian Island salmon gillnet fisheries, and the Bristol Bay salmon fisheries (Angliss and Lodge 2002). Subsistence will continue to be a major source of mortality in the future but is limited to the Pribilof Islands, but levels of take are expected to be well below 10 percent of the PBR for this species.

- **Cumulative Effects.** The cumulative effects of mortality from internal and external factors are considered insignificant because the expected levels of take for fur seals would be well below the PBR of this species. The contribution of the groundfish fisheries is very small and approaches zero. Thus, population level effects are not anticipated.

Availability of Prey

- **Direct/Indirect Effects.** The effects of the groundfish fisheries under FMP 2.1 include a substantial increase in the removal of northern fur seal forage. The overall harvest of northern fur seal prey species is rated as conditionally significant adverse.

- **Persistent Past Effects.** Effects of groundfish harvest in the past have likely occurred from overlap of prey species and fish targeted by the foreign and JV fisheries in the BSAI as well as by the State and Federal fisheries. Climate and oceanic fluctuations are also suspected in past changes in the abundance and distribution of prey.

- **Reasonably Foreseeable Future External Effects.** Effects on prey availability for northern fur seal in the future are anticipated to come from a small overlap in prey species with the State-managed salmon and herring fisheries in nearshore areas and effects of climate change/regime shifts on prey species abundance and distribution. Climate effects are largely unknown but could potentially have adverse effects on the availability of prey.

- **Cumulative Effects.** The cumulative effect of prey availability from both the internal contribution of the groundfish fisheries and external effects on prey such as other fisheries and possibly long-term climate change is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Spatial/Temporal Concentration of Harvest

- **Direct/Indirect Effect.** Effects of groundfish fisheries under FMP 2.1 on the spatial/temporal concentration of fisheries harvest are a substantial departure from the baseline conditions and are thus determined to be conditionally significant adverse.

- **Persistent Past Effect.** Effects of past fisheries harvest on prey are primarily from the foreign and JV fisheries and the BSAI state and federal domestic fisheries. There has been concern with regard to displaced/increased fishing effort that encroaches into nearshore areas of the Pribilof Islands and results in increased overlap with fur seal foraging areas. After adoption of measures designed to protect Steller sea lions, the proportion of the total June-October pollock catch in fur seal foraging habitat increased from an average of 40 percent in 1995-1998 to 69 percent in 1999-2000 (NMFS 2001b). There is particular concern for the potential impact of this increased fishing pressure on lactating females from St George Island where catch rates were consistently higher than in areas used by females from St. Paul (Robson *et al.* 2004).

- **Reasonably Foreseeable Future External Effects.** Effects of the spatial/temporal harvest of prey species is primarily from the foreign and Federal domestic fisheries outside the EEZ, due to the extensive range of the fur seals when they are away from their breeding rookeries. State-managed fisheries have very limited overlap with fur seal prey. Climate change was also identified as a potential factor in spatial/temporal effects on prey.

- **Cumulative Effects.** The cumulative effects of the spatial/temporal harvest of prey resulting from internal and external sources are considered conditionally significant adverse. This rating is based on the substantial decline in northern fur seal populations and is conditional on the actual contribution that the harvest of prey species plays in this declining trend.

<u>Disturbance</u>

- **Direct/Indirect Effects.** Levels of disturbance are expected to be substantially greater than those which occurred to northern fur seals under the baseline conditions and could potentially have population-level effects that are expected to be conditionally significant adverse.

- **Persistent Past Effects.** Past disturbance of fur seals includes commercial groundfish fisheries harvest by JV fisheries, foreign and federal domestic fisheries, state-managed fisheries and, to a lesser extent, the subsistence harvest of fur seal on the Pribilof Islands. It is unlikely that disturbance persists as a result of these past activities but the ongoing fisheries do continue to result in some level of disturbance to fur seal while they are in the BSAI region.

- **Reasonablely Foreseeable Future Effects.** Disturbance effects on fur seal were identified from state-managed fisheries, general vessel traffic, and subsistence activities on the Pribilof Islands.

- **Cumulative Effects.** The cumulative effects of disturbance were determined to be conditionally significant adverse based on the conditionally significant internal effects of the fisheries when added to the external human-caused disturbance. This rating is conditional on the increased disturbance occurring in foraging areas important to fur seals and having a population level effect.

Direct/Indirect Effects FMP 2.2

<u>Incidental Take/Entanglement in Marine Debris</u>

Effects do not deviate from those described under FMP 2.1.

Fisheries Harvest of Prey Species

Under FMP 2.2 , the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 69 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, this change in the harvest of adult pollock, which is a key prey species of northern fur seals in the EBS, is rated significantly adverse. Overall, the harvest of northern fur seal prey species was determined to be conditionally significant adverse as population level effects are plausible but the rating is conditional on whether the increased level of pollock harvest projected under FMP 2.2 results in limited prey resources such that fur seals are impacted at the population level.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant to northern fur seals as they do not deviate from the spatial/temporal measures under the baseline conditions. However, effects to northern fur seals from spatial/temporal concentration of the fisheries under the strategy defined as the baseline for this environmental analysis were rated conditionally significant adverse in the Steller sea lion SEIS (NMFS 2001b). Therefore, while the spatial/temporal effects of FMP 2.2 are insignificant relative to the baseline, the baseline has been described as having potential adverse effects on northern fur seals.

Disturbance

Disturbance of northern fur seals under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore considered insignificant.

Cumulative Effects

The past/present effects on the northern fur seal are described in Section 3.8.2 (Table 3.8-2). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6). See Table 4.6-5 for a summary of the cumulative effects under FMP 2.2.

Mortality

- **Direct/Indirect Effects.** Under FMP 2.2, effects of incidental take and entanglement are not expected to have population-level effects and are considered insignificant.

- **Persistent Past Effects.** Persistent past effects on northern fur seals are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on northern fur seals are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of mortality from internal and external factors are considered insignificant because the expected levels of take for fur seals would be below the PBR of this species. The contribution of the groundfish fisheries is very small and approaches zero. Thus, population level effects are not anticipated.

Prey Availability

- **Direct/Indirect Effects.** The combined harvest of northen fur seal prey species under FMP 2.2 is expected to result in conditionally significant adverse population-level effects on northern fur seal.

- **Persistent Past Effects.** Persistent past effects on the northern fur seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the northern fur seal are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of prey availability from the internal contribution of the groundfish fisheries and external effects on prey from other fisheries and possibly long-term climate change are conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the northern fur seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the northern fur seal are the same as described under FMP 2.1.

- **Cumulative Effects.** Cumulative effects of the spatial/temporal harvest of prey from internal and external sources are conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the northern fur seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the northern fur seal are the same as described under FMP 2.1.

- **Cumulative Effects.** Cumulative effects of disturbance to northern fur seals from both internal and external effects are considered insignificant because these effects are similar to the baseline condition and population-level effects are unlikely.

4.6.8.4 Harbor Seals

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, incidental takes and entanglements of harbor seals expected to occur incidental to groundfish fisheries under FMP 2.1 are not expected to result in population level effects. Increased harvest rates under this management alternative may result in the increased take of 2 harbor seals relative to the baseline, for a total estimated average of fewer than 7 animals per year. This level of incidental take would not result in changes to the population trajectory for this species. Therefore, takes and entanglements of harbor seals incidental to groundfish fisheries are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Under FMP 2.1, the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 140 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in the harvest of this key harbor seal prey species is considered to be significant. See the discussion regarding the unusually low fishing mortality rate of EBS pollock in 2002 in Section 4.5.8.1. The harvest of EBS pollock under the FMP 2.1 management regime meets the criteria of a significantly adverse impact to harbor seals.

The fishing mortality rate of GOA pollock is expected to increase by an average of 100 percent under FMP 2.1 relative to the comparative baseline over the next 5 years. The change in F is significant at the population level for harbor seals under the 2.1 scenario. Under Alternative bookend 2.1, the BSAI Pacific cod fishing mortality rate is expected to increase by 79 percent, which is determined to be significantly adverse to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest under FMP 2.1 are expected to be significantly adverse to harbor seals with a 124 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for harbor seals (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to harbor seals. The combined harvest of harbor seal prey species under FMP 2.1 is expected to be substantially above the baseline level and thus result in significantly adverse population level effects.

Spatial/Temporal Concentration of the Fishery

Spatial and temporal fishing measures in FMP 2.1 deviate from the baseline in that closure areas established for the protection of environmental components other than Steller sea lions would be repealed. Spatial partitioning of offshore commercial harvests from the Steller sea lion conservation measures and inshore feeding harbor seals is likely to limit the degree of potential competition with fisheries, although the foraging range of harbor seals may still overlap commercial fishing grounds. Such overlaps exist in regard to the western and GOA harbor seal stocks whereas the southeast Alaska stock of harbor seals overlaps little with federally managed commercial groundfish fisheries (Ferrero *et al.* 2000). However, repealing trawl closure areas in southeast Alaska would be expected to result in increased overlap between groundfish fisheries and the southeast Alaska harbor seal stock. Opening up these areas reduces the protection of prey resources in nearshore areas that have been shown to be used by foraging harbor seals and could plausibly result in adverse impacts to harbor seals due to removal of fish in these areas where harvest did not occur under the baseline conditions. Thus the effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are rated conditionally significantly adverse to harbor seals.

Disturbance

Disturbance of harbor seals is expected to increase under the FMP 2.1 management regime if trawling activity occurs in previously closed areas. Catch of fishery target species is also projected to increase under FMP 2.1 relative to the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to the level that population-level effects could occur and is determined to be conditionally significant adverse to harbor seals.

Cumulative Effects

A summary of the effects of the past/present with regards to the harbor seal is presented in Section 3.8.4. (Table 3.8-4). The predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above (Table 4.6-5). Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Takes and entanglements of harbor seals expected to occur incidental to groundfish fisheries under FMP 2.1 are not expected to result in population level effects, and therefore are considered to be insignificant.

- **Persistent Past Effect.** Residual effect on local populations of State predator control programs (1950s to 1972) and commercial hunts (1963 to 1972) may still occur in some areas although there are no data on these factors. Foreign and JV groundfish fisheries in the 1960s and 1970s have likely contributed to some level of direct harbor seal mortality from entanglement in gear, but based on the near shore distribution of harbor seals, there was likely minimal direct interaction, and mortality is believed to have been very low. From 1990 to 1996, minimum estimates of harbor seals taken incidentally in groundfish gear in the Bering Sea were 4 per year and fewer than 1 per year in the GOA. In southeast Alaska, 4 harbors seals are estimated to be killed each year on longlines. Harvest of harbor seals for subsistence purposes is likely the highest cause of anthropogenic mortality for this species since the cessation of commercial harvests in the early 1970s. Between 1992 and 1998, the state-wide subsistence harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which were taken in southeast Alaska (Wolfe and Hutchinson-Scarbrough 1999). Subsistence harvest of Bering sea stock of harbor seals is approximately 161 animals, 42 percent of PBR for this species. For the GOA stock, the harvest is at approximately 91 percent of the PBR for this stock. For the southeast stock, harvest is at approximately 83 percent of PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take of harbor seal in state-managed fisheries such as salmon gillnet fisheries would be expected to continue at its present low rate. Subsistence take is expected to continue to be the greatest source of human-controlled mortality with a relatively high percentage of the PBR in both the GOA and southeast Alaska stock and a lower take in the BSAI region. Climate change is likely not a factor in the direct mortality of harbor seal although there would likely indirect effects.

- **Cumulative Effects.** The cumulative effects of mortality were determined to be insignificant since the combined contribution between the various sources would continue to be under the PBR for this species.

Availability of Prey

- **Direct/Indirect Effects.** The combined harvest of harbor seal prey species under FMP 2.1 is expected to be much greater than the baseline level and result in significantly adverse effects on prey availability.

- **Persistent Past Effects.** Availability of prey for harbor seal in the past has likely been affected by foreign and JV fisheries, federal domestic groundfish fisheries and state-managed salmon and herring fisheries since the fish targeted by these fisheries are also prey of the harbor seal. Climate change/regime shift could possibly have been a factor in fluctuations in prey availability in the past.

- **Reasonably Foreseeable Future External Effects.** State-managed salmon and herring fisheries are identified as potential adverse effects on harbor seal prey availability. Climate change/regime shift will continued to be a contributing factor although the effects can be either beneficial or adverse, depending on direction and magnitude of the change.

- **Cumulative Effects.** The cumulative effect on prey availability was determined to be significantly adverse based on a significant internal effect and the additional contribution of external effects and is likely to have a population-level effect on harbor seals.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The effects of the spatial/temporal concentration of the fisheries under FMP 2.1 are rated conditionally significantly adverse to harbor seals.

- **Persistent Past Effects.** Effect of groundfish harvest in the past has likely occurred from overlap of harbor seal prey species and fish targeted and areas fished by the foreign and JV fisheries in the BSAI as well as the State and Federal fisheries.

- **Reasonably Foreseeable Future External Effects.** Future effect on spatial/temporal harvest is considered to come from the competitive overlap in prey species with the state-managed fisheries in nearshore areas such as salmon and herring and from climate change/regime shifts on prey species abundance and distribution. Since these fisheries generally occur in the nearshore areas in comparsion to groundfish fisheries, overlap is more pronounced than with the groundfish fisheries.

- **Cumulative Effects.** A cumulative effect of spatial/temporal harvest of prey is identified and rated as conditionally significant adverse, based on the increased level of harvest of harbor seal prey species, fishing areas newly opened, contribution from state-managed fisheries, and conditional on prey being substantially less available and resulting in a population-level effect.

Disturbance

- **Direct/Indirect Effect.** Disturbance of animals under FMP 2.1 may increase to the level that population-level effects could occur and is determined to be conditionally significant adverse to harbor seals.

- **Persistent Past Effects.** Disturbance of harbor seals from past effects include commercial groundfish fisheries harvest by JV fisheries, foreign and federal domestic fisheries and to a lesser extent the subsistence harvest of harbor seals. It is unknown whether these past activities have persistent effects in the present but the ongoing fisheries activities and subsistence do continue to result in some level of disturbance to harbor seal.

- **Reasonablely Foreseeable Future Effects.** State-managed fisheries, general vessel traffic and subsistence activities would continue to create some level of disturbance to harbor seal in the foreseeable future.

- **Cumulative Effects.** A cumulative effect was identified for disturbance from contributions from internal sources and external factors such as other fisheries. However, since fishing effort would increase substantially under FMP 2.1, and the effects of this level of disturbance are not well understood, the cumulative effect on harbor seal is considered conditionally significant adverse, conditional on the actual locations and time period of this new disturbance.

Direct/Indirect Effects FMP 2.2

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under FMP 2.1 and are considered insignificant.

Fisheries Harvest of Prey Species

Under FMP 2.2 , the fishing mortality rate (F) of EBS pollock is expected to increase by an average of 69 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key harbor seal prey species is rated significant. See the discussion regarding the unusually low fishing mortality rate in 2002 (which served as the comparative baseline) in Section 4.5.8.1. The harvest of EBS pollock under the FMP 2.2 management regime meets the criteria of a significantly adverse impact to harbor seals.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 13 percent under the FMP 2.2 bookend relative to the comparative baseline over the next 5 years. The change in F is insignificant at the population level for harbor seals under the FMP scenario. Under FMP 2.2, the BSAI Pacific cod fishing mortality rate is expected to increase by 28 percent, which is determined to be significantly adverse to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest under the FMP 2.2 bookend are expected to be significantly adverse to harbor seals with a 64 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for harbor seals (e.g. cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives was determined to be insignificant to harbor seals. The combined harvest of harbor seal prey species under FMP 2.2 is expected to be substantially greater than the baseline for some species but not for others, leading to a rating of conditionally significantly adverse effect on prey availability. This rating is conditional on whether harvest rates under FMP 2.2 actually deplete harbor seal prey availability to the point that population-level effects occur.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant to harbor seals as they do not deviate from the spatial/temporal measures under the baseline condition and are not likely to cause population level effects.

Disturbance

Disturbance of harbor seals under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore considered to be insignificant.

Cumulative Effects

The past/present effects on the harbor seal are described in Section 3.8.4 (Table 3.8-4). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Takes and entanglements of harbor seals expected to occur under FMP 2.2 are expected to be similar to the baseline level and are considered to be insignificant at the population level.

- **Persistent Past Effects.** Persistent past effects on the harbor seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the harbor seal are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effects of mortality were determined to be insignificant since the combined contribution between the various sources would continue to be under the PBR for this species.

Prey Availability

- **Direct/Indirect Effects.** The combined harvest of harbor seal prey species under FMP 2.2 is expected to result in conditionally significant adverse population-level effects on harbor seals.

- **Persistent Past Effects.** Persistent past effects on the harbor seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on harbor seal are same as described under FMP 2.1.

- **Cumulative Effects.** Effects on prey availability were found to be cumulative based on both internal and external effects on prey from other fisheries and possibly long-term climate change. This cumulative effect is considered conditionally significant adverse based on the internal effects of decreased availability of prey species. This rating is conditional on whether prey availability has played a role in the past population decline of harbor seals and whether future combined harvest rates actually deplete harbor seal prey availability to the point that population-level effects occur.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are similar to the baseline and determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the harbor seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on the harbor seal are the same as described under FMP 2.1.

- **Cumulative Effects.** Cumulative effects on spatial/temporal harvest of prey are rated as conditionally significant adverse based on the increased level of harvest of harbor seal prey species under FMP 2.2 plus a contribution from state-managed fisheries. This rating is conditional on whether past spatial/temporal patterns of prey harvest have played a role in the past population decline of harbor seals and whether future combined harvest patterns actually cause localized depletions of food to the point that population-level effects occur.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the harbor seal are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on harbor seal are the same as described under FMP 2.1.

- **Cumulative Effects.** Disturbance to harbor seal is found to be cumulative based on contributions from both internal and external effects. This effect was considered insignificant because it is similar to the baseline condition and population-level effects are unlikely.

4.6.8.5 Other Pinnipeds

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

Due to the low level of documented interactions between other pinnipeds and groundfish fisheries (see section 4.5.8.5), takes and entanglements of other pinnipeds incidental to groundfish fisheries under FMP 2.1 are expected to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

As stated under FMP 1, the effects of fisheries harvests on ice seal prey species are insignificant under the baseline due to limited overlap with the fisheries, and are not likely to change under any of the alternative regimes. The effects of fisheries harvest on prey species are determined to be insignificant to ice seals under FMP 2.1.

With regard to Pacific walrus, their diet is composed almost exclusively of benthic invertebrates (97 percent), particularly bivalve molluscs. Fish ingestion has been considered incidental to their normal feeding behavior (Fay and Stoker 1982). Groundfish removals would not have a significant effect on walrus populations.

The diet of northern elephant seals in the GOA is unknown; however, the species is known to be a deep diver. This behavior suggests that their foraging may be partitioned by depth from most groundfish fishing activities. The effects of groundfish harvests on prey species for northern elephant seals are determined to be unknown under all of the alternative FMPs.

Spatial/Temporal Concentration of the Fishery

Due to the limited potential for competitive overlap between pinnipeds included in this section and the groundfish fisheries, the spatial/temporal concentrations of the fisheries are expected to be insignificant to marine mammals in this category under all of the alternative FMP scenarios.

Disturbance

FMP 2.1 repeals area closures established for the protection of some of the species in the "other pinnipeds" category (e.g. walrus). The level of disturbance on pinnipeds is expected to increase under the 2.1 management regime. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to a level at which population level effects could occur, especially on walrus as groundfish fisheries would be permitted in the immediate vicinity of important walrus habitat. The effect of disturbance is therefore rated conditionally significantly adverse for "other pinnipeds."

Cumulative Effects

The past/present effects on "other pinnipeds" are described in Section 3.8.3 and Sections 3.8.5 through 3.8.9 (Tables 3.8-3 and 3.8-5 through 3.8-9) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1are described above. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

<u>Mortality</u>

- **Direct/Indirect Effects.** Incidental take and entanglement under FMP 2.1 for species in the "other pinniped" category are considered insignificant.

- **Persistent Past Effects.** Past external effects on the populations of pinniped include low levels of incidental take in the foreign, JV, and domestic groundfish fisheries and low levels of take in the State-managed fisheries. Spotted seal incidental mortality in groundfish fisheries is one per year between 1995 and 1999 (Angliss *et al.* 2001). For bearded seal, the BSAI groundfish fisheries take an average of 0.6 per year. The Bristol Bay salmon drift gillnet fishery from 1990-1993 indicated that 14 mortalities and 31 injuries of bearded seal. No mortalities of ringed seal have been observed in the last ten years in the BSAI groundfish (Angliss *et al.* 2001). For ribbon seal incidental take, the Bering Sea trawl fishery took one in 1990, one in 1991, and one in 1997. An average of 86 elephant seals is taken each year in various gillnet fisheries from California to Washington. Incidental take included one in the Bering Sea trawl fishery reported in 1990, two in the GOA trawl fishery in 1990, and three in the GOA longline fishery in 1990. One juvenile elephant seal, originally misidentified as a bearded seal, was taken in the Bering Sea trawl fishery in 1991 (Angliss *et al.* 2001). Of the 17 Pacific walrus that were caught each year in groundfish trawl fisheries in the EBS between 1990 and 1997, over 80 percent were already decomposed (Gorbics *et al.* 1998). Subsistence is the major human-cause external factor for morality. Subsistence annual harvest rates include 5,265 spotted seal, 6,788 bearded seal, 100 ribbon seal, 9,567 ringed seal, 1,000 walrus and zero elephant seal.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries will likely continue to take very small numbers of seals in this group. Subsistence take of these marine mammals will likely continue at a similar rate to the baseline conditions.

- **Cumulative Effects.** Mortality within the other pinniped group was considered cumulative, based on both internal effects of the groundfish fisheries and external effects such as subsistence harvest. For spotted, ringed, bearded, and ribbon seals, PBRs cannot be calculated. Walrus take is below PBR and population level effects are unlikely. Elephant seal populations are expanding so overall mortality is considered insignificant. Contributions of the groundfish fisheries to overall mortality is very small.

Abundance of Prey

- **Direct/Indirect Effect.** Except for elephant seals, where the amount of prey overlap is unknown, there is very little overlap of species taken in the groundfish fisheries with prey of the pinnipeds in this group and the effects of fisheries harvest on prey species are determined to be insignificant under FMP 2.1.

- **Persistent Past Effects.** Past effects on spotted seal prey include foreign, JV, and domestic groundfish fisheries and State-managed fisheries for salmon and herring. For the ice seals, elephant seals and walrus, no persistent past effects were identified due to minimal overlap with commercial fisheries.

- **Reasonably Foreseeable Future External Effects.** Future effects on the spotted seal were identified from state-managed fisheries. Climate change may be either a beneficial factor or adverse factor for the ice seals, due to the potential effects on the extent of ice cover in the Bering Sea and effect on abundance and distribution of prey.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance of prey for pinnipeds is considered insignificant for all species. Spotted seals have some overlap of prey with the groundfish fisheries but the harvest of prey by the fisheries is not expected to have population level effects. The amount of groundfish fishery overlap with elephant seals is unknown but, since the elephant seal population is expanding, food does not appear to be limiting so cumulative effects on prey availability are considered insignificant. The amount of prey overlap with the other pinniped species is very limited and is considered insignificant for all species in this group.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects**. The spatial/temporal concentrations of the fisheries are expected to be inconsequential to animals in this category under all of the alternative FMP scenarios, and are therefore rated as insignificant.

- **Persistent Past Effects.** Persistent past effects on spotted seal include foreign, JV, and domestic groundfish fisheries and State-fisheries. For Other Species, no persistent past effects are identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries within the range of spotted seal would be expected to be conducted in the future in a manner similar to the baseline conditions. Future effects of spatial/temporal concentration of fisheries on ice seals and walrus would not be expected.

- **Cumulative Effects.** The spatial/temporal concentration of the groundfish fishery and all other fisheries is considered to have an insignificant cumulative effect on pinniped prey due to limited overlap. Population-level effects are unlikely for any of the species in this group.

Disturbance

- **Direct/Indirect Effects.** Increased levels of disturbance from the baseline are expected under the FMP 2.1 and are considered conditionally significant adverse.

- **Persistent Past Effects.** Past sources of disturbance of spotted seals have come from the foreign, JV, and the federal domestic groundfish fisheries in the BSAI and state-managed fisheries for salmon. Overlap of fisheries is minimal for most of species. The primary source of external disturbance to the "other pinniped" category would be related to the subsistence harvest.

- **Reasonably Foreseeable Future.** State-managed fisheries could be expected to continue at a level similar to the baseline conditions. Disturbance from subsistence harvest activities in future years would be expected to be similar to the baseline conditions.

- **Cumulative Effects.** Disturbance was determined to be cumulative based on both internal and external effects. This cumulative effect is found to be conditionally significant adverse, especially for walrus, based on repeal of groundfish area closures and greatly increased fishing activity. This rating is conditional on the location and timing of the expanded fisheries actually causing population-level effects on the different species.

Direct/Indirect Effects FMP 2.2

Incidental Take/Entanglement in Marine Debris

Due to the low level of documented interactions between other pinnipeds and groundfish fisheries, incidental takes and entanglements of other pinnipeds under FMP 2.2 are likely to be similar to the baseline condition and are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Effects do not deviate from those described under 2.1 and are considered insignificant.

Spatial/Temporal Concentration of the Fishery

Effects do not deviate from those described under 2.1 and are considered insignificant.

Disturbance

Disturbance of pinnipeds under FMP 2.2 is not expected to increase relative to the baseline and is therefore considered to be insignificant.

Cumulative Effects

The past/present effects on the other pinnipeds are described in Section 3.8.3 and Sections 3.8.5 through 3.8.9 (Tables 3.8-3 and 3.8-5 through 3.8-9). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Effects of incidental take and entanglement under FMP 2.2 are considered insignificant.

- **Persistent Past Effects.** Persistent past effects on other pinnipeds are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on other pinnipeds are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of mortality on other pinnipeds is the same as described under FMP 2.1 and is considered insignificant.

Prey Availability

- **Direct/Indirect Effects.** Effects on prey availability under FMP 2.2 are considered insignificant.

- **Persistent Past Effects.** Persistent past effects on other pinnipeds are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on other pinnipeds are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of prey availability on other pinnipeds is the same as described under FMP 2.1 and is considered insignificant.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Effects of spatial/temporal concentration of the fisheries under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on other pinnipeds are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on other pinnipeds are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of spatial/temporal concentration of harvest is the same as described under FMP 2.1 and is considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on other pinnipeds are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on other pinnipeds are the same as described under FMP 2.1

- **Cumulative Effects.** Cumulative effects of disturbance on other pinnipeds are likely to be similar to the baseline condition and are therefore considered insignificant and unlikely to have population effects on any species considered.

4.6.8.6 Transient Killer Whales

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

Increased harvest rates under this management alternative may result in the increased take of fewer than one killer whale relative to the baseline (see section 4.5.8.6), for a total estimated average of fewer than 3 animals per year. Most incidental takes in the fisheries are probably resident killer whales since they feed on fish and would be more likely to be drawn to fishing vessels. This level of incidental take would not result in changes to the population trajectory of transient killer whales. Therefore, takes and entanglements of transient killer whales incidental to groundfish fisheries under FMP 2.1 are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The diet of transient killer whales consists of marine mammals. Since the groundfish fisheries are expected to kill very few marine mammals through incidental take under FMP 2.1, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant under FMP 2.1.

Spatial/Temporal Concentration of the Fishery

The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant under FMP 2.1.

Disturbance

FMP 2.1 would result in the repeal of area closures established for the protection of environmental components other than Steller sea lions, such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of marine mammals under FMP 2.1 may increase to the level that population level effects could occur and is, therefore, determined to be conditionally significant adverse to transient killer whales.

Cumulative Effects

The past/present effects on the transient killer whales are described in Section 3.8.22 (Table 3.8-22) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effect.** With regard to incidental take, FMP 2.1 is likely to have insignificant effects on the population trajectory of transient killer whales.

- **Persistent Past Effects.** Mortality has been documented in the JV fisheries, domestic groundfish fisheries, state-managed fisheries, and intentional shootings. Past incidental take in the groundfish fisheries is fewer than two animals per year but it is not known if these animals were transients or residents. In addition to mortalities caused by entanglement, killer whales are also susceptible to injury or mortality through vessel strikes. One killer whale was reported to be killed when it struck the propeller of a BSAI groundfish trawl vessel in 1998 (Angliss and Lodge 2002). The EVOS resulted in the loss of half of the individual killer whales from the AT1 pod in PWS (Matkin *et al.* 1999). This distinct group of whales is being evaluated for recognition as a separate stock and for protection as a depleted stock under the MMPA. Contaminant levels in whales in this group were found to be many times higher than in other killer whales (Makin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Mortality from external factors is identified for other state-managed fisheries, intentional shooting, and marine pollution, particularly bio-accumulating pollutants such as DDT and PCBs (Matkin *et al.* 1999).

- **Cumulative Effects.** Mortality is considered cumulative based on the internal effects of the groundfish fisheries and external effects of other fisheries. The cumulative effects are determined to be insignificant and are unlikely to have population level effects. The exception to this finding is the AT1 transient group in PWS. The cumulative effect of mortality on this group was determined to be significantly adverse due to the past external effects of the EVOS and subsequent population decline.

Prey Availability

- **Direct/Indirect Effects.** Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant.

- **Persistent Past Effects.** Since marine mammals are the primary prey of transient killer whales, all of the factors that have been identified as affecting the abundance or distribution of cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include commercial and subsistence harvest, intentional shootings, incidental take in all fisheries, marine pollution, climate change, and regime shifts. In addition, there is the potential for past indirect effects of fisheries on the abundance of Steller sea lions, fur seals, and harbor seals, all of which are important prey species for transient killer whales. Declines in harbor seals in PWS after the EVOS could have affected the AT1 group of transient killer whales through their food supply (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey species important to transient killer whales, primarily marine mammals, would include state-managed fisheries to a smaller extent and subsistence harvest of the various marine mammals.

- **Cumulative Effects.** The cumulative effects on different marine mammal species are varied, with some populations declining substantially while others increase. Although some individual whales may specialize on particular prey species, the ability of these top predators to switch prey and forage over vast areas is believed to decrease the importance of any one species or stock of marine mammal prey. The overall availability of prey does not appear to be having population level effects on transient killer whales and therefore the cumulative effect is considered insignificant.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant.

- **Persistent Past Effects.** All persistent past effects that have been identified for cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include the potential contribution of the spatial/temporal concentration of past fisheries to have caused localized depletion of prey for Steller sea lions, harbor seals, and northern fur seals with consequent population-level effects on those species.

- **Reasonably Foreseeable Future External Effects.** The future spatial/temporal concentration of external fisheries could have indirect effects on the abundance and distribution of marine mammals that are important prey for transient killer whales.

- **Cumulative Effects.** The cumulative effects of the spatial/temporal concentration of fisheries on different marine mammal species result in changes to the abundance and distribution of prey to transient killer whales. Since transient killer whales. are able to switch prey and forage over vast areas, the potential localized depletion of any one species or stock of marine mammal prey is unlikely to have population level effects on the killer whales. The cumulative effect of the spatial and temporal harvest of fish from all fisheries does not appear to be having population level effects on transient killer whales and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance to killer whales are expected to increase substantially from the baseline and are rated conditionally significant adverse.

- **Persistent Past Effects.** Some levels of disturbance have likely come from foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Vessel traffic external to the fisheries has also contributed to overall disturbance of these animals. Effects of the level of disturbance on transient killer whales are largely unknown.

- **Reasonably Foreseeable Future External Effects.** External effects of State-managed fisheries and other vessel traffic on disturbance will likely occur in future years at a level similar to the baseline.

- **Cumulative Effects.** Disturbance of transient killer whales was determined to be cumulative based on the presence of both internal and external factors. This cumulative effect is considered conditionally significant adverse and likely to have population level effects. This is conditional on the actual location and timing of the disturbance and whether transient killer whales are displaced from areas important to the species to the extent that population level effects occur.

Direct/Indirect Effects FMP 2.2

For transient killer whales, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

Disturbance of killer whales under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore rated insignificant.

Cumulative Effects

For transient killer whales, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on the transient killer whales are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on transient killer whales are the same as described under FMP 2.1.

- **Cumulative Effects.** Disturbance of transient killer whales was determined to be cumulative based on the presence of both internal and external factors. This cumulative effect is expected to be generally similar to the baseline condition, is not likely to have population-level effects, and is therefore considered insignificant.

4.6.8.7 Other Toothed Whales

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 2.1 is not likely to result in significant changes to the population trajectories of toothed whales, including the endangered sperm whale. Incidental takes attributed to the fisheries and entanglement in fishing gear and marine debris occur at low levels thought to be insignificant to toothed whale populations (see Section 4.5.8.7).

Fisheries Harvest of Prey Species

The effects of the alternatives on the toothed whales are largely constrained by differences between their prey and the fisheries harvest targets. FMP 2.1 is not expected to increase the level of interactions relative to the baseline and are determined to be insignificant at the population level.

Spatial/Temporal Concentration of the Fishery

Groundfish fisheries have little competitive overlap with toothed whales. Spatial and temporal fishing measures under the baseline conditions do not appear to be causing localized depletion of prey for any species of toothed whale. Changes to the spatial/temporal concentration of the fisheries under FMP 2.1 are expected to result in effects that are insignificant to toothed whales at the population level.

Disturbance

FMP 2.1 repeals area closures established for the protection of environmental components other than Steller sea lions such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to the level that population level effects could occur and is therefore determined to be conditionally significant adverse to endangered sperm whales and other toothed whales.

Cumulative Effects

The past/present effects on the other toothed whale category are described in Section 3.8.19 through 3.8.21 and 3.8.23 through 3.8.25 (Tables 3.8-19 through 3.8-25) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1 are described above. The effects considered in this analysis are listed in Table 4.6-5. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Incidental takes attributed to the fisheries and entanglement in fishing gear and marine debris occur at low levels thought to be insignificant at the population level for all species in the toothed whale category and are therefore insignificant.

- **Persistent Past Effects.** Persistent past effects on species within the other toothed whale group include incidental take and entanglement in foreign, JV, federal domestic groundfish fisheries and state-managed fisheries and subsistence hunting on beluga whales. The decline of the Cook Inlet beluga population is thought to have resulted from subsistence harvests, which ranged from 21 to 123 animals per year between 1993 and 1998. Only one beluga was harvested in 2001 by hunters from Native Village of Tyonek and one beluga in 2002 by the Cook Inlet community hunters. Belugas are incidentally taken in the state-managed salmon gillnet fisheries in Bristol Bay and Cook Inlet. However, one beluga was reported to be taken from the eastern Bering Sea stock in 1996 and 7 were reported taken in Bristol Bay in 2000. In the BSAI and GOA groundfish fisheries, no mortality or serious injuries to belugas have been observed. Harbor porpoise have not been taken in the observed groundfish fisheries over a ten-year period between 1990 to 1998 (Angliss and Lodge

2002). Salmon gillnet fisheries in southeast Alaska take approximately 3 individuals per year. Dall porpoise mean annual mortality was 6.0 for the Bering Sea groundfish trawl fishery, 1.2 for the GOA groundfish trawl fishery, and 1.6 for the Bering Sea groundfish longline fishery. The Alaska Peninsula/Aleutian Island salmon drift gillnet fishery has a higher take of Dall's Porpoise with an estimated 28 porpoises in one year (1990). Thousands of Pacific white-sided dolphins were killed annually between 1978 and 1991 in the high seas driftnet fisheries, which no long occur (Angliss *et al.* 2001). During the same time span, one Pacific white-sided dolphin was taken in the BSAI trawl fishery and one in the BSAI longline fishery (Angliss *et al.* 2001). State-managed salmon gillnet fisheries take approximately 2 dolphins per year.

Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 with high counts occurring in 1968 when 16,357 sperm whales were harvested, after which the population was severely depleted. Sperm whale interactions with longline fisheries operating in the GOA are known to occur and may be increasing in frequency. Sperm whales have been known to prey on sablefish caught on commercial longline gear in the GOA. Only three entanglements have been reported in the GOA longline fishery.

For killer whales, the combined mortality from the observed groundfish fisheries was 1.4 whales per year (Angliss *et al.* 2001). While it is most likely that whales interacting with fisheries are from resident pods (since they eat fish), no genetic testing has been done on whales incidentally taken in the groundfish fisheries to ascertain whether they were from resident or transient stocks.

For beaked whales (Baird's, Cuvier's, or Stejneger's), no incidental take or entanglement in BSAI and GOA groundfish trawl, longline, and pot fisheries has been documented (Hill and DeMaster 1999).

- **Reasonably Foreseeable Future External Effects.** Future effects on mortality of these species were identified for state-managed fisheries and subsistence for some species such as the beluga whale. Total mortality from these sources is expected to be very minimal.

- **Cumulative Effects.** Cumulative effects of mortality were determined to be insignificant for all non-ESA-listed species based on the internal contribution from the groundfish fisheries and external contribution from other sources. This cumulative effect rating is due to the low level of incidental take in the groundfish fisheries and limited external human-caused mortality.

  For the endangered sperm whale, the cumulative effect of mortality was also considered insignificant due to the very low level of incidental take from the groundfish fisheries and other fisheries and very limited human-caused mortality from external sources.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 2.1 on the toothed whales are largely constrained by differences between their prey and the fisheries harvest targets and are determined to be insignificant at the population level.

- **Persistent Past Effects.** Past effects on the availability of prey for this group are identified for fisheries in general and include the foreign, JV, and federal domestic groundfish fisheries and the state-managed fisheries for salmon and herring. The diversity of diet in this whale group results in limited overlap for most species with the possible exception of sperm whales and resident killer whales.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries were identified as an external factor having a potential effect on prey for these species in the future. Climate and regime shift are also identified but the direction and magnitude of these effects could be either beneficial or adverse.

- **Cumulative Effects.** The ability of these whale species to forage over wide areas and on a variety of prey species moderates any potential impacts from fisheries competition. Cumulative effects on prey availability were identified for this group, including a very limited contribution from the groundfish fishery, but the degree of fishery harvest and bycatch of prey important to these whale species is not expected to have population-level effects on any species, including the endangered sperm whale, and is therefore considered insignificant.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effect.** The groundfish fisheries have little competitive overlap with toothed whales so changes to the spatial/temporal concentration of the fisheries under FMP 2.1 are expected to result in effects that are insignificant to toothed whales at the population level.

- **Persistent Past Effects.** The spatial/temporal concentration of foreign, JV, and domestic groundfish fisheries and the State-managed fisheries are believed to have had minimal effects on the abundance and distribution of toothed whale prey.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue in similar manner as the under the baseline conditions. Effects of future external activities on toothed whale prey are expected to be minimal.

- **Cumulative Effects.** The ability of toothed whales to forage over wide areas and on a variety of prey species moderates any potential impacts from localized depletion of prey from the spatial/temporal concentration of fisheries. Cumulative effects on prey abundance and distribution, including a very limited contribution from the groundfish fishery, are not expected to have population-level effects on any species, including the endangered sperm whale, and are therefore considered insignificant.

Disturbance

- **Direct/Indirect Effect .** Increased levels of disturbance from the baseline are expected under the FMP 2.1 and are considered conditionally significant adverse.

- **Persistent Past Effects.** Past potential disturbance effects on species in this group were identified for foreign, JV, and federal domestic groundfish fisheries; however, there is little indication of an adverse effect of this level of disturbance. General vessel traffic likely also contributes to disturbance to these species.

- **Reasonably Foreseeable Future External Effects.** Increases in the general marine vessel traffic and continued fishing activity in the state-managed fisheries were identified as potential sources of disturbance for these species.

- **Cumulative Effects.** Disturbance was determined to be cumulative based on both internal and external effects. This cumulative effect is considered conditionally significant adverse and likely to have population level effects for endangered sperm whale and other toothed whales. This rating is conditional on the actual location and timing of the disturbance and whether toothed whales are displaced from important foraging areas to the extent that population level effects occur.

Direct/Indirect Effects FMP 2.2

For toothed whales in this group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

Disturbance of toothed whales under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore considered to be insignificant.

Cumulative Effects

For toothed whales in this group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance under FMP 2.2 are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects on endangered sperm whales and non ESA-listed toothed whales are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects on endangered sperm whales and non ESA-listed toothed whales are the same as described under FMP 2.1.

- **Cumulative Effects.** Disturbance from both internal and external effect on endangered sperm whales and non ESA-listed toothed whales is likely to be similar to the baseline level and is considered insignificant at the population level for all species.

4.6.8.8 Baleen Whales

FMP 2.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With respect to take and entanglement in marine debris incidental to groundfish fisheries, FMP 2.1 does not conflict with any recovery plan for endangered whales, and is expected to have an insignificant effects on the population trajectories of baleen whales. See the discussion provided for incidental take of other baleen whales in Section 4.5.8.8.

Fisheries Harvest of Prey Species

The effects of FMP 2.1 are determined to be insignificant to baleen whale species in regards to harvest of prey due to the lack of competitive overlap in species targeted by each.

Spatial/Temporal Concentration of the Fishery

Groundfish fisheries have very little competitive overlap with baleen whales for forage species, therefore, changes to the spatial/temporal concentration of the fisheries under FMP 2.1 are expected to result in effects that are insignificant to baleen whales at the population level.

Disturbance

FMP 2.1 repeals area closures established for the protection of environmental components other than Steller sea lions such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. Coupled with the expansion of the fishery into new areas and an overall increase in fishing pressure, disturbance of animals under FMP 2.1 may increase to the level that population-level effects could occur and is therefore determined to be conditionally significantly adverse to endangered baleen whale species and other non ESA-listed baleen whales.

Cumulative Effects

The past/present effects on the other baleen whale group are described in Sections 3.8.11 through 3.8.18 (Tables 3.8-11 through 3.8-18) and the predicted direct/indirect effects of the groundfish fishery under the FMP 2.1 bookend are described above (Table 4.6-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.6-1).

Mortality

- **Direct/Indirect Effects.** The low level of take of baleen whales projected to occur under FMP 2.1 is considered insignificant.

- **Persistent Past Effects.** Commercial whaling during the last century has had a lingering effect on almost all of the baleen whales in this group, with the possible exception of the minke whale. These include the endangered blue whales, fin whales, sei whales, humpback whales, northern right whales and the non ESA listed gray whales. A full discussion of the effects of commercial whaling is presented in Section 3.8.9. Subsistence whaling has also affected several of the baleen whales in the past. Gray whales are harvested both in Alaska and in Russia with a 5-year quota of 620 whales. The 1968-1993 average take for Russian and Alaska Natives combined was 159 whales per year. Bowhead whales are harvested under International Whaling Commission which allows up to 67 strikes per year although actual strikes have been fewer than the quota since 1978. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Fin whales were reported in this region year-round, most often in the summer and autumn (POP 1997). Humpback whales are present year-round in Alaska waters but are most frequently reported during the summer and autumn. In 1997, a dead humpback was found entangled in netting and trailing orange buoys near the Bering Strait. It is often difficult to determine if the entanglement occurred with active or derelict gear, or to identify the fishery the derelict gear originated from. Two mortalities (in October 1998 and February 1999) were reported by observers in the BS pollock trawl fishery operating near Unimak Pass. The extent of interactions between bowhead whales and the groundfish fishery are not known. Bowhead whales are present in the Bering Sea during winter and early spring but are usually associated with ice-covered regions. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Of 236 bowhead whales examined from the Alaskan subsistence harvest (from 1976 to 1992), three had visible ship-strike injuries from unknown sources and six had ropes attached or scars from fishing gear (primarily pot gear), one found dead was entangled in ropes similar to those used with fishing gear in the Bering Sea (Philo *et al.* 1992). Since 1992, additional bowhead whales have been observed entangled in pot gear or with scars from ropes. The extent of interactions between gray whales and the groundfish fishery is not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Since 1997, five entanglements (mostly in pot gear) and one ship strike mortality have been reported in Alaska waters. Since 1989, no incidental takes of right whales are known to have occurred in the north Pacific. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. Because the right whale population is believed to be very small, any mortality incidental to commercial fisheries would be considered to be significant. Yet, based on the lack of reported mortalities of right whales, the estimated annual mortality rate incidental to commercial fisheries is zero whales per year from this stock.

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and State-managed fisheries are expected to continue to take small numbers of baleen whales in the coming years. Entanglement in fishing gear will also continue to affect baleen whales throughout their ranges. Subsistence for gray whales and bowhead will continue to be the largest source of human-caused mortality.

- **Cumulative Effects.** Cumulative effects of mortality resulting from internal effects of the fishery and contributions from external factors are considered conditionally significant adverse for fin, humpback, and northern right whales due to past effects on their population, potential for interactions with fisheries, and their endangered status. Right whales are very rare so even one human-caused mortality could be considered significant. Given the overlap of their preferred habitat with the BSAI fisheries, the chances of future adverse interactions with fishing gear are more than negligible. The adverse rating for these three species is conditional on whether future take or entanglement substantially affects their rates of recovery. Cumulative effects are found to be insignificant for the endangered blue, bowhead, and sei whales. These species rarely interact with the fisheries so population-level effects are not anticipated. Mortality is also considered insignificant for non-ESA-listed minke and gray whales. Population-level effects are not expected for either of these species.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 2.1 are determined to have an insignificant effect on both endangered and non ESA-listed baleen whale species due the lack of competitive overlap in species targeted.

- **Persistent Past Effects.** Persistent past effects on availability of prey were not identified due to the lack of competitive overlap in prey species targeted.

- **Reasonably Foreseeable Future External Effects.** Future effects were identified for state-managed fisheries such as herring, which are preyed on by humpback whales and fin whales. Other species would not be affected through prey.

- **Cumulative Effects.** The cumulative effects of prey availability are considered insignificant for both endangered and non ESA-listed whale species in this group due to the limited overlap of prey species with the fisheries. Population-level effects are not anticipated.

Temporal and Spatial Concentration of the Fishery

- **Direct/Indirect Effect.** Changes to the spatial/temporal concentration of the fisheries are expected to result in insignificant effects for both endangered and non ESA-listed baleen whales at the population-level.

- **Persistent Past Effects.** Persistent past effects of temporal and spatial concentrations of the fisheries were not identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries would continue to contribute some degree of effect on several species of baleen whales.

- **Cumulative Effects.** Cumulative effects on prey availability are not likely to have population-level effects due to the very low overlap in prey species for this group and are considered insignificant. The contribution of the groundfish fisheries is minimal.

Disturbance

- **Direct/Indirect Effects.** Increased levels of disturbance in comparison to the baseline would likely occur to both endangered and non ESA-listed baleen whales under the FMP 2.1and are considered conditionally significant adverse.

- **Persistent Past Effects.** Some level of disturbance has likely occurred from foreign, JV, and domestic groundfish fishing and state -managed fisheries along with general vessel traffic. For some species such as the gray whale and bowhead whale, subsistence activities have contributed to disturbance of these animals.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and general vessel traffic from recreational boating and whale watching to commercial fishing would be expected to continue in future years and well as subsistence activities.

- **Cumulative Effects.** The cumulative effects of disturbance were determined to likely result in population-level effects for both endangered and non ESA-listed species in this group and, therefore, are considered conditionally significant adverse. This rating is conditional on the actual location and timing of the disturbance and whether baleen whales are displaced from important foraging areas to the extent that population level effects occur.

Direct/Indirect Effects FMP 2.2

For baleen whales, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

Disturbance of both endangered and non ESA-listed baleen whales under the FMP 2.2 management regime is not expected to increase relative to the baseline and is therefore considered insignificant.

Cumulative Effects

For baleen whales, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and spatial and temporal concentration of the fishery under FMP 2.2 are the same as discussed under FMP 2.1 and are considered insignificant on the population level.

Disturbance

- **Direct/Indirect Effect.** Similar levels of disturbance as those that occurred to both endangered and non ESA-listed baleen whales under baseline conditions are expected under FMP 2.2 and are considered insignificant.

- **Persistent Past Effects.** Persistent past effects of disturbance are the same as described under FMP 2.1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects of disturbance on baleen whales are the same as described under FMP 2.1.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external sources is determined to be similar to the baseline condition and not likely to result in a population-level effect for any of the species in this group. Therefore, the cumulative effect is considered to be insignificant.

4.6.8.9 Sea Otters

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Incidental Take/Entanglement in Marine Debris

With respect to take and entanglement in marine debris incidental to groundfish fisheries, FMP 2.1 and FMP 2.2 are not expected to result in significant effects on the population trajectories of sea otters. See the discussion provided for incidental take of sea otters in Section 4.5.8.9.

Fisheries Harvest of Prey Species

Given the minor importance of groundfish in their diet (see Section 4.5.8.9), fisheries removals under FMP 2.1 and FMP 2.2 are not expected to substantially alter sea otter prey abundance relative to the baseline and are considered to have insignificant effects on sea otters.

Spatial/Temporal Concentration of the Fishery

The grounds for suggesting competition for forage between sea otters and commercial fisheries is weak despite the broad geographical distribution of sea otters in the GOA and the Aleutian Islands. Sea otters inhabit waters of the open coast, as well as bays and the inside passages of southeastern Alaska. Since their primary prey items are found on the bottom in the littoral zone, to depths of 50 m, the majority of otters feed within 1 km of the shore (Kenyon 1969). In areas where shallow waters extend far offshore (e.g., Unimak Island), sea otters have been reported as far as 16 km offshore. They are often seen resting and diving for food in and near kelp beds (Kenyon 1969). Because of this habitat preference for shallow areas, they do not overlap spatially with groundfish fisheries. Therefore, the effects of the spatial/temporal concentrations of the fisheries are insignificant for sea otters for both FMP 2.1 and FMP 2.2

Disturbance

FMP 2.1 repeals area closures established for the protection of environmental components other than Steller sea lions, such as the Pribilof Islands habitat conservation area, the walrus protection area, salmon, herring, and crab savings areas, and certain areas that were closed to trawling under the baseline. The level of disturbance on sea otters is not expected to increase under FMP 2.1 due to the spatial partitioning of sea otters, which occur in shallow, nearshore areas, and groundfish fisheries. The disturbance levels predicted under FMP 2.2 are not expected to deviate from baseline conditions. Therefore, the effects of disturbance from groundfish fisheries on sea otters are rated insignificant according to the criteria in Table 4.1-6.

Cumulative Effects

The past/present effects on the sea otter are described in Section 3.8.10 (Table 3.8-10) and the predicted direct/indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described above. The effects considered in this analysis are listed in Table 4.5-70. Representative direct effects used in this analysis include mortality and disturbance with major indirect effects being availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The effects on sea otters under FMP 2.1 and FMP 2.2 are considered insignificant, with respect to incidental catch and entanglement.

- **Persistent Past Effects.** Commercial exploitation for pelts had a huge impact on sea otters dating from the mid-1700s to the late 1800s, causing them to become nearly extinct (Bancroft 1959, Lensink 1962). Protective measures instituted in 1911 have allowed remnant groups to increase and reoccupy much of the historic sea otter range in Alaska (Kenyon 1969, Estes 1980). Residual effects from this early harvest likely persist in several areas. Alaska Natives have hunted sea otters for pelts and meat throughout history. Current harvest levels represent 9 percent of PBR for the southwestern stock, 15 percent of PBR for the southcentral stock, and 35 percent of PBR for southeast stock. (USFWS 2002a, 2002b, and 2002c). In 1992, fisheries observers reported 8 sea otters taken incidentally by the Aleutian Island Black Cod Pot Fishery. During that year, only a third of the fisheries were observed, yielding an estimate of 24 otters killed in cod pot gear. No other sea otter takes were reported from observed fisheries in the range of the southwest stock from 1993 through 2000. In 1997, one sea otter was reported to have been taken by the BSAI groundfish trawl fishery (USFWS 2002a, 2002b, and 2002c). Oils spills, such as the EVOS, can result in substantial mortality of sea otters. Sea otter numbers have declined dramatically from the Alaska Peninsula to the Bering Sea, and this stock is being considered for listing under the ESA.

- **Reasonably Foreseeable Future External Effects.** Low levels of incidental take in commercial and subsistence fisheries, subsistence hunting, and periodic mortalities from oil spills are likely to continue in the future. Population-level effects from transient killer whale predation may continue in the southwest Alaska stock, depending on the recovery of alternate prey and behavior of transient killer whales.

- **Cumulative Effects.** The cumulative effects of mortality from all sources are different for different stocks of sea otters. The populations of the southeast and southcentral stocks of sea otters appear to be stable or increasing and are not expected to have additional mortality pressures in the future. These stocks are therefore considered to experience insignificant effects from mortality. The rapid decline of the southwest Alaska stock does not appear to be the result of food shortages, disease, or toxic contamination and is likely the result of increased predation by transient killer whales following the collapse of their preferred sea lion prey population in the 1980s (Estes *et al.* 1998). Since the mechanisms of the population decline are still under investigation, the cumulative effects on the southwest stock are considered conditionally significant adverse through mortality and are conditional on whether excessive mortality is a primary cause for the recent decline.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 2.1 and FMP 2.2 on sea otters are limited by differences between their prey and the fisheries harvest targets. Sea otters consume a wide variety of invertebrate prey species and occasionally groundfish (e.g., sablefish, rock greenling, and Atka mackerel). As such, the effects of harvest of key prey species in groundfish fisheries are determined insignificant for sea otters.

- **Persistent Past Effects.** Groundfish fisheries have had little effect on the availability of prey in the past due to the limited overlap in prey species of the sea otter and the fish targeted by the groundfish fisheries. There is some minor overlap in state-managed crab fisheries with sea otter prey.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries that take crab from shallow waters were identified as external sources for effects on prey availability. The overlap primarily occurs in inshore areas or offshore areas with relatively shallow water.

- **Cumulative Effects.** Cumulative effects of prey availability were determined to be insignificant due to the very limited overlap between fisheries and sea otter forage species and are not likely to have population-level effects on sea otters.

Spatial/Temporal Concentration of the Fisheries

- **Direct/Indirect Effects.** Despite the broad geographical distribution of sea otters in the GOA and the Aleutian Islands, they do not generally overlap spatially with groundfish fisheries. Therefore, the effects of the spatial/temporal concentrations of the fisheries are insignificant for sea otters.

- **Persistent Past Effects.** The limited overlap of groundfish fisheries and other fisheries in the past has resulted in limited interaction with sea otters. Past effects may come from spatial/temporal concentration and have likely occurred in very specific areas associated with state-managed crab fisheries.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries are likely to continue into the future at a level similar to the baseline conditions.

- **Cumulative Effects.** Cumulative effects of spatial/temporal concentration of the fisheries are insignificant due to the limited overlap with sea otter habitat and are unlikely to result in population-level effects.

Disturbance

- **Direct/Indirect Effects.** The effects of disturbance caused by vessel traffic, fishing operations, and sound production on sea otters in the GOA and BSAI are expected to be insignificant. Levels of disturbance under the FMP 2.1 and FMP 2.2 are expected to be similar to the baseline and are considered insignificant to sea otter populations.

- **Persistent Past Effects.** Past effects of disturbance are primarily related to minor disturbance by vessel traffic from fisheries and other vessels associated with subsistence harvest of sea otters.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue at a level similar to the baseline. Vessel traffic within sea otter habitat in future years would also be expected to be similar to the baseline.

- **Cumulative Effects.** Cumulative effects of disturbance on sea otters are considered insignificant and unlikely to result in any population-level effects. Contribution of the groundfish fishery to the overall cumulative effect is minimal.

4.6.9 Socioeconomic Alternative 2 Analysis

This policy alternative would maximize biological and economic yield from the resource while still preventing overfishing of the groundfish stocks. This section contains both quantitative and qualitative assessments of select economic and social effects of FMP 2.1 and FMP 2.2.

4.6.9.1 Harvesting and Processing Sector Profiles

The model and analytical framework used in the analysis of the effects of FMP 2.1 on the harvesting and processing sectors are described in Section 4.1.7.

As in FMP 1, model projections are based on 2001 prices and product mixes. Actual prices may rise or decline with levels of catch, changes in market conditions, or other factors. Since FMP 2.1 results in large increases in the catches of certain species for both catcher vessels and catcher processors, prices may decrease for some species as a result of the increase in supply. The extent to which prices would decrease depends on demand elasticities. Due to the presence of a large number of substitutes for Alaska groundfish products, the demand for these products is believed to be relatively elastic. In other words, prices for groundfish products are unlikely to be substantially influenced by changes in harvests. Also, ex-vessel prices are determined by negotiations between individual processors on one side and either bargaining associations for catcher vessels or individual fishermen on the other side. Ex-vessel prices may not behave as one might expect in a competitive market. Actual prices will ultimately depend on the relative bargaining power of harvesters and processors.

Moreover, the FMP 2.1 model projections of groundfish retained harvests may be overestimated. The elimination of the observer program in all fisheries except the BSAI pollock fishery will increase the reliance of fishery managers on the data collected through current industry recordkeeping and reporting requirements. A reliance on logbook data will significantly decrease the precision of total catch data available for fishery managers. With less precise data, fishery managers are likely to adopt a conservative approach and close fisheries before actual catches reach the TAC.

Table 4.6-6 summarizes projected impacts of FMP 2.1 on the harvesting and processing sectors. The numbers in the table reflect the 5-year average of outcomes projected for 2003 to 2007. Under FMP 2.1, there would be significant increases in the harvest of groundfish species as a result of a large projected increase in the TAC and the removal of PSC limits. The 5-year mean estimate of groundfish wholesale product value is about $2.2 billion, a 52 percent increase when compared to the baseline.

Under FMP 2.1, groundfish wholesale product value is projected to be at a peak of $2.8 billion in 2003. However, the harvest of pollock in the BSAI in that year is predicted to be unsustainable. Consequently, product value is expected to decline rapidly such that product value in 2006 is approximately 68 percent of the 2003 estimated value and 86 percent of the 5-year mean. An upward trend is expected after 2006, and by 2007, the product value is anticipated to be about $1.9 billion.

The 5-year mean estimate of the pollock harvest is 680 thousand mt (47 percent) higher than the comparative baseline. Pacific cod harvest are expected to increase by 165 thousand mt (75 percent), and harvest of flatfish are predicted to increase by 103 thousand mt (60 percent). Species in the A-R-S-O aggregation as a whole are predicted to increase by 40 thousand mt (27 percent). Total groundfish payments to labor are expected to increase by 54 percent, and groundfish employment will increase by about 6,900 FTE positions.

4.6.9.1.1 Catcher Vessels

Direct/Indirect Effects of FMP 2.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period in Table 4.6-6 to 2001 catcher vessel conditions reveals that under FMP 2.1 there would be a significant increase in retained harvests of pollock and Pacific cod relative to the comparative baseline. The large projected increase in the TAC for these species and the removal of PSC limits are expected to increase catches of pollock and Pacific cod by about 48 percent and 188 percent, respectively. Retained harvests of A-R-S-O species are also expected to increase significantly.

Ex-Vessel Value

As a result of the predicted increases in harvest tonnage of groundfish species, the ex-vessel value of groundfish landed by catcher vessels is expected to increase significantly relative to the comparative baseline. Increased pollock harvests by the three classes of AFA-eligible trawl catcher vessels account for much of the increase in groundfish ex-vessel value. In addition, a significant increase in ex-vessel value is expected for small trawl catcher vessels and fixed-gear vessels, largely through an increase in the harvest of Pacific cod and species in the A-R-S-O complex.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to increase significantly under FMP 2.1.

Impacts on Excess Capacity

FMP 2.1 is expected to substantially increase the quantity of catch and products from the groundfish fisheries. Therefore, a decrease in the level of excess capacity in the harvesting sector is predicted in the short-term. However, because FMP 2.1 repeals all effort limitation programs other than those that are statutorily-mandated, excess capacity in the harvesting sector is expected to significantly increase over the long-term as new vessels and processing facilities enter the groundfish fisheries with a significantly adverse effect in comparison to the baseline condition.

Average Costs

It is difficult to determine the net effect of various influences on average costs, and it will likely vary by fishery and species. Overall, however, a significant increase in average costs is expected under FMP 2.1 relative to the comparative baseline. In the short-term, average costs per unit of catch for some catcher vessels can be expected to decrease somewhat under FMP 2.1 due to the increase in the overall level of production resulting from the increased TAC and elimination of PSC limits. Many costs are fixed (e.g., loan repayments, general office and accounting expenses and insurance costs); they do not change with the level of production. These costs would be allocated to a larger amount of product, thereby lowering the average cost per unit of catch. However, over the long-term it is expected that catch per unit of effort will decrease as harvest levels increase and capital expenditures will increase with the entry of new vessels and intensification of the race for fish. As a result, any cost savings under this FMP would likely be negated.

Variable costs will increase with the increase in catch, and the increase in the supply of fish is likely to put downward pressure on ex-vessel prices. The extent to which processors versus catcher vessels would share changes in harvesting costs and the extent to which catcher vessels are willing to accept lower prices as total supply increases will depend on their relative bargaining power as well as price elasticities of the products made from the fish. However, large decreases in ex-vessel prices and the associated variable costs of production for processors are not expected under FMP 2.1.

Elimination of the current VMS requirement may have a adverse impact on the fishing industry, as it could lead to the closure of all Steller sea lion critical habitat to fishing. By allowing NOAA Fisheries to effectively monitor compliance with a large number of complex area-based fishing restrictions, VMS affords vessels an opportunity for continued access to some historic fishing grounds within critical habitat. In the absence of VMS, it is possible that all critical habitat would have to be closed to fishing should it be determined by NOAA Fisheries that effective monitoring of the remaining Steller sea lion protection measures is no longer possible. The results of such a closure would be an increase in vessel travel time and higher operating costs.

The economic advantage conferred on some sectors of the groundfish fisheries by the elimination of PSC limits would come at the expense of other domestic fisheries in the region. Specifically, the increase in prohibited species bycatch would impose economic costs on harvesters and processors of crab, halibut, herring, and salmon in the form of foregone catches and product. No estimates of these losses under FMP 2.1 are available. However, it is estimated that increased gross revenue in groundfish fisheries would exceed the value of losses incurred in directed fisheries for halibut, salmon, and crab.

<u>Fishing Vessel Safety</u>

It is expected that FMP 2.1 will have both significantly beneficial and adverse effects on fishing vessel safety. However, it is uncertain whether the beneficial effects would outweigh the adverse effects. On the one hand, the increased competition among fishermen is expected to increase the risks fishermen will take to harvest fish. The adverse effects would be particularly severe in the sablefish longline fishery because FMP 2.1 would eliminate the vessel safety benefits of the IFQ program. These benefits result from the elimination of the race for fish and the associated freedom to decide when to fish and at what rate to fish. On the other hand, because FMP 2.1 would remove some fishing restrictions in nearshore areas, it would allow vessels to spend more time fishing nearer to shore and would reduce the potential for the risk of accidents and injury due to hazardous weather and other conditions. This could be particularly true in southeast Alaska where repeal of the LLP would open all of the area east of 144°W longitude to trawling. Other beneficial safety effects are expected to be realized in the Bristol bay area with the opening of the Nearshore Bristol bay closures in areas 506 and 512; along the Aleutian Islands where the Chinook Savings Area, Herring Savings Area, and Red King Crab Closure area would be open; and around Kodiak with the opening of the Kodiak Type 1 and Type 2 Areas.

Cumulative Effects of FMP 2.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety. For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** There would be a significant increase in retained harvest of pollock and Pacific cod relative to the comparative baseline. Increased TAC and the removal of PSC limits are expected to increase catches of pollock and Pacific cod by about 48 percent and 188 percent respectively. Retained harvests of other groundfish species will also increase significantly.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990's, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under "Groundfish Landings By Species Group" at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects.** Although there are currently downward trends in the commercial salmon and crab fisheries, the predicted increases in retained harvests under FMP 2.1 are high enough for many species (187 percent for Pacific cod and 48 percent for pollock) that they are expected to mitigate the reductions in other fisheries. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these effects are not expected to result in significant effects under FMP 2.1. Overall, significantly beneficial cumulative effects are expected under FMP 2.1.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is expected to increase significantly under FMP 2.1, much of which is accounted for by increases in pollock harvests.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990's, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under "Groundfish Landings By Species Group" at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Significantly beneficial cumulative effects are expected for ex-vessel value under FMP 2.1. The significant increases in harvests of Pacific cod, pollock and the A-R-S-O complex (187.6 percent, 48.3 percent, and 17.9 percent, respectively) account for the significant increases in ex-vessel value. Other fisheries reductions are likely to be mitigated by these increases for vessels that participate in multiple fisheries.

<u>Employment and Payments to Labor</u>

- **Direct/Indirect Effects.** Under FMP 2.1 employment and payments to labor are expected to be significantly beneficial (increases of 110 percent and 64 percent respectively) primarily due to the increases in harvest.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The increases in employment and payments to labor (64 percent for both) predicted under FMP 2.1 as a result of increases in TAC and removal of PSC limits are likely to result in significantly beneficial cumulative effects on employment and payments to labor. Potential increases in municipal or landings taxes in rural Alaska communities due to reductions in subsidies and power cost equalization programs could indirectly reduce payments to labor. Although reductions in the salmon and crab fisheries are adversely affecting employment and payments to labor in other fisheries, the increases predicted under FMP 2.1 are expected to mitigate these effects.

<u>Impacts on Excess Capacity</u>

- **Direct/Indirect Effects.** A substantial increase in excess capacity is likely to result due to the repeals of all effort license limitation programs other than those statutorily mandated, with a significantly adverse effect in comparison to the baseline condition. For further details (see the Direct/Indirect section at the beginning of Section 4.6.9.1.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of 4.5.9.1.

- **Cumulative Effects.** Programs implemented to reduce excess capacity in the groundfish fishery such as the LLP, are eliminated under FMP 2.1 This could result in additional vessels entering the fishery thereby exacerbating existing overcapacity. This, in conjunction with the remaining excess capacity in other fisheries, results in significantly adverse cumulative effects under FMP 2.1 (see Appendix F-8 – Overcapacity Paper).

Average Costs

- **Direct/Indirect Effects.** A significant increase in average costs are expected though they will likely vary by fishery and by species, with a significantly adverse effect in comparison to the baseline condition. These variations are described in further detail in Section 4.6.9.1 under Direct /Indirect Effects on Average Costs above.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** As described in detail under the direct/indirect discussion of average costs at the beginning of Section 4.6.9.1, multiple variables influence changes in average costs such as area closures, transit time, harvest levels, and the race for fish. Recent reductions in government subsidies and power cost sharing programs have caused communities to rely even more on fishing revenues. Thus, there is potential for fish taxes to be raised in upcoming years. This could result in higher average costs. Area closures for the salmon and crab fisheries have the same affects as do groundfish closures, often increasing transit time and operating costs. However, long-term projections suggest that catches per unit of effort will decrease as TACs and capital expenditures increase with the entry of new vessels and intensification of the race for fish. These new entries and the amplification of the race for fish, combined with the effects of other closures in directed fisheries for halibut, salmon, and crab will likely result in significantly adverse cumulative effects under FMP 2.1.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Significantly beneficial and significantly adverse effects are anticipated due to the uncertainty of whether increased competition among fishermen is expected to increase their risks to harvest fish or whether benefits of reduced closures in nearshore areas would reduce safety risks. Details on these variables can be found under the direct/indirect effects discussion at the beginning of Section 4.6.9.1.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market; and contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. While additional closures that may result from management measures in other fisheries may increase the risk to fishermen, the reduction of nearshore closures under FMP 2.1 may reduce risks. However, the safety risks are particularly severe under the sablefish longline fishery as a result of the elimination of vessel safety benefits under the IFQ program under this FMP. Significantly beneficial or adverse cumulative effects could result under FMP 2.1.

Direct/Indirect Effects of FMP 2.2

The model and analytical framework used in the analysis of the effects of FMP 2.2 on the harvesting and processing sectors are described in Section 4.1.7.

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 catcher vessel conditions reveals that under FMP 2.2 there would be a significant increase in retained harvests of pollock and Pacific cod relative to the comparative baseline. The projected increase in the TAC for these species is expected to increase catches of pollock and Pacific cod by about 20 percent and 54 percent, respectively. Flatfish harvests are rated as insignificant under FMP 2.2.

Ex-Vessel Value

As a result of the predicted increases in harvest tonnage of groundfish species, the overall ex-vessel value of groundfish landed by catcher vessels is expected to increase significantly relative to the comparative baseline. Increased pollock harvests by the three classes of AFA-eligible trawl catcher vessels account for much of the increase in groundfish ex-vessel value. In addition, a significant increase in ex-vessel value is expected for smaller trawl catcher vessels and pot catcher vessels, largely through an increase in the harvest of Pacific cod.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to increase under FMP 2.2, but the increase is of marginal significance.

Impacts on Excess Capacity

No significant change in excess harvesting capacity is expected to occur under FMP 2.2 relative to the comparative baseline. This FMP would maintain current measures to reduce excess capacity and the race for fish in the Alaska groundfish fisheries. Current measures that address overcapacity include the LLP; the sablefish longline fishery IFQ program, which includes provisions for community purchase of quota shares; the cooperatives established in the BSAI pollock fishery under the AFA, and the western Alaska CDQ program. These measures have been successful in limiting harvesting and processing capacity in Alaska groundfish fisheries, and further decreases in capacity in the BSAI pollock fishery and sablefish longline fishery are expected. However, no additional overcapacity measures would be implemented under this FMP. A recent report by Felthoven *et al.* (2002) indicates that significant excess capacity remains in several groundfish fisheries.

Average Costs

No significant change in average costs is expected to occur under FMP 2.2 relative to the comparative baseline. Average costs per unit of catch for catcher vessels can be expected to decrease somewhat under this FMP due to the increase in the overall level of production resulting from the increased TAC. Many costs are fixed (e.g., loan repayments, general office and accounting expenses and insurance costs); they are not reduced with the level of production. These costs would be allocated to a larger amount of product, thereby lowering the average cost per unit of catch. However, it is possible that catch per unit of effort will decrease as harvest levels increase. This would mitigate the cost savings discussed above. It is difficult to determine the net effect of these influences, and it will likely vary by fishery and species. Nevertheless, over the long-term average costs are not expected to change significantly.

Fishing Vessel Safety

No significant change in fishing vessel safety is expected to occur under FMP 2.2 relative to the comparative baseline. The risk to fishermen is expected to remain high under this FMP. This is in part due to regulations that require fishermen to operate farther from shore or in areas and seasons with more hazardous weather conditions. In particular, the existing area closures will continue to require smaller catcher vessels based out of the Alaska Peninsula, Aleutian Islands, and Kodiak communities to travel far to fish, exposing the vessels to additional safety risks. The continued use of the race for fish to allocate TAC and PSC limits among competing fishermen in some fisheries is also expected to have a adverse effect on fishing vessel safety.

Cumulative Effects of FMP 2.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety. For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** A significant increase in retained harvest of pollock and Pacific cod relative to the comparative baseline is projected under FMP 2.2. Retained harvests of other groundfish species will also increase significantly.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects.** Similar to FMP 1, the predicted increases in retained harvests under FMP 2.2 are marginal for most species, except Pacific cod. The reductions in other fisheries could adversely affect harvest levels in the groundfish fisheries. Overall, significantly beneficial cumulative effects are expected under FMP 2.2.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is expected to increase significantly under FMP 2.2.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Significantly beneficial cumulative effects are expected for ex-vessel value under FMP 2.2. The significant increases in Pacific cod and pollock harvests (51 percent and 20 percent respectively) account for the significant increases in ex-vessel value. Given the decreases in state subsidies for power generation, education and municipal revenue sharing, the importance of fishing, especially in rural Alaska, is increasing. The decreases in state subsidies may however, result in increases in fish landing taxes which could reduce ex-vessel value. The 20 percent increase predicted for overall groundfish ex-vessel value under FMP 2.2, could mitigate these potential effects but that is not likely. Therefore, significantly beneficial cumulative effects are anticipated for ex-vessel value under FMP 2.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Under FMP 2.2, employment and payments to labor are expected to be significantly beneficial (increases of 19 percent and 22 percent respectively) primarily due to the increases in harvest.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The marginal increases predicted for employment and payments to labor under FMP 2.2 associated with increases in retained harvest, especially for Pacific cod. Potential increases in municipal or landings taxes in rural Alaska communities due to reductions in subsidies and power cost equalization programs could indirectly reduce payments to labor. Cumulative effects are likely to be significantly beneficial even though there are current reductions in other fisheries such as salmon and crab and potential increases in fish landing taxes resulting from decreased state and municipal subsidies.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Changes in excess capacity are likely to be insignificant under FMP 2.2.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Excess capacity is not expected to change significantly under FMP 2.2. Although the license limitation efforts help to reduce capacity, it is still predicted to remain high in the groundfish fisheries. Excess capacity is likely to also remain in other fisheries unless management addresses this issue. Therefore, cumulative effects are likely to be insignificant and excess capacity will continue. For details see the Overcapacity Paper in Appendix F-8.

Average Costs

- **Direct/Indirect Effects.** Insignificant effects are expected to occur for average costs under FMP 2.2.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Average costs are not expected to change significantly from the baseline condition under FMP 2.2. Associated or shared costs with other fisheries will continue to have an affect on costs in the groundfish fishery. Recent reductions in government subsidies and power cost sharing programs have caused communities to rely even more on fishing revenues. Thus, there is potential for fish taxes to be raised in upcoming years. This could result in higher average costs. Similar to FMP 1, insignificant cumulative effects are likely under FMP 2.2.

Fishing Vessel Safety

- **Direct/Indirect Effects.** No significant effects on fishing vessel safety are expected to result from FMP 2.2.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects contributed to increased demand for groundfish species. They are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Under FMP 2.2, no additional closures are to be implemented other than those that are in place under the baseline condition. Closures implemented through other fisheries may affect vessel safety in the groundfish fisheries, although these closures are not expected to result in a significant cumulative effect on vessel safety.

4.6.9.1.2 Catcher Processors

Direct/Indirect Effects of FMP 2.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 catcher processor conditions reveals that under FMP 2.1 there would be a significant increase in catches of all groundfish species or species groups relative to the comparative baseline. The large projected increase in the TAC for these species and the removal of PSC limits are expected to increase catches of flatfish, pollock, and Pacific cod by about 71 percent, 45 percent, and 30 percent, respectively. Harvests of A-R-S-O species are expected to increase around 23 percent.

Groundfish Gross Product Value

As a result of the predicted increases in harvest tonnage of groundfish species, the overall wholesale product value of groundfish processed by catcher processors is expected to increase significantly relative to the comparative baseline. This increase is the result of significant increases in the value of pollock products produced by surimi trawl catcher processors and fillet trawl catcher processors; flatfish products produced by head-and-gut trawl catcher processors; Pacific cod products produced by pot catcher processors, longline catcher processor and head-and-gut trawl catcher processors; and products from A-R-S-O species produced by head-and-gut trawl catcher processors and longline catcher processors.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase significantly under FMP 2.1. Head-and-gut trawl catcher processors, surimi trawl catcher processors and fillet trawl catcher processors account for most of this increase.

Product Quality and Product Utilization Rate

No significant change in overall product quality or product utilization rate is expected to occur under FMP 2.1 relative to the comparative baseline. The product value for the BSAI pollock fishery is expected to remain high as a result of the establishment of the AFA cooperatives and end of the race for fish. These measures will also mitigate the effects of the elimination of IR/IU regulations. However, the resumption of the race for fish in the sablefish longline fishery could result in a decrease in the quality of sablefish product. Because both the intensity of this adverse effect and the probability of its occurrence are uncertain, it is considered conditionally significant adverse.

Excess Capacity

As with catcher vessels, the repeal of all effort limitation programs other than those that are statutorily-mandated is expected to result in a significant increase in excess capacity in the harvesting sector in the long-run with a significantly adverse effect in comparison to the baseline condition.

Average Costs

As with catcher vessels, a significant increase in average costs is predicted under FMP 2.1 relative to the comparative baseline as a result of lower catches per unit of effort associated with higher TACs and because of the increase in capital expenditures with the entry of new vessels and intensification of the race for fish. Thus, there would be a significantly adverse effect under FMP 2.1.

Fishing Vessel Safety

As with catcher vessels, either a significant improvement or reduction in fishing vessel safety could occur under FMP 2.1 relative to the comparative baseline. On the one hand, the increased competition among fishermen is expected to increase the risks fishermen will take to harvest fish. On the other hand, because FMP 2.1 would remove some fishing restrictions in nearshore areas, it would allow vessels to spend more time fishing nearer to shore and would reduce the potential for the risk of accidents and injury due to hazardous weather and other conditions. Thus a significantly adverse or beneficial effect on fishing vessel safety would be expected under FMP 2.1.

Cumulative Effects of FMP 2.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, significantly beneficial effects are expected for retained harvests of groundfish species.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Although there are currently downward trends in the commercial salmon and crab fisheries, the predicted increases in retained harvests under FMP 2.1 are high enough for many species (23 to 71 percent) that they are expected to mitigate the reductions in other fisheries. Overall, significantly beneficial cumulative effects are expected under FMP 2.1. Other economic development activities and other sources of municipal and state revenue are not expected to offset the large increases in TAC in the groundfish fishery. While climate change may result in potential increases or decreases in fish populations as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase significantly from the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Significantly beneficial cumulative effects are expected for gross product value under FMP 2.1. The significant increases in harvests of pollock, flatfish and Pacific cod, in particular, account for the significant increases in value. Other fisheries reductions are likely to be mitigated by these increases for vessels that participate in multiple fisheries.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Significant increases in employment and payments to labor are predicted for catcher processors under FMP 2.1.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase in groundfish employment (44 percent) under FMP 2.1, is so significant that it is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase (39 percent) under FMP 2.1 thereby mitigating some of the reductions in other fisheries. Potential increases in municipal or landings taxes in rural Alaska communities due to reductions in subsidies and power cost equalization programs could indirectly reduce payments to labor, though this is not likely to have a strong effect under FMP 2.1. Therefore, significantly beneficial cumulative effects on employment and payments to labor are anticipated under FMP 2.1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** Overall, insignificant effects in product quality and product utilization rates are expected under FMP 2.1 relative to the baseline. However, the resumption of the race for fish in the sablefish longline fishery could result in a decrease in the quality of sablefish product. Because both the intensity of this adverse effect and the probability of its occurrence are uncertain, it is considered conditionally significant adverse.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed under the Section 4.5.9.1.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. However, the resumption of the sablefish longline fishery could result in decreased product quality. Overall, increases in product quality and utilization are likely in the long-term, though these improvements are not likely to result in significant cumulative effects under FMP 2.1. Due to the uncertainty of the intensity this effect may have on the groundfish fisheries, conditionally significant adverse cumulative effects may occur under FMP 2.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Significantly adverse effects in excess capacity are expected under FMP 2.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of 4.5.9.1.

- **Cumulative Effects.** Excess capacity still remains in other fisheries as well as the groundfish fishery. Measures such as LLP are repealed under FMP 2.1, which is likely to exacerbate the race for fish (Overcapacity Paper Appendix F-8). Given that effort limitation programs are discontinued under this FMP and excess capacity in other fisheries remains, significantly adverse cumulative effects are expected for excess capacity as it is expected to worsen from the baseline level.

Average Costs

- **Direct/Indirect Effects.** Significantly adverse effects in average costs are expected under FMP 2.1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As stated above in Section 4.6.9.1, average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Increases in closure areas increase costs, whereas decreases in closures usually decrease costs. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with average costs in the groundfish fishery, cumulative effects may result. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. As FMP 2.1 results in a reduction in closures, except for Steller sea lion related measures, cumulative effects on average costs in the groundfish fisheries could be reduced. However, the resumption of the race for fish is likely to increase costs. The expansion of the race for fish, in conjunction with potential increases in closed areas in other fisheries, result in significantly adverse cumulative effects for average costs.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Significantly beneficial and significantly adverse effects are anticipated due to the uncertainty of whether increased competition among fishermen is expected to increase their risks to harvest fish or whether benefits of reduced closures in nearshore areas would reduce safety risks.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As vessel safety is primarily a function of the race for fish, distance to fishing areas and sea conditions relative to vessel size, the reduction in closures under FMP 2.1 are expected to improve vessel safety. However, the race for fish under FMP 2.1 could result in increased risks to vessels. Significantly adverse or beneficial cumulative effects could result under FMP 2.1.

Direct/Indirect Effects of FMP 2.2

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 catcher processor conditions reveals that under FMP 2.2 there would be a significant overall increase in catches of groundfish species. As a result of a projected increase in the TAC, catches of flatfish and pollock are expected to increase by about 44 percent and 19 percent, respectively. Harvests of Pacific cod are expected to increase around 39 percent.

Groundfish Gross Product Value

As a result of the predicted increases in harvest tonnage of groundfish species, the overall wholesale product value of groundfish processed by catcher processors is expected to increase significantly relative to the comparative baseline. This increase is the result of significant increases in the value of pollock products produced by surimi trawl catcher processors and fillet trawl catcher processors; flatfish products produced by head-and-gut trawl catcher processors; and Pacific cod products produced by pot catcher processors, longline catcher processor and head-and-gut trawl catcher processors.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under FMP 2.2, but the increase is of marginal significance. Head-and-gut trawl catcher processors, surimi trawl catcher processors and fillet trawl catcher processors account for most of this increase.

Product Quality and Product Utilization Rate

No significant change in overall product quality or product utilization rate is expected to occur under FMP 2.2 relative to the comparative baseline.

Excess Capacity

As with catcher vessels, no significant change in excess harvesting capacity is expected to occur under FMP 2.2 relative to the comparative baseline. This FMP would maintain current measures to limit capacity and reduce the race for fish in the Alaska groundfish fisheries.

Average Costs

As with catcher vessels, no significant change in average costs is expected to occur under FMP 2.2 relative to the comparative baseline. Fixed costs per ton will decline as catches increase; however, variable cost per ton is expected to increase as the average catch per unit of effort declines in response to higher harvest levels.

Fishing Vessel Safety

As with catcher vessels, no significant change in fishing vessel safety is expected to occur under FMP 2.2 relative to the comparative baseline.

Cumulative Effects of FMP 2.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.6-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9 and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Significantly beneficial effects are expected for groundfish landings by species group under FMP 2.2.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Although there are currently downward trends in the commercial salmon and crab fisheries, catcher processors that rely on a mix of groundfish, salmon and crab may experience a reduction in harvest levels. However, this reduction may be offset by the predicted increases in TAC for flatfish, pollock and Pacific cod. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. Significantly beneficial cumulative effects are projected for FMP 2.2.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase significantly from the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). Although during recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing, the increases in product value projected under FMP 2.2 are likely to offset these reductions. Significantly beneficial cumulative effects for groundfish gross product value are anticipated under FMP 2.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Significantly beneficial effects are predicted for catcher processors under FMP 2.2.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The increase in groundfish employment (23 percent) under FMP 2.2, is likely to mitigate some of the current reductions in other fisheries such as crab and salmon. Similarly, payments to labor are also projected to increase (23 percent) under FMP 2.2, thereby mitigating some of the reductions in other fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be significantly beneficial under FMP 2.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** No significant changes in product quality or utilization rate are expected under FMP 2.2 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** As stated under FMP 2.1, advances in technology have improved product quality and utilization for various fisheries throughout the world. Overall, increases in product quality and utilization are likely in the long-term though these improvements are not expected to result in significant cumulative effects under FMP 2.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** No significant changes in excess capacity are expected under FMP 2.2 relative to the baseline. Current measures to reduce excess capacity and the race for fish would be maintained.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under FMP 2.2, no cumulative effects are expected for excess capacity as conditions are not expected to change significantly from the baseline.

Average Costs

- **Direct/Indirect Effects.** No significant change in average costs are expected under FMP 2.2 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** As stated under FMP 2.1, average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed and variable costs, as well as area closures also have an effect on average costs. In contrast to FMP 2.1, closures do not change significantly from the baseline condition, and although fixed costs per ton decline as catch increases, variable costs per ton will increase. Insignificant cumulative effects on average costs in the groundfish fisheries are likely under FMP 2.2.

Fishing Vessel Safety

- **Direct/Indirect Effects.** No significant change in fishing vessel safety is expected under FMP 2.2.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, distance to fishing areas and sea conditions relative to vessel size. Additional closures that may result from other fisheries management measures may increase the risk to fishermen, however, these effects are not expected to be significant under FMP 2.2. As there are no predicted increases in area closures under FMP 2.2, cumulative effects on vessel safety are insignificant compared to the baseline condition.

4.6.9.1.3 Inshore Processors and Motherships

Direct/Indirect Effects of FMP 2.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 inshore plant and mothership conditions reveals that under FMP 2.1 there would be a significant increase in catches of pollock and Pacific cod relative to the comparative baseline. The large projected increase in the TAC for these species and the removal of PSC limits are expected to increase catches of pollock and Pacific cod by about 48 percent and 179 percent, respectively. Catches of A-R-S-O species are also expected to increase significantly.

Groundfish Gross Product Value

As a result of the predicted increases in harvest tonnage of groundfish species, the overall wholesale product value of groundfish processed by inshore plants and motherships is expected to increase significantly relative to the comparative baseline. Increased deliveries of pollock and Pacific cod to Bering Sea pollock shore plants account for much of the increase in product value. However, the product value of all inshore processing plants and motherships is expected to increase significantly as a result of the overall increase in groundfish catch.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore plants and motherships are expected to increase significantly under FMP 2.1. Bering Sea pollock shore plants account for most of the increase in employment and payments to labor.

Product Quality and Product Utilization Rate

As with catcher processors, no significant change in overall product quality or product utilization rate is expected to occur under FMP 2.1 with the exception of sablefish. The resumption of the race for fish in the sablefish longline fishery could result in a decrease in the quality of sablefish product. Because both the intensity of this adverse effect and the probability of its occurrence are uncertain, it is considered conditionally significant adverse.

Excess Capacity

In general, the increase in the TAC under FMP 2.1 will mean a significant reduction in excess processing capacity as throughput increases. In contrast to catcher vessels and catcher processors, the repeal of effort limitation measures is not expected to a substantial and rapid increase in the capacity of inshore processing facilities because those measures were not directed at controlling processing capacity.

Average Costs

In contrast to the harvesting sector, the inshore processing sector is expected to realize a significant decrease in average costs under FMP 2.1 relative to the comparative baseline. Higher catches in the groundfish fisheries and a larger number of fishing vessels will likely eliminate upward pressure on ex-vessel prices, and greater throughput over constant fixed costs will result in significantly lower average costs for processing facilities.

Cumulative Effects of FMP 2.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are expected to be significantly beneficial with increases in retained groundfish harvests for certain species.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Although there are downward trends in the commercial salmon and crab fisheries, inshore plants and motherships are projected to experience such increases in groundfish harvests that significantly beneficial cumulative effects are anticipated under this FMP. Other economic development activities and other sources of municipal and state revenue can have an effect on the processing plants through landings taxes and other tax mechanisms, however, these are not expected to have significant effects under FMP 2.1.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase significantly from the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). Although during recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing, the dramatic increases in gross product value (62 percent) predicted under FMP 2.1 are likely to result in significantly beneficial cumulative effects.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Significantly beneficial effects are predicted for catcher processors under FMP 2.1.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The increase in groundfish employment (64 percent) under FMP 2.1, is likely to mitigate some of the reductions currently taking place in other fisheries such as salmon and crab. Similarly, payments to labor are also projected to increase (63 percent) under FMP 2.1. Potential increases in municipal or landings taxes in rural Alaska communities due to reductions in subsidies and power cost equalization programs could indirectly reduce payments to labor, though this is not likely to have a strong effect under FMP 2.1. Therefore, significantly beneficial cumulative effects on employment and payments to labor are expected under FMP 2.1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** Insignificant changes in product quality or utilization rate are expected under FMP 2.1 relative to the baseline. However, the resumption of the race for fish in the sablefish longline fishery could result in a decrease in the quality of sablefish product. Because both the intensity of this adverse effect and the probability of its occurrence are uncertain, it is considered conditionally significant adverse.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. However, the resumption of the sablefish longline fishery could result in decreased product quality. Overall, increases in product quality and utilization are likely in the long-term though these improvements are not likely to result in significant cumulative effects under FMP 2.1. Due to the uncertainty of the intensity this effect may have on the groundfish fisheries, conditionally significant adverse cumulative effects may occur under FMP 2.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Significantly beneficial effects in excess capacity are expected under FMP 2.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** The increase in throughput is expected to result in significantly beneficial cumulative effects (Appendix F-8 Overcapacity Paper).

Average Costs

- **Direct/Indirect Effects.** Significantly beneficial effects in average costs are expected under FMP 2.1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As stated in Section 4.6.9.1, average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while product value is variable. In contrast to the harvesting sector, processors that have greater throughput over fixed costs have lower costs as a result. As FMP 2.1 is projected to result in greater throughput for inshore processors and motherships, significantly beneficial cumulative effects are likely. Average costs are expected to be reduced under this FMP.

Direct/Indirect Effects of FMP 2.2

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to the 2001 inshore plant and mothership conditions reveals that under FMP 2.2 there would be a significant increase in catches of pollock and Pacific cod relative to the comparative baseline. The projected increase in the TAC for these species is expected to increase catches of pollock and Pacific cod by about 21 percent and 49 percent, respectively.

Groundfish Gross Product Value

As a result of the predicted increases in harvest tonnage of groundfish species, the overall wholesale product value of groundfish processed by inshore plants and motherships is expected to increase significantly relative to the comparative baseline. Increased deliveries of pollock and Pacific cod to Bering Sea pollock shore plants account for much of the increase in product value.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore plants and motherships are expected to increase under FMP 2.2, but the increase is of marginal significance.

Product Quality and Product Utilization Rate

No significant change in overall product quality or product utilization rate is expected to occur under FMP 2.2 relative to the comparative baseline.

Excess Capacity

Because processing amounts are expected to increase substantially with the increase in TAC, excess capacity in the inshore processing sector is expected to significantly decrease.

Average Costs

Average costs are expected to decline significantly in the inshore processing sector, as fixed costs are spread over greater throughput amounts. Unlike harvesters, inshore processors are not expected to experience higher variable costs. Rather, economies of scale within this sector are likely to result in lower average variable costs.

Cumulative Effects of FMP 2.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are expected to increase significantly compared to the baseline with increases of 49 percent for Pacific cod and 21 percent for pollock.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** As stated under FMP 2.1, the current downward trends in the commercial salmon and crab fisheries, catcher vessels that rely on a mix of groundfish, salmon and crab may result in reduction in harvest levels. However, the increases in harvest projected for groundfish species under FMP 2.2 are likely to mitigate some of these reductions and result in significantly beneficial cumulative effects for groundfish landings. Although other economic development activities and other sources of municipal and state revenue can indirectly affect processors due to recent reductions in government subsidies and power cost sharing programs, these effects are not expected to be significant under FMP 2.2.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase significantly, especially for Bering Sea pollock shore plants.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut).The recent decline in state municipal revenue sharing, power cost equalization, and contribution to education programs have is not expected to offset the significant increases in gross product value predicted under FMP 2.2 due primarily to the increases in pollock and Pacific cod in the Bering Sea. For these reasons, significantly beneficial cumulative effects on gross product value are expected to result from FMP 2.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Significantly beneficial effects are predicted for inshore processors and motherships under FMP 2.2.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Although reductions in the salmon and crab fisheries are currently taking place, the increase in groundfish employment (22 percent) under FMP 2.2 is likely to mitigate some of the reductions in these other fisheries. Similarly, payments to labor are also projected to increase (21 percent) under FMP 2.2 thereby mitigating some of the reductions in other fisheries Therefore, cumulative effects on employment and payments to labor are expected to be significantly beneficial under FMP 2.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** No significant changes in product quality or utilization rate are expected under FMP 2.2 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, the continuation of this harvest strategy may hinder some of these improvements. Overall, increases in product quality and utilization are likely in the long-term though these improvements are not likely to result in significant cumulative effects under FMP 2.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Significantly beneficial effects on excess capacity are expected under FMP 2.2 due to the increases in processing amounts.

- **Persistent Past Effects.** For details on persistent past effects see the beginning of 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed above under the section Groundfish Landings By Species Group.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Appendix F-8 Overcapacity Paper). The continuation of these programs in conjunction with increased TAC and retained harvests projected for FMP 2.2, significantly beneficial cumulative effects are expected.

Average Costs

- **Direct/Indirect Effects.** Significantly beneficial effects in average costs are expected under FMP 2.2 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects see Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described under FMP 2.1, average costs in the groundfish fisheries are often associated or shared with other fisheries. As fixed costs are spread over a greater amount of throughput under FMP 2.2, they are likely to decrease significantly. Similar to FMP 1, closures do not change significantly from the baseline condition, therefore cumulative effects on average costs in the groundfish fisheries are expected to be significantly beneficial.

4.6.9.2 Regional Socioeconomic Effects

The predicted direct and indirect effects of the groundfish fishery under Alternative 2 (FMP 2.1 and FMP 2.2) are described below. The past/present effects on regions that participate in the groundfish fishery are described in Section 3.9 (Table 3.9-126) and below; these regions (illustrated in Figures 3.9-9 through 3.9-13) include:

- Aleutian Islands/Alaska Peninsula (comprised of the Aleutians East Borough and the Aleutians West Census Area, which includes the communities of Unalaska, Nikolski, Atka, Adak and the Pribilof Islands).

- Kodiak Island (Kodiak Island Borough, which includes the City of Kodiak).

- Southcentral Alaska (the Kenai Peninsula Borough, Matanuska-Susitna Borough, Municipality of Anchorage, and the Valdez-Cordova Census Area, which includes the PWS region).

- Southeast Alaska (from Yakutat Borough to Dixon Entrance).

- Washington inland waters (all counties bordering Puget Sound and the Strait of Juan de Fuca).

- Oregon coast (Lincoln, Tillamook, and Clatsop counties).

This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. Due to the linkages of potential effects on regions that participate in the groundfish fishery to changes in harvest and processing levels under each of the policy alternatives and illustrative bookends, the direct and indirect effects of each alternative are based on an economic model that distributes potential effects to each of the participating regions. The indicators used to assess potential regional effects include the following:

- In-region Processing and Related Effects.
- Regionally Owned At-Sea Processors.
- Extra-regional Deliveries of regionally Owned Catcher Vessels.
- In-region Deliveries of regionally Owned Catcher Vessels.
- Total Direct, Indirect, and Induced Labor Income and FTE's.

As discussed earlier, these indicators also reflect changes in other important regional characteristics such as secondary economic activity associated with the support of fishing, state and municipal revenue generated by fishing, and indirectly population, to the extent that it is related to employment opportunities. For more information on the economic model used to assess direct and indirect regional effects (see the analysis for FMP 1 and Section 4.1.7 of the document).

Direct and Indirect Effects of FMP 2.1

Policy Alternative 2 removes or reduces some of the controls of the groundfish fishery, eliminates CDQ quotas, increases TAC, and represents a more aggressive harvest strategy. Under FMP 2.1, in general there is a strong net overall increase in fishery socioeconomic indicator values over baseline conditions for all regions. For example, total value of processing sales increases by about 52 percent over baseline conditions, while total processing and harvesting related income and employment increase by 53 and 56 percent, respectively, for all regions combined. These changes are driven to a large degree by the expansion of the pollock fishery, but essentially all values increase to some extent as a result of a more aggressive harvest strategy (higher TACs) and a removal of PSC limits. Elimination of the CDQ multi-species groundfish program also serves to increase overall TAC for relevant species for the non-CDQ portion of the fishery (while increases in the pollock fishery - and proportional increase of value of the CDQ portion of that fishery - would serve to offset losses from the discontinuation of the multi-species program to the CDQ region itself). Regional increases in the Alaska Peninsula and Aleutian Islands region are driven to a large degree by increased shoreplant activity (both pollock and Bering Sea cod), while Kodiak increases are driven by a mix of pollock, Pacific cod, and sablefish increases. The pattern for southcentral Alaska is similar to that seen for Kodiak while southeast changes are more directly attributable to sablefish by itself. The following subsections provide a region-by-region summary of change under FMP 2.1 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 2.1, total in-region groundfish processing value would increase by 64 percent (with increases in both BSAI and GOA). In-region processing-associated labor income and FTE jobs would both increase by 64 percent. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would decline sharply in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional deliveries by regionally owned catcher vessels would increase by 40 percent and in-region deliveries would decrease, but by a less than significant amount. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 40 and 57 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs both would decrease by a less than significant amount, but for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. (Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes.) The total regional direct, indirect, and induced labor income would increase by about 62 percent and FTE employment would increase by about 62 percent under this FMP (from a base of $226 million in labor income and 4,796 FTEs). FMP 2.1 has beneficial impacts for the Alaska Peninsula and Aleutian Islands region, and a number of these impacts are considered significant on a local sector and a regional (and multiple community) basis.

Kodiak Island. Total in-region groundfish processing value would increase by 57 percent (with higher values for GOA; BSAI values are not a significant portion of the regional total). Associated labor income and FTE jobs would also increase by 57 percent. Regionally owned at-sea processing value would increase (with the vast majority of the increase attributable to changes in BSAI values), as would associated labor income and FTEs, but none of these increases are large enough to be considered significant. (In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total; labor income and FTEs distribution between these processing sectors follows a similar pattern.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by 170 and 78 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 170 and 274 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 78 and 99 percent, respectively, but over a smaller base than seen for extra-regional deliveries. On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would increase by about 59 percent and FTE employment would increase by about 76 percent under this FMP (from a base of $65 million in labor income and 1,600 FTEs). FMP 2.1 has consistently beneficial impacts for the Kodiak Island region, and a number of these impacts are considered significant on a local sector and a regional (or at least the community of Kodiak) basis.

Southcentral Alaska. Total in-region groundfish processing value would increase by 104 percent (all attributable to GOA increases). Associated labor income and FTE jobs would also increase by 104 percent. Regionally owned at-sea processing value would increase by 78 percent (with increases in both BSAI values and GOA values), and associated labor income increasing by 78 percent and FTEs increasing by 79 percent. (In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by 116 and 124 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 116 and 115 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 124 and 137 percent, respectively. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model clearly tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase by about 103 percent and FTE employment would increase by about 107 percent (from a base of $23 million in labor income and 567 FTEs).

FMP 2.1 has consistently beneficial impacts for the southcentral Alaska region, and a number of these impacts are considered significant on a local sector basis. While some communities are likely to experience some noticeable benefits from these gains, on a regional basis (and in most involved communities), a relatively low level of groundfish dependency in local economies within this region tends to lessen what would otherwise appear to be a relatively large overall impact.

Southeast Alaska. Total in-region groundfish processing value would increase by 26 percent (all attributable to GOA decreases). Associated labor income and FTE jobs would also increase by 26 percent (but both are relatively low values). Regionally owned at-sea processing value would decrease by 49 percent (with decreases in BSAI values offset to a degree by increases in GOA values), and associated labor income and FTEs both decreasing by 49 percent. (In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would increase by about 57 percent and in-region deliveries by regionally owned catcher vessels would increase by 24 percent. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 51 and 58 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 24 and 25 percent, respectively. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase, but not by a large enough amount to be considered significant, while FTE employment would increase by about 20 percent (from a base of $34 million in labor income and 879 FTEs). FMP 2.1 has consistently beneficial impacts for the southeast Alaska region, and a number of these impacts are considered significant on a local sector basis. As was the case for the southcentral Alaska region for this FMP, while some communities are likely to experience some noticeable benefits from these gains, on a regional basis (and in most involved communities), a relatively low level of groundfish dependency in local economies within the southeast Alaska region tends to lessen what would otherwise appear to be a relatively large overall impact.

Washington inland waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase by 45 percent (with increases in both BSAI and GOA values, although GOA values are comparatively very small), and associated labor income and FTEs would increase by 43 and 49 percent, respectively. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by 58 and 55 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 58 and 112 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 55 and 131 percent, respectively. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase by about 47 percent and FTE employment would also increase by about 47 percent (from a base of $557 million in labor income and 10,316 FTEs). FMP 2.1 has consistently beneficial impacts for the Washington inland waters region, and while a number of these impacts are considered significant on a local sector basis, none are likely to be significant on a community or regional basis as a result of the relative size of the communities and the size and diversity of the local economy.

Oregon coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase by 48 percent, and associated labor income and FTE jobs would increase 48 and 106 percent, respectively. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this FMP. The total regional direct, indirect, and induced labor income would increase by about 48 percent and FTE employment would increase by about 73 percent (from a base of $15 million in labor income and 318 FTEs). FMP 2.1 has consistently beneficial impacts for the Oregon coast region and while some of these impacts may be considered significant on a local sector basis, none are considered significant on a community or regional basis due to a relatively low level of economic dependency on the groundfish fishery.

Cumulative Effects of FMP 2.1

See Table 4.6-6 for a summary of the cumulative effects on regions and communities under FMP 2.1.

<u>In-Region Processing and Related Effects</u>

- **Direct/Indirect Effects.** For FMP 2.1, direct/indirect effects are considered significantly beneficial for the Alaska Peninsula/Aleutian Islands, Kodiak Island, southcentral Alaska, and southeast Alaska regions. Direct/indirect effects are generally insignificant for the Washington inland waters, and Oregon coast regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1, cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are generally insignificant, although for different reasons in different regions. The influence of external factors is adverse for many of the in-region processors based in Alaska and their associated regions. Trends in multi-species fisheries and other sources of municipal and state revenue, primarily due to the continued crab closures, downturn in salmon and reductions in state and municipal revenue, result in adverse effects on in-region processing and municipal revenue. These adverse external effects are offset by significant increases in Alaska in-region processing, resulting in a finding of insignificant cumulative effect. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant, and there are no reasonably foreseeable events that would have a significant contribution, resulting in a finding of insignificant cumulative effect.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** Under FMP 2.1, direct/indirect effects are considered significantly beneficial for the southcentral Alaska and Washington inland waters regions. Direct/indirect effects are generally insignificant for the Alaska Peninsula/Aleutian Islands, Kodiak Island, and Oregon coast regions, and are significantly adverse for the southeast Alaska region.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1, cumulative effects on regionally owned at-sea processing and on related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. While direct/indirect effects are beneficial for southcentral Alaska and Washington inland waters regions, reasonably foreseeable external effects will not contribute much to cumulative effects, particularly given the size and diversity of the regional economies. Direct/indirect effects are insignificant in Kodiak Island, where most of the Alaska at-sea processor fleet is based. As indicated previously, with a more diversified economy and population base, cumulative effects in Kodiak Island will be adverse due to external factors, but cumulatively insignificant.

Extra-regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 2.1, direct and indirect effects are significantly beneficial for all six regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1, significantly beneficial effects for all regions contribute to regional economies. However, given the size and diversity of some regional economies, and the adverse nature of external effects related to other fisheries and revenue sharing in the Alaska regions that offset benefits, cumulative effects are insignificant for all regions.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 2.1, direct/indirect effects are significantly beneficial for Kodiak Island, southcentral Alaska, southeast Alaska, and Washington inland waters; effects are insignificant for the Alaska Peninsula/Aleutian Islands, and Oregon coast regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1 the direct/indirect effects range from beneficial to insignificant. However, given the size and diversity of some regional economies, and the adverse nature of external effects related to other fisheries and revenue sharing in the Alaska regions that offset benefits, cumulative effects are insignificant for all regions.

Total Direct, Indirect, and Induced Labor Income and FTEs

- **Direct/Indirect Effects.** Under FMP 2.1, direct/indirect effects on labor income and employment increase and are significantly beneficial for all regions, except for southeast Alaska, where the increase is insignificant.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.1 direct/indirect effects on labor income and employment are significantly beneficial for all regions. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Trends in other fisheries (particularly salmon) and reductions in municipal revenue decrease labor income and employment and offset these benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects are beneficial, but insignificant in all regions.

Direct/Indirect Effects of FMP 2.2

Under FMP 2.2, in general fishery socioeconomic indicators fall in a range between the values seen under FMP 1 and those seen under FMP 2.1. Indicators at the most aggregated level are greater than baseline conditions for all regions. For example, total value of processing sales increases by about 22 percent over baseline conditions, while total processing and harvesting related income and employment increase by 22 and 19 percent, respectively, for all regions combined. Pollock and Pacific cod values are up overall, but the effects of this increase are most pronounced in the Alaska Peninsula and Aleutian Islands and Kodiak regions. Sablefish and rockfish increases play a large proportional role in the overall increases seen in the southcentral and southeast Alaska regions. One caveat to the data that appear in the regional summaries for this FMP, however, is that the model tends to overstate the increases seen in southcentral and understate the increases in southeast due to apportionment difficulties, so regional variations between these two should be treated with caution. (Overall values for the two regions combined are apparently accurate; it is the split between the two that is problematic.) As with FMP 2.1, essentially all socioeconomic indicator values increase to some extent as a result of a more aggressive harvest strategy compared to baseline conditions. Unlike FMP2.1, however, the CDQ multi-species groundfish program continues unchanged from baseline conditions under FMP 2.2. The following subsections provide a region-by-region summary of change under FMP 2.2 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 2.2, total in-region groundfish processing value would increase by 24 percent (with increases in both BSAI and GOA values). In-region processing associated labor income and FTE jobs would also increase by 24 percent. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would increase in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional deliveries by regionally owned catcher vessels would remain the same and in-region deliveries would decrease, but by an amount that is considered less than significant. Catcher vessel payments to labor would remain the same and FTE jobs associated with extra-regional deliveries would decrease, but not to a significant degree. For in-region deliveries, catcher vessel payments to labor and FTEs would also decrease (by a less than significant amount), but for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. (Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes.) The total regional direct, indirect, and induced labor income would increase by about 24 percent and FTE employment would increase by 23 percent under this FMP (from a base of $226 million in labor income and 4,796 FTEs). FMP 2.2 would result in beneficial impacts for the Alaska Peninsula and Aleutian Islands region, and a number of these impacts would be considered significant on a local sector and a regional (and multiple community) basis.

Kodiak Island. Total in-region groundfish processing value would increase (with high values for both GOA and BSAI; BSAI values are not a significant portion of the regional total) as would associated labor income and FTE jobs, but these increases would not rise to the level of significance. Regionally owned at-sea processing value would increase by 25 percent (with the vast majority of the increase attributable to changes in BSAI values), and associated labor income and FTEs would increase by 24 and 25 percent, respectively. (In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total; labor income and FTEs distribution between these processing sectors follow a similar pattern.) The value of extra-regional deliveries by regionally owned catcher vessels would increase by 32 percent, and while in-region deliveries would also increase, this increase would not be significant. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 32 and 38 percent, respectively. For in-region deliveries, catcher vessel payments to labor would increase and FTEs would decrease, but neither change would be significant (and would be over a smaller base than seen for extra-regional deliveries). On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would increase as would FTE employment under this FMP (from a base of $66 million in labor income and 1,600 FTEs), but these changes would not rise to the level of significance. FMP 2.2 would generally result in beneficial impacts for the Kodiak Island region, and a number of these impacts would be considered significant on a local sector basis, but it would appear that the impacts, while beneficial, would be less than significant on a regional (or community of Kodiak) basis.

Southcentral Alaska. Total in-region groundfish processing value would increase by 34 percent (all attributable to GOA increases). Associated labor income and FTE jobs would also increase by 34 percent. Regionally owned at-sea processing value would increase by 34 percent (with relatively large increases in BSAI values and smaller increases in GOA values), and associated labor income and FTEs both increasing by 34 and 35 percent, respectively. (In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would increase, but by less than a significant amount, while in-region deliveries would rise by 41 percent. Catcher vessel payments to labor associated with extra-regional deliveries would increase and FTE jobs would decrease, but neither change would be significant. For in-region deliveries, catcher vessel payments to labor and FTEs would increase, but this change would also be less than significant. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase by about 31 percent and FTE employment would increase 22 percent (from a base of $23 million in labor income and 567 FTEs). FMP 2.2 would generally result in beneficial impacts for the southcentral Alaska region, and some of this rise to the level of significance on a local sector basis. As noted in the FMP 2.1 discussion, however, there are indications that the model overstates gains attributed to the southcentral and understates gains to the southeast Alaska region. Further, given the economic diversity of the involved southcentral communities and the relatively low level of groundfish dependency in the local economies, impacts that appear significant on a sector basis are not likely to be significant on a regional or even a community basis, with very few possible exceptions.

Southeast Alaska. Total in-region groundfish processing value would decrease by an insignificant amount (all attributable to GOA decreases), as would associated labor income and FTE jobs (but both are relatively low values). Regionally owned at-sea processing value would increase by 25 percent (with increases in BSAI values and GOA values), and associated labor income and FTEs both increasing by 25 percent. (In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would increase by 22 percent, while in-region deliveries would decrease by a less than significant amount. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 22 and 23 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would about the same. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income and associated FTEs would all increase (from a base of $34 million in labor income and 879 FTEs), but these changes would not rise to the level of significance. FMP 2.2 would have generally beneficial impacts on the southeast Alaska region, and these impacts would be significant for some local sectors, regional level impacts resulting from this FMP are unlikely to be significant given the diversity of the local economies and the relative lack of dependence on the groundfish fishery.

Washington inland waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase by 22 percent (with increases in both BSAI and GOA values, although GOA values are comparatively very small), and associated labor income and FTEs would increase by 22 and 23 percent, respectively. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by 24 and 21 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would increase by about 24 and 23 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 21 and 29 percent, respectively. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase by about 22 percent and FTE employment would increase, but by a less than significant amount (from a base of $557 million in labor income and 10,316 FTEs). FMP 2.2 would result in significantly beneficial impacts to local sectors in the Washington inland waters region, but these impacts would not rise to the level of significance on a regional or a community of Seattle basis, given the scale of the local economy and the relative lack of dependency on the groundfish fishery.

Oregon coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase by 22 percent, and associated labor income and FTE jobs would increase 22 and 28 percent, respectively. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this FMP. The total regional direct, indirect, and induced labor income would increase by about 22 percent and FTE employment would increase by about 24 percent (from a base of $15 million in labor income and 318 FTEs). FMP 2.2 would result in significantly beneficial impacts to the local catcher vessel sector in the Oregon coast region, but these impacts would not be significant on a community or regional basis, given the scale and diversity of local economies and the low degree of dependency on the groundfish fishery.

Cumulative Effects of FMP 2.2

See Table 4.6-6 for a summary of the cumulative effects on regions and communities under FMP 2.1 and FMP 2.2.

In-Region Processing and Related Effects

- **Direct/Indirect Effects.** For FMP 2.2, direct/indirect effects are considered significantly beneficial for the Alaska Peninsula/Aleutian Islands and southcentral Alaska regions. Direct/indirect effects are generally insignificant for the Kodiak Island, southeast Alaska, Washington inland waters, and Oregon coast regions. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, cumulative effects fall between FMP 2.1 and FMP 1. Within the four Alaska regions, benefits from increased processing are offset by the adverse external effects in other fisheries, economic development and state and municipal revenue. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant, and there are no reasonably foreseeable events that would have a significant contribution. Cumulative effects for all six regions are cumulatively insignificant.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** For FMP 2.2, direct/indirect effects are considered significantly beneficial for the Kodiak Island, southcentral Alaska, southeast Alaska, and Washington inland waters regions. Direct/indirect effects are generally insignificant for the Alaska Peninsula/Aleutian Islands and Oregon coast regions. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for In-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, direct/indirect effects are beneficial for four regions and insignificant for the other two regions. Based on direct/indirect benefits and economic diversity, adverse external factors in Alaska regions are offset, and cumulative effects are insignificant.

Extra-regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 2.2, direct and indirect effects are significantly beneficial for the Washington inland waters, Kodiak Island, southeast Alaska, and Oregon coast regions and insignificant for southcentral Alaska and Alaska Peninsula/ Aleutian Islands. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, cumulative effects are insignificant for all regions, where direct/indirect benefits generally offset adverse external factors in Alaska regions. In southeast Alaska, direct/indirect effects are insignificant, and adverse external effects are likely to result in adverse but insignificant cumulative effects.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 2.2, direct/indirect effects are significantly beneficial for southcentral Alaska and Washington inland waters and are insignificant for the Alaska Peninsula/Aleutian Islands, Kodiak Island, southeast Alaska, and Oregon coast regions. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, direct/indirect effects of in-region deliveries range from beneficial to insignificant. However, given the size and diversity of some regional economies, and the adverse nature of external effects related to other fisheries and revenue sharing in the Alaska regions that offset benefits, cumulative effects are insignificant for all regions.

Total Direct, Indirect, and Induced Labor Income and FTEs

- **Direct/Indirect Effects.** Under FMP 2.2, direct/indirect effects on labor income and employment increase and are significantly beneficial for Alaska Peninsula/Aleutian Islands, southcentral Alaska, Washington inland waters, and Oregon coast regions. In Kodiak Island and southeast Alaska the increase is insignificant. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all FMPs. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 2.2, employment increases in all regions, but not necessarily in a significant manner. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Trends in other fisheries (particularly salmon) and reductions on municipal revenue, decrease labor income and employment offset these benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects are beneficial, but insignificant in all regions.

4.6.9.3 Community Development Quota Program

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described below. The past/present effects on CDQ are described in Section 3.9 (Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is allocation of catch to CDQ groups. It should be noted that allocation reflects potential revenue to CDQ groups, and indirectly the potential funds that are available for approved economic development activities in CDQ communities.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Community Development Quota Related Impacts Under FMP 2.1

Under FMP 2.1, the fishery would be returned to an open-access scenario, where many time/area closures, gear restrictions, and PSC restrictions are repealed. The Federally mandated effort limitation program enacted under the American Fisheries Act, with its CDQ allocation for pollock, would remain in place, and the CDQ Program, mandated by the MSA, would be modified to allocate only a percentage of the BSAI TAC for pollock to the CDQ Program. All other effort limitation programs including, but not limited to, the multi-species CDQ groundfish program, would be repealed. The multi-species groundfish CDQ program has steadily grown in relative importance since its inception, and in 2000 it accounted for approximately one-tenth of all CDQ royalties. Due to the loss of revenue and other economic and employment opportunities under this FMP, repeal of the multi-species program would generate adverse impacts to CDQ groups. However, under FMP 2.1, the pollock fishery would expand substantially over baseline conditions, so it is assumed that the pollock CDQ program would proportionally expand with the rest of that fishery. In terms of net change, this expansion would offset the losses incurred as a result of the discontinuation of the multi-species program, but it is the case that losses and gains would not be evenly distributed among CDQ groups due to differential reliance on the various species under the overall CDQ program (and within the multi-species program in particular). As a result, the significance of direct/indirect effects are unknown.

Community Development Quota Related Impacts Under FMP 2.2

As noted above, under FMP 2.2, direct/indirect effects would be similar to FMP 1. The existing level of BSAI groundfish quota would continue to be apportioned under the CDQ program to the 65 eligible western Alaska communities through the established CDQ groups. It is assumed that the multi-species CDQ program and quotas would continue as well. Under FMP 2.2, TAC increases, so no adverse impacts to the CDQ program or regions are anticipated.

Cumulative Effects of FMP 2.1 and FMP 2.2

Cumulative effects on CDQ for FMP 2.1 and FMP 2.2 are summarized on Table 4.6-6.

CDQ Allocations

- **Direct/Indirect Effects.** Under FMP 2.1, the direct/indirect effects of the groundfish fisheries on the CDQ program are unknown. Under FMP 2.2, the direct/indirect effects of the groundfish fisheries on the CDQ program are insignificant.

- **Persistent Past Effects.** The past/present effects on the CDQ program for groundfish fisheries include establishment of CDQ program; FMP amendments that further added or defined CDQ in 1992, 1995, 1996, and 1998; establishment of multi-species CDQ programs, and persistent limitations on economic development and associated employment activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, other sources of municipal and state revenue all have the potential to affect the CDQ program adversely or beneficially. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1, the potential cumulative effects for the CDQ program are unknown. There is some level of adverse cumulative effects to the CDQ program but significance is unknown. Under this FMP the fishery would be returned to an open access scenario creating increased competition. The multi-species CDQ groundfish program would be repealed, and the overall groundfish CDQ program would be scaled back to only a single species, pollock. Discontinuation of the multi-species program would be an adverse impact, but given the increase in pollock TAC under this FMP, the CDQ return on pollock is expected to increase resulting in a beneficial impact. However, the losses and gains would not be evenly distributed among CDQ groups due to the differential reliance on various species. Under FMP 2.2, the cumulative effect on the CDQ program is insignificant. With guaranteed CDQ shares through the CDQ program, no significantly adverse cumulative impacts to the CDQ program are expected.

4.6.9.4 Subsistence

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described below. The past/present effects on subsistence are described in 3.9 (including a summary in Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis are other fisheries such as foreign JV, domestic, and state-managed fisheries, other economic development activities, sport and personal use, and long-term climate change and regime shift.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Potential impacts to subsistence fall into four main categories: subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon in western Alaska and bycatch in the groundfish fisheries, and indirect impacts on other subsistence activities, including loss of income that would be otherwise directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would be otherwise be available for joint production opportunities.

Under FMP 2.1, increases in the commercial fishery are anticipated but would not result in significantly adverse direct/indirect impacts to baseline subsistence groundfish fishing conditions. This FMP would have a conditionally significant adverse impact on Steller sea lion subsistence activities or take over baseline conditions. Although Steller sea lion protection measures are retained, questions remain about the impact of reduced pelagic forage availability as noted in earlier sections. If these issues result in significant Steller population decline, a significantly adverse impact to Steller sea lion subsistence activities could result. Under this FMP bookend, salmon bycatch may be expected to increase due to the repeal of PSC restrictions. This would create a conditionally significant adverse impact on subsistence salmon fisheries, with the conditions for significance being met if the resulting level of increased bycatch results in significant decreases in salmon returns to subsistence fishery areas. Catcher vessel activity and labor income are anticipated to increase under this FMP; therefore no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

Under FMP 2.2, no changes in the commercial fishery are anticipated that would result in impacts to baseline subsistence groundfish fishing conditions. There is also no indication that this FMP would have an adverse impact on Steller sea lion subsistence activities or take over baseline conditions. (Although under this FMP a more aggressive harvest policy is implemented, Steller sea lion protection measures are retained so it is assumed there are no adverse impacts to that species, but there are still concerns with pelagic forage availability as noted earlier). Salmon bycatch would essentially remain the same as under baseline conditions and is determined to have no significantly adverse effect on the return of salmon to western Alaska rivers; therefore no significantly adverse impacts to subsistence salmon fisheries are expected to result. Catcher vessel activity and labor income are anticipated to increase under this FMP; therefore no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

Cumulative Effects of FMP 2.1 and FMP 2.2

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described above. The past/present effects on subsistence are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. Representative indicators used in this analysis are the same as those used in the direct/indirect analysis and include subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon, and indirect impacts on other subsistence activities (Table 4.6-6). For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Subsistence Use of Groundfish

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, no changes in the commercial fishery are anticipated that would result in impacts to baseline subsistence groundfish fishing conditions. The effects of FMPs 2.1 and 2.2 are insignificant.

- **Persistent Past Effects.** Foreign JV, domestic, and state-managed fisheries have decreased populations of some species of groundfish used for subsistence. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries and long-term climate change have a potential to adversely contribute to subsistence use of the groundfish fisheries. Economic development and sport and personal use are not likely to adversely contribute to subsistence use of the groundfish fisheries. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1 and FMP 2.2, the cumulative effects for subsistence use of groundfish are insignificant. The external impacts of other fisheries, economic development activities, and sport and personal use of groundfish are not likely to contribute to significantly adverse cumulative effects on the groundfish fisheries. Other state-managed fisheries could have adverse impacts to the subsistence use of groundfish due to the direct competition for the same species, but are not considered to be significant. The long-term climate change could adversely affect groundfish stocks.

Subsistence use of Steller Sea Lions

- **Direct/Indirect Effects.** Under FMP 2.1, there would be a conditionally significant adverse impact on Steller sea lion subsistence activities or take compared to baseline conditions. Although Steller sea lion protection measures are retained, questions remain about the impact of reduced pelagic forage availability as noted in earlier sections. If these issues result in significant Steller population decline, a significantly adverse impact to Steller sea lion subsistence activities could result. Under FMP 2.2, effects would be similar to FMP 1 and there would be insignificant effects on Steller sea lion subsistence activities or take over baseline conditions.

- **Persistent Past Effects.** The past/present effects on subsistence use of Steller sea lions include the following: a long-term decline in population of Steller sea lions due to a number of factors; a long-term decline in relative importance of marine mammals in local diets; commercial groundfish fishing taking prey species utilized by Steller sea lions; and Steller sea lion protection measures designed to assist in population recovery instituted in 2000. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, economic development, and long-term climate change have a potential to adversely contribute to Steller sea lions subsistence activities. Sport and personal use is not likely to adversely contribute to subsistence use of Steller sea lions. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMPs 2.1, a conditionally significant adverse cumulative effect is identified for subsistence use of Steller sea lions. The adverse cumulative effects on subsistence use of Steller sea lions all reduce the availability of Steller sea lions for subsistence use. They include the combined take for subsistence in other fisheries and in the groundfish fisheries and the reduced availability resulting from the continuing endangered status and long-term decline in abundance. Under FMP 2.2, the cumulative effect for subsistence use of Steller sea lions is insignificant. The adverse cumulative effects are not sufficient to significantly impact subsistence.

Subsistence Use of Western Alaskan Salmon and Bycatch in the Groundfish Fishery

- **Direct/Indirect Effects.** Under FMP 2.1, salmon bycatch may be expected to increase due to the repeal of prohibited species catch restrictions. This would create a conditionally significant adverse impact on subsistence salmon fisheries, with the conditions for significance being met if the resulting level of increased bycatch results in significant decreases in salmon returns to subsistence fishery areas. Under FMP 2.2, salmon bycatch would essentially remain the same as under baseline conditions and is determined to have insignificant effects.

- **Persistent Past Effects.** The past/present effects on subsistence use of salmon include the following: utilization for subsistence since pre-contact times; and Area M closures implemented to decrease intercept of salmon; these factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities and long-term climate change and regime shift could all adversely contribute to salmon subsistence activities. Sport and personal use is not likely to adversely contribute to salmon subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1, a conditionally significant adverse cumulative effect is identified for subsistence use of salmon. Given the removal of the prohibited species catch caps, poor stock status of salmon runs in western Alaska and the combined effects of groundfish and state fisheries bycatch potential in BSAI and GOA, the availability of depressed salmon stocks for subsistence could be significantly impacted. Under FMP 2.2, insignificant cumulative effects are identified as the conditions are not expected to change from FMP 1.

Indirect Impacts on Other Subsistence Activities (Income and Joint Production Opportunities)

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, catcher vessel activity and labor income are anticipated to be neutral or increase,; therefore insignificant effects to subsistence through a decline in income or joint production opportunities are expected to occur.

- **Persistent Past Effects.** The past/present effects on the indirect impacts on other subsistence activities include joint production as a part of local groundfish and other commercial fishery development from the outset; and income from fishing used for investment in subsistence is similar to use of income from other activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shift could all adversely or beneficially contribute to indirect subsistence activities. Sport and personal use is not likely to adversely contribute to indirect impacts on other subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1 and FMP 2.2, an insignificant cumulative effect is identified for indirect subsistence use. Under FMP 2.1 the increased opportunities for joint production are beneficial but not significant, offset by trends in other fisheries such as salmon. Under FMP 2.2 adverse cumulative effects are similar to the baseline and are not enough to have significant impacts on subsistence. Income catcher vessel activity, and joint production opportunities are not expected to be effected adversely. However, the external impacts of other fisheries, other economic development activities, and long-term climate change and regime shift could potentially contribute adversely to the indirect subsistence use.

4.6.9.5 Environmental Justice

The predicted direct and indirect effects of the groundfish fishery under Alternative 2 (FMP 2.1 and FMP 2.2) are described below. The past/present effects on Environmental Justice are described in Section 3.9 (and are summarized in Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The external effects used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, other sources of municipal and state revenue, and long-term climate change and regime shift.

Direct/Indirect Effects of FMP 2.1

Potential impacts that drive Environmental Justice issues include employment/municipal revenue and taxes in communities with significant percentages of special populations (Alaska Native and minority processing workforce); revenue to Alaska Native-owned catcher vessels; revenue to Alaska Native-owned catcher processors; subsistence activities associated with groundfish, Steller sea lion, and salmon; and the loss of income from fishing that would be otherwise directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. The regions that could experience potential impacts include the Alaska Peninsula and Aleutian Islands, Kodiak Island, southcentral Alaska, southeast Alaska, Washington inland waters, Oregon coast, the CDQ regions, and western Alaska communities that harvest salmon for subsistence purposes.

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominantly Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 2,194 jobs; therefore, insignificant environmental justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $758 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities and therefore no associated environmental justice impacts would occur. In this region the ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under FMP 2.1, the total value of catcher vessel operations would increase as would corresponding labor income and employment; therefore, no associated Environmental Justice impacts would result.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 324 jobs; therefore, insignificant Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $127 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the City and the Kodiak Island Borough, but given local and regional demographics, this change is not likely to be relevant as an Environmental Justice issue. Ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the City of Kodiak itself, and therefore the local fleet associated population is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under FMP 2.1, the total value of catcher vessel operations would increase as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be connected to Environmental Justice issues.

Southcentral Alaska. As described in existing conditions, Environmental Justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and thus it is unlikely that environmental justice issues will be associated with any employment change. In general, under FMP 2.1 overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns. Similarly, processing value increases, as do catcher vessel associated values, but these changes are not tied to Environmental Justice concerns. The direct/indirect effects on environmental justice are therefore, insignificant.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall environmental justice concerns appear not to apply in this region. In general, under FMP 2.1 overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to Environmental Justice concerns. Similarly, processing value increases and analogous catcher vessel associated values increase, but this change is not associated with environmental justice concerns. The direct/indirect effects on Environmental Justice are therefore, insignificant.

Washington inland waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, Environmental Justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under FMP 2.1, at-sea processing labor income increases by 43 percent and FTEs increase by 49 percent, so there are insignificant Environmental Justice impacts associated with this change.

Oregon coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under FMP 2.1 overall combined direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are not linked to Environmental Justice concerns. The direct/indirect effects on Environmental Justice are therefore, insignificant.

CDQ region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve Environmental Justice concerns. As described in Section 4.6.9.3, the CDQ program and region would experience adverse impacts under FMP 2.1 from the elimination of the multi-species CDQ program. However, while these decreases would be offset by increases in returns from the pollock CDQ allocation for an overall net gain, this offset will not be uniform across CDQ groups.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve Environmental Justice concerns. Subsistence activities where there are potential Environmental Justice issues under FMP 2.1 include the harvest of Steller sea lion (primarily and activity in the Alaska Peninsula/Aleutian Islands region), and salmon (primarily an issue in western Alaska, where poor runs have adversely affected subsistence harvests). Increased TAC and reduction in or elimination of measures to limit salmon by-catch would potentially create significantly adverse Environment Justice issues for communities in the Alaska Peninsula/Aleutian Islands region that harvest Steller Sea lions, and in western Alaska communities that rely on salmon.

Under FMP 2.1, increased opportunities related to income and joint production indicate that there are insignificant impacts on Environmental Justice issues.

Cumulative Effects of FMP 2.1

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 are described above. The past/present effects on Environmental Justice Issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicators used in this analysis are the same as those used in the direct/indirect analysis.

- **Direct/Indirect Effects.** Under this FMP, direct/indirect impacts are insignificant as no changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline. However, conditionally significant adverse effects on western Alaskan communities due to increased salmon bycatch under FMP 2.1 are possible.

- **Persistent Past Effects.** Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, other sources of municipal/state revenue, and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1, an insignificant cumulative effect is identified for Environmental Justice, with the exception of a conditionally significant adverse effect on salmon subsistence in western Alaska. In general, benefits, including municipal revenues, would increase for both Alaska Native and non-Native communities participating in groundfish fisheries, but overall cumulative effects are insignificant. Increased joint production opportunities for subsistence are beneficial effects, but are cumulatively insignificant. The multi-species groundfish CDQ program would be eliminated under FMP 2.1, creating some level of adverse cumulative effects, but these effects would be largely offset by increased returns under the pollock CDQ program. Under FMP 2.1 salmon bycatch could be expected to increase due to the repeal of prohibited species catch restrictions. This could create conditionally significant adverse cumulative effects to subsistence fishery areas. Adverse cumulative effects to Steller sea lion subsistence activities could result but are not expected to be significant.

Direct/Indirect Effects of FMP 2.2

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominantly Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 827 jobs; therefore, no environmental justice associated impacts would result. Total in-region groundfish processing value would increase from $464 million to $575 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities and therefore no associated environmental justice impacts would occur. In this region the ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under FMP 2.2, the total value of catcher vessel operations would decrease as would corresponding labor income and employment; therefore, an apparent Environmental Justice impact may occur, but it is likely that this apparent decline is at least in part an artifact of the output model's limitation on the ability to adequately assign western Gulf of Alaska catch to the region rather than an actual decline.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would decrease over baseline conditions by about 37 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $86 million. The increased in-region processing value would provide higher municipal revenue and taxes to the City and the Kodiak Island Borough, and given local and regional demographics, this is not likely to be an Environmental Justice issue. Ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the City of Kodiak itself, and therefore the local fleet associated population is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under FMP 2.2, the total value of catcher vessel operations would increase as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be relevant as an Environmental Justice issue.

Southcentral Alaska. As described in existing conditions, environmental justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and thus it is unlikely that Environmental Justice issues will be associated with any employment change. In general, under FMP 2.2 overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns. Similarly, processing value increases and catcher vessel associated values increase, but these changes are not tied to Environmental Justice concerns. See Table 3.9-126 for a summary of the direct/indirect effects on environmental justice in the southcentral Alaska region and communities.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall Environmental Justice concerns appear not to apply in this region. In general, under FMP 2.2 overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to Environmental Justice concerns. Similarly, processing value decreases, but this change is not associated with Environmental Justice concerns.

Washington inland waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, Environmental Justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under FMP 2.2, at-sea processing labor income and FTEs increase by 22 and 23 percent, respectively, so there are no Environmental Justice impacts associated with this change.

Oregon coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under FMP 2.2 overall combined direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are not considered relevant to Environmental Justice concerns.

CDQ region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve Environmental Justice concerns. As described in Section 4.6.9.3, the CDQ program and region would experience impacts under FMP 2.2 similar to those seen under FMP 1, with no significantly adverse impacts foreseen.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve Environmental Justice concerns. As described above, adverse impacts to subsistence activities are not foreseen under FMP 2.2 (with the possible exception to Steller sea lion population dynamics), therefore no associated Environmental Justice impacts are anticipated.

Cumulative Effects of FMP 2.2

The predicted direct and indirect effects of the groundfish fishery under FMP 2.2 are described above. The past/present effects on Environmental Justice Issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicators used in this analysis is the same as that used in the direct/indirect analysis (Table 4.6-6).

- **Direct/Indirect Effects.** Under this FMP, direct/indirect impacts range from beneficial to adverse, but any changes in the commercial fishery would result in insignificant effects to baseline, with the exception of conditionally significant adverse effects on western Alaskan communities due to increased salmon bycatch under FMP 2.2. However, the overall effects are still insignificant.

- **Persistent Past Effects.** Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, other sources of municipal/state revenue, and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.2, an insignificant cumulative effect is identified for Environmental Justice. In general, benefits, including municipal revenues, would increase for both Alaska Native and non-Native communities participating in groundfish fisheries, but cumulative effects are insignificant. Increased joint production opportunities for subsistence are beneficial effects, but are cumulatively insignificant. Salmon bycatch could have adverse cumulative effects but not enough to be significant. Significantly adverse cumulative effects to Steller sea lion subsistence activities could result but not enough to be significant.

4.6.9.6 Market Channels and Benefits to U.S. Consumers

The predicted direct and indirect effects of the groundfish fishery under the FMP 2.1 and FMP 2.2 are described below. The past/present effects on Market Channels and Benefits to U.S. Consumers are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. Representative indicators used in this analysis include product quantity, product year-round availability, product quality, and product diversity on Market Channels and Benefits to U.S. Consumers activities.

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

FMP 2.1 is expected to have an insignificant effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. FMP 2.1 will result in the increased production of most groundfish products. An estimate of the final market value of BSAI and GOA seafood products is not available; however, it would be substantially greater than $2.2 billion, the projected 5-year mean of the wholesale product value of BSAI and GOA groundfish after primary processing under FMP 2.1. This product value mean is 57 percent greater than the comparative baseline. While most products produced from Alaska groundfish enter an international market, some of the consumer benefits of this increased production are expected to accrue to American seafood consumers. The price elasticity of demand for groundfish products is fairly high in the U.S. market, but assuming that the demand for groundfish products is not perfectly elastic, the expected increase in production could result in lower prices and a gain of consumer surplus (i.e., net benefits) to the American public. The magnitude of that gain will depend on price elasticities that are not quantifiable at this time and on the degree to which production is shifted toward or away from export markets. However, it is unlikely that the gain in consumer surplus will be significant. Moreover, these potential consumer benefits may be partially offset by the expected decrease in quality of some groundfish products that results from the intensification of the race for fish occurring under this FMP.

FMP 2.2 is expected to have an insignificant effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. Under FMP 2.2 the BSAI and GOA groundfish fisheries are expected to continue to provide high and relatively stable levels of seafood products to domestic and foreign markets. An estimate of the final market value of BSAI and GOA seafood products is not available; however, it would be substantially greater than $1.7 billion, the projected 5-year mean of the wholesale product value of BSAI and GOA groundfish after primary processing under FMP 2.2. This product value mean is 26 percent greater than the comparative baseline. While most products produced from Alaska groundfish enter an international market, some of the consumer benefits of this increased production are expected to accrue to American seafood consumers. The price elasticity of demand for groundfish products is fairly high in the U.S. market, but assuming that the demand for groundfish products is not perfectly elastic, the expected increase in production could result in lower prices and a gain of consumer surplus (i.e., net benefits) to the American public. However, it is unlikely that the gain in consumer surplus will be significant.

Cumulative Effects of FMP 2.1 and FMP 2.2

For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Market Channels and Benefits to U.S. consumers

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2, increases in benefits to U.S. consumers of groundfish products are expected to occur but are insignificant.

- **Persistent Past Effects.** These effects on benefits to U.S. consumers of groundfish products include: Alaska Seafood Marketing Institute product promotion activities, research and public awareness regarding the health benefits of seafood consumption, aquaculture development increasing overall availability and demand for seafood products, and changes in processing technology increasing seafood quality.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable effects include other fisheries (supply of product) and long-term climate change and regime shift. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 2.1 and FMP 2.2, an insignificant cumulative effect is identified for benefits to U.S. consumers of groundfish products. FMP 2.1 will result in the increased production of most groundfish products with the potential decrease in quality of some groundfish products. FMP 2.2 will result in an expected increase in production with the potential to result in lower prices and a gain of consumer surplus. However, it is unlikely that the gain in consumer surplus will be significant. The external impacts of other fisheries have the potential to contribute adversely or beneficially to the U.S. consumers of groundfish products and the groundfish market channels. However, the wholesale groundfish product value in conjunction with products from other fisheries is not expected to change benefits to U.S. consumers. The long-term climate change and regime shift could adversely effect availability for market channels due to the natural fluctuations in groundfish stocks.

4.6.9.7 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (Including Non-Consumptive and Non-Use Benefits)

The predicted direct and indirect effects of the groundfish fishery under FMP 2.1 and FMP 2.2 are described below. Benefits derived from marine ecosystems and associated species are used as a surrogate to evaluate non-consumptive and non-use benefits. The past/present effects on non-consumptive and non-use Benefits to U.S. general public are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits).

Direct/Indirect Effects of FMP 2.1 and FMP 2.2

Under FMP 2.1, the Bering Sea and GOA marine ecosystems and species associated with them are expected to generate significantly lower levels of some benefits relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 2.1 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.6.10 of the Draft Programmatic SEIS.

As described in Section 3.9.7, the Bering Sea and GOA marine ecosystems and species associated with them provide a broad range of benefits to the American public. Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. While there are difficulties in estimating the value the public places on protecting ecological conditions, Section 3.9.7 provides a qualitative discussion of possible benefits provided by the Bering Sea and GOA marine ecosystems. In addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing. Furthermore, some people may not directly interact with the Bering Sea and GOA marine ecosystems and the various species associated with them but derive satisfaction from knowing that the structure and function of these ecosystems are protected.

The focus in this analysis is on the direct and indirect effects of the alternatives on ecosystem benefits other than those that accrue to members of society who make a living harvesting, processing and distributing BSAI and GOA groundfish products or who purchase and consume these products. The direct and indirect effects of the alternatives on firms and communities that derive value from the commercial harvest and processing of groundfish are described elsewhere in the Draft Programmatic SEIS. Similarly, the effects of the alternatives on consumers of groundfish products are discussed in a separate section of the Draft Programmatic SEIS.

The value people assign to those marine ecosystem benefits that are unrelated to commercial groundfish fisheries are thought to be considerable. For example, the value of protecting the Steller sea lion alone may be substantial. As discussed in Section 3.9.7, a contingent valuation study suggests that there is a significant willingness to pay on the part of the American public for an expanded Federal Steller sea lion recovery program. At this time, however, there is insufficient information to provide a comprehensive measure of the benefits derived from these ecosystems and the various species associated with them.

A primary outcome of this FMP bookend is a large increase in the harvest levels that occur in most groundfish fisheries relative to the comparative baseline. In addition, time/area closures, gear restrictions, and bycatch restrictions would be repealed. As discussed in Section 4.6.10, the increase in harvest levels and elimination of measures are expected to have significantly or conditionally significant adverse consequences for predator-prey relationships, energy flow and balance, and diversity. In turn, these adverse effects on the Bering Sea and GOA marine ecosystems and associated species are expected to lead to a significant reduction in the levels of some of the benefits these ecosystems and species provide.

FMP 2.2 resembles FMP 2.1 in that it also represents a more aggressive harvest strategy. While some of the current measures that reduce the potential adverse effects of fishing on the Bering Sea and GOA marine ecosystems and species associated with them would remain in place under FMP 2.2, the increased harvest levels that occur under this FMP are predicted to have a significantly or conditionally significant adverse impact on predator-prey relationships for some marine mammals (Section 4.6.10). Consequently, the levels of some of the benefits these marine ecosystems and species provide may be lower than the comparative baseline. The significance of this effect is conditional, as both the intensity of the effect and the probability of its occurrence are uncertain.

Cumulative Effects of FMP 2.1 and FMP 2.2

For a summary of the direct/indirect and cumulative ratings see Table 4.6-6.

Benefits derived from Marine Ecosystems and Associated Species

- **Direct/Indirect Effects.** Under FMP 2.1 and FMP 2.2 the risks of adverse effects that the Alaska groundfish fishery could have on marine ecosystems are increased. FMP 2.1 represents a more aggressive harvest strategy, as does FMP 2.2 but to a lesser extent. This is predicted to have a conditionally significant adverse impact on the levels of some of the benefits these ecosystems and associated species generate.

- **Persistent Past Effects.** Persistent past effects on non-consumptive and non-use benefits) include: an increase in public awareness of marine ecosystems; increased participation in recreational fishing and eco-tourism activities; and public perceptions with regard to fisheries management. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects include other fisheries, and long-term climate change and regime shifts. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under both FMP 2.1 and FMP 2.2, a conditionally significant adverse cumulative effect is identified for benefits to the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits). The external effects of other fisheries have the potential to contribute adversely to benefits the public derives from marine ecosystems and associated species. FMP 2.1 and FMP 2.2 management measures could accelerate the introduction of non-native species, effect a change in pelagic forage availability, spacial and temporal concentration of fishery impact on forage, removal of top predators (potential for seabird bycatch and subsistence harvests of marine mammals), could increase the risk of changes in species, functional, and structural habitat diversity for the ecosystem. Long-term climate changes and regime shifts, in combination with fisheries-related pressures, could adversely affect species diversity due to the natural fluctuations in groundfish stocks. The greater fishing effort under FMP 2.1 could incrementally contribute to energy removal and energy redirection occurring on the groundfish fisheries.

4.6.10 Ecosystem Alternative 2 Analysis

Ecosystems are populations (consisting of single species) and communities (consisting of two or more species) of interacting organisms and their physical environment that form a functional unit with a characteristic trophic structure (food web) and material cycles (movement of mass and energy among the groups). The following analyses of potential direct/indirect and cumulative effects of Alternative 2 apply to the BSAI and GOA ecosystems. Where available information allows, each ecosystem is addressed separately.

In most cases, however, information is insufficient to allow individual consideration, and the two ecosystems are treated as a single entity.

As explained in Section 4.5.10, the analyses include numerous indicators representing potential direct, indirect, and cumulative effects of the alternative and specific bookends where applicable. Significance thresholds for the effect categories are presented in Table 4.1-7.

Direct/Indirect Effects FMP 2.1 and FMP2.2 – Ecosystems

Change in Pelagic Forage Availability

Pelagic forage availability is assessed by evaluating population trends in pelagic forage biomass for species with age-structured population models. Trends in bycatch of other forage species (herring, squid, and forage species group) in the groundfish fisheries are a measure of the potential impact on those groups in the BSAI and GOA (Figures H.4-19 and H.4-20 of Appendix H). Table 4.5-81 summarizes the average values from 2003-2008 for these measures and the percent change in the average values from the baseline amounts.

In FMP 2.1, pelagic forage biomass in the BSAI (Bering Sea walleye pollock and Aleutian Islands Atka mackerel) would decline by about 17 percent but would still be high relative to historical levels in the assessment. In the GOA, pelagic forage biomass (specifically, walleye pollock) shows an average increase of about 38 percent from the baseline. Twenty-year biomass projections show similar trends. Bycatch of other forage species almost triples in the BSAI and increases about 45 percent in the GOA. The absolute amount of bycatch in each region is relatively small (4,890 mt and 380 mt, respectively). Estimates of forage biomass from food web models of the EBS indicate that this bycatch is probably a small proportion of the total forage biomass (Aydin *et al.* 2002). However, lack of population-level assessments for some species in the forage species group means that corresponding species-level effects are unknown. If a target fishery were to develop for forage species such as capelin, there is a potential for the combined effects of fishing to affect predators such as seabirds, which leads to a conditionally significant adverse impact of this FMP on seabirds. However, the amount of forage needed by predators is uncertain.

In FMP 2.2, pelagic forage biomass in the BSAI (Bering Sea walleye pollock + Aleutian Islands Atka mackerel) would decline by about 13 percent. Pelagic forage biomass (specifically, walleye pollock) in the GOA shows an average increase of about 53 percent from the baseline. Twenty-year biomass projections show similar trends. Bycatch of other forage species more than doubles in the BSAI and decreases by about 25 percent in the GOA. The absolute amount of bycatch in each region is relatively small (3,500 mt and 190 mt, respectively). As concluded in FMP 2.1, estimates of forage biomass from food web models of the EBS indicate that this bycatch is probably a small proportion of the total forage biomass (Aydin *et al.* 2002). However, lack of population-level assessments for some species in the forage species group means that corresponding species-level effects are unknown.

Because target species that rely on these forage species for prey are not brought below their MSSTs by these changes, FMP 2.1 and FMP 2.2 are determined to have insignificant effects on the BSAI and GOA target species with respect to pelagic forage availability (Table 4.1-7). The amount of prey needed for Steller sea lions and the importance of adult pollock to northern fur seals have not been determined. The predicted changes in prey for FMP 2.1 and FMP 2.2 may have significantly adverse and conditionally significant adverse effects relative to the baseline for these marine mammals. Sections 4.6.1 through 4.6.8 discuss effects of pelagic forage abundance on other resource categories.

Spatial and Temporal Concentration of Fishery Impact on Forage

Spatial and temporal concentration of fishery impacts on forage species is assessed qualitatively by considering the potential for the alternatives to concentrate fishing on forage species in regions utilized by predators that are tied to land, such as pinnipeds and breeding seabirds. Additionally, possibility for concentration of fishing effort to result in an ESA listing or lack of recovery to an ESA-listed species is considered. FMP 2.1 would continue the existing closures around Steller sea lion rookeries, repeal the ban on forage fish, and open areas previously closed to trawling (except Steller sea lion closures), but still retain the spatial/temporal allocation of TAC for pollock and Atka mackerel. Because this FMP retains Steller sea lion closures, it should not result in space/time concentrations of fisheries removals that would impair the long-term viability of Steller sea lions. If a fishery were to be initiated on the forage species group, there is potential for this to result in removals large enough to impact breeding seabird populations that rely on these smaller forage species. However, the level of removals resulting in significant population-level effects on seabirds is unknown. Bering Sea pollock fisheries have shown increasing catch in northern fur seal foraging habitat, but more research is required to determine if the amounts of pollock removed are having a population-level effect. Therefore, FMP 2.1 is considered to have a conditionally significant adverse effect on the ecosystem with regard to spatial/temporal concentration of fisheries on forage species. FMP 2.2 would continue all the existing closures, including those around Steller sea lion rookeries, and would retain the spatial/temporal allocation of TAC for pollock and Atka mackerel. This FMP is judged to have an insignificant effect on the ecosystem with regard to spatial/temporal concentration of fisheries on forage species.

Removal of Top Predators

Removal of top predators, either through directed fishing or bycatch, is assessed by evaluating the trophic level of the catch relative to trophic level of the groundfish biomass (Figures H.4-21 through H.4-24 of Appendix H), bycatch levels of sensitive top predator species such as birds and sharks (Figures H.4-25 and H.4-26 of Appendix H), and a qualitative evaluation of the potential for catch levels to cause one or more top-level predator species to fall below biologically acceptable limits (minimum stock size threshold for groundfish, lead to ESA listing or prevent recovery of an ESA-listed species). Trophic level of the catch in both the BSAI and GOA is a very stable property, changing less than 3 percent on average from the baseline, and trophic level of the groundfish species for which we have age-structured models, changes less than one percent on average. Under FMP 2.1, top-predator bycatch amounts would increase by an average of about 53 percent relative to the baseline in the BSAI and about 40 percent over the baseline in the GOA. The absolute values of average catch for these species are estimated to be 1,032 mt and 1,840 mt in the respective regions under this FMP (Table 4.5-81). FMP 2.2 would result in top-predator bycatch amounts increasing about 16 percent in the BSAI and decreasing an average of 12 percent in the GOA relative to the baseline. Average catch of these species in the BSAI and GOA is estimated to be 782 mt and 1,150 mt, respectively (Table 4.5-81).

Increased fishing effort and the retention of former seabird protection measures under FMP 2.1 are considered conditionally significant adverse measures for ESA-listed seabirds such as short-tailed albatross. Also, removal of area closures around the Pribilof Islands may lead to disproportionate take of fulmars from that colony. Thus, FMP 2.1 may have a conditionally significant adverse impact on seabird top predators. FMP 2.1 and FMP 2.2would not further impair the recovery of whale species through direct takes. Sections 4.6.7 and 4.6.8 discuss the effects of groundfish fishery direct takes on specific seabird and marine mammal populations. The effect of shark bycatch on shark populations is unknown at present, and research directed at better assessing population levels of these sensitive (late maturing, low fecundity, low natural mortality) species is needed to better assess the potential effects from groundfish fisheries. Section 4.6.3 contains further information on sharks. Stability in trophic level of the catch is indicative of minimal effect of the fishery on target and PWS species top predators (Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut). See Section 4.6.1 for details on these target species and Section 4.6.2 for Pacific halibut. Overall, FMP 2.1and 2.2 would have insignificant effects on whales, pinnipeds, top-predator target, and PSC species and unknown effects on top predators such as sharks. FMP 2.1 may result in conditionally significant adverse effects on seabirds. However, because seabird bycatch levels in FMP 2.2 are expected to be similar to the baseline, FMP 2.2. is determined to have an insignificant effect on seabird population status.

Introduction of Non-Native Species

The introduction of non-native species through ballast water exchange and hull-fouling organism release from fishing vessels could potentially disrupt Alaskan marine food web structure (Fay 2002). There have been 24 species of non-indigenous species of plants and animals documented primarily in shallow-water marine and estuarine ecosystems of Alaska, with 15 species recorded in PWS. It is possible that most of these introductions were from tankers or other large commercial vessels that have large amounts of ballast exchange. However, exchange via fishery vessels that take on ballast from areas where invasive species have already been established and then transit through Alaskan inshore waters has been identified as a threat in a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). Consequently, this effect is evaluated as conditionally significant adverse in the baseline.

Total groundfish catch levels are used as an indicator of potential changes in the amount of these releases via groundfish fishery vessels (Figures H.4-27 and H.4-28 of Appendix H, Table 4.5-82). Total catch would increase by about 42 percent in the BSAI and 69 percent in the GOA under FMP 2.1, relative to the baseline. These catch levels are at the upper end of catches previously observed in these areas, indicating an increased potential for fishing vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms. Because there is insufficient information regarding fishing effort levels that would result in a successful introduction, this potential effect is evaluated as conditionally significant adverse with respect to predator-prey relationships. Under FMP 2.2, total catch would increase by about 17 percent in the BSAI and 14 percent in the GOA. These catch levels are similar to recent catches in these areas. Therefore, the potential direct/indirect effects of FMP 2.2 on predator-prey relationships through the introduction of non-native species are evaluated as insignificant.

Energy Flow and Balance

As discussed in Section 3.10, fishing may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal back into the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. Baseline energy removals, in the form of total retained catch, were less than one percent of the total system energy determined by mass-balance modeling of the system and were determined to have an insignificant impact on the ecosystem. FMP 2.1 retained-catch removals (Table 4.5-81), which change about 35 percent and 79 percent from the baseline in the BSAI and GOA, respectively, are large changes relative to the baseline. Therefore, potential impacts of FMP 2.1 on energy removals are determined to be conditionally significant adverse with respect to the potential for producing changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7). FMP 2.2

retained-catch removals (Table 4.5-81) change 17 and 20 percent from the baseline in the BSAI and GOA, respectively, and are still less than one percent of the total system energy as determined from mass-balance modeling in the EBS. Impacts of FMP 2.2 on energy removals are determined to be insignificant.

Energy re-direction, in the form of discards or fishery offal production or unobserved gear-related mortality, can potentially change the natural pathways of energy flow in the system. Animals damaged when passing through the meshes of trawls may later die and be consumed by scavengers. Bottom trawls can expose benthic organisms and make them more vulnerable to predation. Discards and offal production can cause local enrichment and changes in species composition or water quality if discards or offal returns are concentrated there. Estimates of total discards (Table 4.5-81, Figures H.4-29 and H.4-30 of Appendix H) under FMP 2.1 more than doubled for the BSAI and increase approximately 36 percent for the GOA relative to the baseline. Because these amounts are large deviations from baseline conditions, they create potential for a conditionally significant adverse effect on ecosystem-level energy cycling characteristics. Trends in total discards in FMP 2.2 show a more than 16 percent increase in the BSAI and a 4 percent decrease in the GOA. These amounts are still less than one percent of the unused detritus already going to the bottom, as estimated from mass-balance modeling of the EBS. Therefore, FMP 2.2 would have an insignificant effect on ecosystem-level energy cycling characteristics.

Change in Species Diversity

Fishing can alter different measures of diversity. Species-level diversity, or the number of species, can be altered if fishing essentially removes a species from the system. Fishing can alter functional diversity from a trophic standpoint if it selectively removes or depletes a trophic guild member and thus changes the way biomass is distributed within a trophic guild. Functional diversity from a structural habitat standpoint can be altered if fishing methods such as bottom trawling remove or deplete organisms such as corals, sea anemones, or sponges that provide structural habitat for other species. Fishing can alter genetic diversity by selectively removing faster-growing fish or removing spawning aggregations that might have genetic characteristics that are different from other spawning aggregations. Larger, older fishes may be more heterozygous (i.e., have more genetic differences or diversity), and some stock structures may have a genetic component (see review in Jennings and Kaiser 1998). Consequently, one would expect a decline in genetic diversity to result from heavy exploitation of a fishery.

Significance thresholds for effects of fishing on species diversity are catch removals high enough to cause the biomass of one or more species (target or non-target) to fall below, or to be kept from recovering from levels already below MSST for target species, or to result in ESA listing for non-target species (Table 4.1-7). Indicators of significance are population levels of target and non-target species relative to MSST or ESA listing thresholds, linked to fishing removals. Bycatch amounts of sensitive (low population turnover rates) groups that lack population estimates (skates, sharks, grenadiers, and sessile invertebrates, such as corals, inhabiting Habitat Areas of Particular Concern, or HAPC) may also indicate potential for fishing impact on these species (Table 4.5-82, Figures H.4-31 and H.4-32 of Appendix H). Closed areas also provide protection, particularly to less-mobile species like HAPC biota, so the amount of area closures across habitat types can indicate the degree of species-level diversity protection. Baseline determinations were made of insignificance for most of these indicators, and unknown for skates and sharks.

Under FMP 2.1, the only closures would be those required under Steller sea lion protection measures. Bycatch of HAPC biota would increase by about 8 percent in the BSAI and stay about the same in the GOA (Table 4.5-81). However, the bycatch model does not take into account the different bycatch rates that might occur due to opening of previously closed areas, and thus HAPC bycatch amounts could increase by an unknown amount. Furthermore, Steller sea lion closures are closer inshore relative to the distribution of some of the most sensitive HAPC biota, corals, and closures may not provide protection against species-level extinction for this group. FMP 2.1 may have conditionally significant adverse effects on HAPC biota. The increased fishing effort and use of former seabird protection measures in this FMP increase the likelihood for ESA listing or for preventing recovery of ESA-listed seabirds such as the short-tailed albatross. The levels of seabird bycatch that would result from FMP 2.1 are unknown. Increased trawling and potential for trawl third-wire mortality increases relative to the baseline in this FMP and may have a conditionally significant adverse impact to seabird species diversity.

FMP 2.2 results in bycatch of HAPC biota increasing by about 28 percent in the BSAI and decreasing by about 3 percent in the GOA (Table 4.5-81). Area closures would most likely be sufficient to provide protection against species-level extinction for this group of sessile organisms, although more research on coral distributions is needed. Therefore, FMP 2.2 would have an insignificant effect on species diversity with respect to HAPC biota. Catch amounts of target species, prohibited species, seabirds, and marine mammals under this FMP would be insufficient to bring these species below minimum population thresholds and would have an insignificant effect on species diversity for these groups. It is unknown whether bycatch amounts of skates, sharks and grenadiers would be at levels high enough to bring species within these groups to minimum population thresholds. Further research on the species-level distribution, abundance trends, and life-history parameters of these species is necessary to assess potential population-level effects. Although forage species population levels are not known, their relatively high turnover rates would likely protect them from falling below minimum biologically acceptable limits. However, some of the species in this forage group are not well studied (e.g., stichaeids, gunnels), and life-history parameter determination should be a priority for future research. Thus, FMP 2.2 would have insignificant and unknown effects on species diversity.

Catch amounts of prohibited species and marine mammals would be insufficient to bring these species below minimum population thresholds and thus are given an insignificant effect on these groups. Some target species would be depleted to levels below their MSST, a significantly adverse effect on species diversity. It is unknown whether bycatch amounts of skates, sharks, and grenadiers would be at levels high enough to bring species within these groups to minimum population thresholds, but these bycatch amounts would increase in FMP 2.1. Further research on the species-level distribution, abundance trends, and life history parameters of these species is necessary to assess the risk of falling below minimum population abundance thresholds. Although forage species population levels are not known, their relatively high turnover rates would likely protect them from falling below minimum biologically acceptable limits. However, some of the species in this forage group are not well studied (e.g., stichaeids, gunnels). Thus, FMP 2.1 would have insignificant (prohibited species, marine mammals, forage), significantly adverse (some target species), conditionally significant adverse (seabirds, HAPC biota), and unknown (skates, sharks, grenadiers) effects on species diversity. Catch amounts of target species, prohibited species, seabirds, and marine mammals under FMP 2.2 would be insufficient to bring these species below minimum population thresholds and would have an insignificant effect on species diversity for these groups. Potential effects of bycatch on skates, sharks, grenadiers and Other Species are unknown for FMP 2.2. More years of survey data and life-history parameter determination for skates, sharks, grenadiers, and Other Species may better define population trends and help determine whether further protection might be warranted. Sections 4.6.1 through 4.6.8 present detailed analyses of the potential for fishery removals to affect minimum population thresholds for each of these groups and thus ultimately to affect species diversity.

Change in Functional Diversity

Functional (either trophic or structural habitat) diversity can be altered through fishing if fishing selectively removes one member of a functional guild, which may result in increases in other guild members. A functional guild is a group of species that use resources within the ecosystem in similar ways. Significance thresholds are catch removals high enough to cause a change in functional diversity outside the range of natural variability observed for the system (Table 4.1-7). Indicators of the possible magnitude of effects include qualitative evaluation of guild or size diversity changes relative to fishery removals, bottom gear effort changes that would provide a measure of benthic guild disturbance, and bycatch amounts of HAPC biota, a structural habitat guild. In FMP 2.1, it is unknown to what degree changes in trophic guild diversity would result from increasing the catch removals of target species that are guild members. Because walleye pollock and Atka mackerel tend to be dominant members of their respective trophic guilds, fishing removals that cause these species to fall below their MSST would tend to increase trophic guild diversity measures because these species would be less dominant. Consequently, the potential effect of FMP 2.1 on trophic diversity is rated as conditionally significant adverse.

Under FMP 2.1, the possible increases in HAPC biota bycatch that could result from opening areas that were previously closed to bottom trawling have not been modeled. Members of the HAPC biota guild serve important functional roles, known only in a preliminary way, to provide fish and invertebrates with structural habitat and refuge from predation. The abundance of these structural species necessary to provide protection is not known, and it may be important to retain populations of these organisms that are well distributed spatially in order to fulfill their functional role. The long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. Existing Steller sea lion trawl closures are spread throughout the Aleutian chain, which likely has some of the highest densities of coral in the region. However, the closures are in waters shallower than where corals tend to be found. Therefore, the increase in fishing pressure and types of areas closed to trawling in this FMP are not sufficient to provide additional protection beyond the baseline to these sensitive organisms and may result in a potentially adverse population-level change. Consequently, this FMP is evaluated as having a significantly adverse effect on structural habitat diversity.

Under FMP 2.2, the species composition and amounts of removals, bottom gear effort, and bycatch amounts of HAPC biota (Table 4.5-82, Figures H.4-31 and H.4-32 of Appendix H) are similar to baseline conditions, in which fishing impacts on functional guild diversity are determined as insignificant for trophic diversity and for structural habitat diversity. Due to similar trends reflecting baseline conditions, the potential direct/indirect effects of FMP 2.2 on functional diversity, both trophic characteristics and structural habitat, are evaluated as insignificant.

Change in Genetic Diversity

Genetic diversity can be affected by fishing through heavy exploitation of certain spawning aggregations or systematic targeting of older age classes that tend to have greater genetic diversity. Under FMP 2.1, some target species would fall below MSST, but because the spatial/temporal management of TAC in the fisheries would not change, the MSST threshold would not be reached as a result of fishing-related declines in genetic diversity. Thus, an insignificant impact of fishing on genetic diversity is expected for this FMP. However, baseline genetic diversity remains unknown for most species and the actual direct/indirect effects that fishing would have on genetic diversity under this FMP are also largely unknown.

Under FMP 2.2, no target species would fall below MSST, and spatial/temporal management of TAC, catch, and selectivity patterns would remain consistent with present conditions. Consequently, the effect of fishing on genetic diversity would be insignificant under FMP 2.2. However, baseline genetic diversity remains unknown for most species and the actual direct/indirect effects that fishing would have on genetic diversity under this FMP are also largely unknown.

Cumulative Effects FMP 2.1 – Ecosystems

The following sections discuss the potential cumulative effects of FMP 2.1 on the ecosystem, acting additively or interactively with the effects of external human actions and natural processes persisting from the past, existing in the present, and predicted for the reasonably foreseeable future. These potential cumulative effects are summarized in Table 4.5-82. Data and calculations supporting the cumulative energy removal analyses for all of the alternatives are presented in Table 4.5-81.

<u>Change in Pelagic Forage Availability</u>

- **Direct/Indirect Effects.** The direct/indirect effects of implementing FMP 2.1 are expected to be significantly adverse for prey species utilized by the Steller sea lion, and conditionally significant adverse for northern fur seal and seabird prey species. FMP 2.1 would have an insignificant effect on BSAI and GOA groundfish target species with respect to pelagic forage availability. For the Steller sea lion, northern fur seal, and seabirds, the projected fishery-induced changes in pelagic forage biomass may be outside the natural level of abundance or variability for prey species relative to predator demands (Table 4.1-7). However, these predator demands, with respect to both quantity and prey preferences, have not been accurately quantified, and the potential short- and long-term effects of this FMP on top predators cannot be predicted with a high degree of confidence.

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from about 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Future climate change, especially a regime shift, would likely affect the productivity, and therefore the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** Direct/indirect effects on pelagic forage availability as modeled under FMP 2.1 are rated as significantly adverse for Steller sea lion prey species and conditionally significant adverse for northern fur seal and seabird prey species. Any potentially adverse contribution by one or more external factors, including State of Alaska directed fishery removals and subsistence harvests of forage fishes such as herring, capelin, or eulachon, would add a small increment of forage fish removal to this significantly or conditionally significant effect without substantially increasing its magnitude. A large marine oil or fuel spill would have the potential to add substantially to the depletion of forage fish populations in combination with heightened fishing pressures under FMP 2.1, resulting in a significantly adverse cumulative effect.

Spatial/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** FMP 2.1 would have a conditionally significant adverse direct/indirect effect on the ecosystem with regard to spatial/temporal concentration of fisheries on forage species. Because this FMP retains Steller sea lion closures, it should not result in space/time concentrations of fisheries removals that would impair the long-term viability of sea lion subpopulations. Levels of forage fish removals sufficient to result in a population-level effect on seabirds are unknown, and there is uncertainty whether a large fishery on forage species would develop under FMP 2.1. Bering Sea pollock fisheries have shown increasing catch in northern fur seal foraging habitat in the baseline, and more research is required to evaluate whether the amounts of pollock removed are having a population-level effect on fur seals. The conditionally significant rating reflects the high degree of uncertainty and lack of data regarding (a) forage requirements of key top predator species and (b) the eventual levels of forage impact that FMP 2.1 fishing effort would produce.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may have persisted into the present and future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have shown effects on recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such conditions may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery occur mainly inshore, overlap with the groundfish fishery is more likely temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines and adversely impact other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that are synergistic with spatial/temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** Under FMP 2.1, a conditionally significant adverse cumulative effect on pelagic forage availability could result in the reasonably foreseeable future, synergistic with the spatial/temporal concentration of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries, principally for herring and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could be depressed sufficiently to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species and reduce or intensify this potential cumulative effect.

Removal of Top Predators

- **Direct/Indirect Effects.** FMP 2.1 may have conditionally significant adverse effects on seabirds, insignificant effects on whales, pinnipeds, top-predator target species, and PSC species, and unknown effects on sharks. The greatest concern regarding the effects of FMP 2.1 on top predators is the increased potential for bycatch of seabirds. Increased fishing effort and the maintenance of former, rather than improved, seabird protection measures under FMP 2.1 are considered conditionally significant adverse measures for ESA-listed seabirds such as short-tailed albatross. Also, removal of area closures around the Pribilof Islands may lead to disproportionate takes of fulmars from that colony. The conditionally significant rating reflects uncertainty about future bycatch levels and existing population-level effects of bycatch removals on seabird species (Section 3.7).

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the low present-day abundance of whale species in the North Pacific. State of Alaska directed groundfish fisheries, which are small and sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, but past harvests may have had a sustained effect on some populations that persist today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a sustainable portion of the Pacific halibut population, a top predator. The current management plan is likely to continue in the reasonably foreseeable future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in Federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea would result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on total numbers of top predators could result from FMP 2.1 in combination with continued high levels of seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, there is a likelihood that the present high levels of seabird bycatch will continue in the reasonably foreseeable future. The conditions under which this cumulative effect could be significant are the continuation of high external seabird bycatch rates in conjunction with a large fuel or oil spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the reasonably foreseeable future, and this could intensify or reduce the potential effects by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** FMP 2.1 could produce a conditionally significant adverse effect on predator-prey relationships through the introduction of non-native species to the BSAI and GOA ecosystems. The condition under which this potential adverse effect would become significant is the establishment of one or more viable exotic populations. This potential effect is rated conditionally significant because there is insufficient information about the relationship between fishing effort levels and the probability that an introduced exotic species would establish a viable population.

- **Persistent Past Effects.** For decades the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002).

From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the reasonably foreseeable future. In addition, commercial shipping, including cruise ships and barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with FMP 2.1, it is conceivable that viable populations could eventually become established in the BSAI and/or GOA, producing a conditionally significant adverse cumulative effect (Table 4.1-7). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that might allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA.

<u>Energy Removal</u>

- **Direct/Indirect Effects.** The effects of FMP 2.1 on energy removal would be conditionally significant adverse. Because predicted catch levels are large changes relative to the baseline, FMP 2.1 is considered to have the potential for producing changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 4 percent of the cumulative biomass that would be removed annually under this FMP (Table 4.5-81). The State of Alaska directed groundfish and subsistence fisheries will remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (doughnut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that are viewed as only partly comparable systems, and their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 2.1 is predicted to have a conditionally significant adverse cumulative effect with respect to energy removal. If the annual total catches of the State of Alaska herring and crab and IPHC halibut fisheries in the reasonably foreseeable future are similar to the 1994-2002 averages, the combined total catch of these external fisheries will represent a 4.3 percent addition to the estimated total catch for the groundfish fisheries alone under this FMP (Table 4.5-81). It is unknown if this additional increment of biomass removal would intensify or make more probable the predicted direct/indirect effect of the groundfish fishery. Further study of fishery removals as energy debits and their resulting ecosystem-level characteristics is needed (Table 4.1-7).

Energy Redirection

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 2.1 on energy redirection are evaluated as conditionally significant adverse. Because total discard biomass projections would result in large changes from baseline conditions under FMP 2.1, the potential for a conditionally significant adverse effect on ecosystem-level energy cycling characteristics exists (Table 4.1-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 2.1 is predicted to have a conditionally significant adverse effect on the ecosystem through energy redirection. The large increase in fishing effort that would occur under this FMP, in combination with external sources such as the IPHC halibut fishery, State of Alaska commercial fisheries, annual subsistence harvests of fish and marine mammals, and the release of graywater and refuse from commercial shipping, could create the potential for a cumulative effect that results in long-term changes outside the range of natural variability. At the local level, water quality degradation can be expected from the increased release of fish processing offal into low-energy environments, such as coves and bays, where nutrients from these wastes can concentrate in sheltered waters and alter local patterns of energy cycling. Although this is not an ecosystem-level effect, it is noted as a consequence of commercial fishing that will continue into the future and may increase under FMP 2.1. The discharge of offal from fish processing facilities and graywater and other refuse from marine vessels into Alaskan waters is regulated through EPA and ADEC permitting programs.

Change in Species Diversity

- **Direct/Indirect Effects.** Predicted effects of FMP 2.1 on species diversity are rated as significantly adverse for target species that would be reduced to levels below their MSSTs, conditionally significant adverse for HAPC biota because of uncertainty regarding the extent to which bycatch of these organisms would increase, conditionally significant adverse for seabirds because of increased fishing effort without a compensatory increase in seabird protection measures, insignificant for prohibited species, forage fish, and marine mammals, and unknown for skates, sharks, grenadiers, and Other Species.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate (including HAPC) species are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated in some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show beneficial correlations with prey abundance, and that cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, beluga whales, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 2.1 , a significantly adverse effect on species diversity could result from seabird bycatch by the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may establish a viable population that would change species diversity in a adverse way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species. Under some combination of these conditions, the biomass of one or more species could fall below minimum biologically acceptable limits (Table 4.1-7).

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** Potential effects on functional diversity in terms of trophic (nutrition-related) characteristics relate to changes in the variety of species within trophic guilds. Under FMP 2.1, the predicted effects of the groundfish fisheries on trophic diversity are rated as conditionally significant adverse. This rating reflects the potential for increased fishing effort to cause pollock and Atka mackerel to fall below their MSSTs, thereby making them less dominant members of their guild. Due to the inability to predict the level of diversity change that may result, this rating is conditional based on the ability of the effect to cause changes in functional diversity outside the range of natural variability observed for the system (Table 4.1-7).

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, little research on this type of effect was conducted in the BSAI and GOA in past decades.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 2.1 could produce a conditionally significant adverse effect on trophic diversity. If the farming of Atlantic salmon along the Pacific coast continues or increases, there is a potential for escaped or released fish to establish one or more viable populations in the future, thus adding a new salmonid to the trophic structure. Other exotic species introduced through commercial shipping and fishing vessels also have the potential to establish viable populations, especially if facilitated by a favorable climatic change, thus altering trophic diversity. In addition, subsistence mammal harvests, particularly where individual subpopulations are placed under pressure, have the potential to affect species diversity within piscivore guilds, at least locally. None of these potential external effects is likely to be interactive or synergistic with the direct/indirect effects of FMP 2.1, because different trophic guilds would be affected, but an additive effect is possible.

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to functional diversity in terms of structural habitat is the removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures for habitat by other species, including economically important groundfish species and their prey. Present (comparative baseline) trawl closures to protect the Steller's sea lion are spread throughout the Aleutian chain, but these closures are in waters shallower than where corals tend to be found. Because the areas that would be closed to trawling under FMP 2.1 would be similar to the comparative baseline conditions, they would not be sufficient to provide protection to these sensitive organisms. Therefore, the potential direct/indirect effects of FMP 2.1 on functional diversity are rated as significantly adverse.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill from commercial shipping could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** The implementation of FMP 2.1 may produce a significantly adverse cumulative effect on structural habitat diversity by damaging or removing benthic HAPC biota, particularly coral. Direct/indirect effects of FMP 2.1 could be intensified under at least three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could add to the effects of bottom trawling by the groundfish fisheries on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity (and thus population size, growth, and ability to recover from damage) as well as distribution of sensitive bottom-dwelling invertebrates that provide ecologically important structural habitat.

<u>Change in Genetic Diversity</u>

- **Direct/Indirect Effects.** If FMP 2.1 were implemented, no target species would fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to present conditions. Fishing pressure would not focus on specific spawning aggregations or systematically target older age classes that tend to have greater genetic diversity. Therefore, effects of the groundfish fisheries on genetic diversity are expected to be insignificant under FMP 2.1. However, baseline genetic diversity remains unknown for most species and the actual effects that fishing would have on genetic diversity under this FMP are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, beluga whales, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 2.1 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. However, none of these factors would directly involve the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. For this reason, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the future.

Cumulative Effects FMP 2.2 – Ecosystems

The following sections discuss the potential cumulative effects on the ecosystem of FMP 2.2, acting additively or interactively with the effects of external human actions and natural processes persisting from the past, occurring in the present, and predicted for the future. These potential cumulative effects are summarized in Table 4.5-82. Data and calculations supporting the cumulative energy removal analyses for all of the alternatives are presented in Table 4.5-81.

<u>Change in Pelagic Forage Availability</u>

- **Direct/Indirect Effects.** Under FMP 2.2, BSAI pelagic forage biomass, as estimated by Bering Sea pollock and Aleutian Islands Atka mackerel, is predicted to decrease relative to the comparative baseline. Total biomass of GOA pollock is predicted to increase during the same period (Table 4.5-81). Bycatch of other forage species would increase by more than 200 percent in the BSAI and decrease by about 25 percent in the GOA. Because target species that rely on these forage species for prey would not be brought below their MSSTs by these changes, FMP 2.2 is determined to have an insignificant effect on the BSAI and GOA ecosystems with respect to pelagic forage availability (Table 4.1-7). However, the quantities of prey needed by Steller sea lions and the importance of adult pollock to northern fur seals have not been determined. Consequently, the predicted changes in pelagic forage availability may have significantly adverse and conditionally significant adverse effects relative to the baseline for these marine mammals.

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from about 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** Direct/indirect effects on pelagic forage availability as modeled under FMP 2.2 are rated as significantly adverse for Steller sea lion prey species and conditionally significant adverse for northern fur seal. Any potentially adverse contribution by one or more external factors, including State of Alaska directed fishery removals and subsistence harvests of forage fishes such as herring, capelin, or eulachon, would add a small increment of forage fish removal to this significantly or conditionally significant effect without substantially increasing its magnitude. However, a large marine oil or fuel spill could have the potential to add substantially to the depletion of forage fish populations, resulting in a significantly adverse cumulative effect for the Steller sea lion and northern fur seal.

Spatial/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** FMP 2.2 would have an insignificant effect on the ecosystem with regard to spatial/temporal concentration of fisheries on forage species. It would not result in fishing concentrations on forage species high enough to impair the long-term viability of the Steller sea lion and other marine mammals or seabirds (Table 4.1-7).

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may persist (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have shown effects on recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such conditions may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery occurs mainly inshore, overlap with the groundfish fishery will be temporal more than spatial.

Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS in 1989 suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning will most likely produce population declines, and adverse impacts to other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that might be synergistic with spatial/temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** Under FMP 2.2, a conditionally significant adverse cumulative effect on pelagic forage availability could result in the future, synergistic with the spatial/temporal concentration of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries, principally for herring, and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could be depressed sufficiently to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (see Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species by reducing or intensifying this potential cumulative effect.

Removal of Top Predators

- **Direct/Indirect Effects.** FMP 2.2 would have insignificant effects on whales, pinnipeds, seabirds, top-predator target species, and PSC species in their function as top predators; and unknown effects on sharks as top predators. Trophic level of the catch, affecting top predators that are target species, would not change significantly from the baseline and would not result in any species near or below MSST. Top predator bycatch amounts would increase over the baseline in the BSAI and decrease in the GOA; these changes would not cause the biomass of one or more top predator species to fall below minimum biologically acceptable limits (Table 4.1-7).

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks, seabirds, and marine mammals. Historical whaling resulting in very high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the low present-day abundance of whale species in the North Pacific (Section 4.5.11). State of Alaska directed groundfish fisheries, which are sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, and past harvests may have sustained effects on some populations today (Section 3.10.1). Finally, there is evidence that past climatic variability may affect the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a sustainable portion of the Pacific halibut population, a top predator. The current management plan is likely to continue in the reasonably foreseeable future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in Federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea would result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on total numbers of top predators could result from FMP 2.2 in combination with continued high levels of seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, there is a likelihood that the present high levels of seabird bycatch will continue in the reasonably foreseeable future. The conditions under which this cumulative effect could be significant are the continuation of high external seabird bycatch rates, intensified by contributions from a large fuel or oil spill and incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and could intensify or reduce the potential cumulative effect by influencing recruitment.

<u>Introduction of Non-Native Species</u>

- **Direct/Indirect Effects.** The potential effects of FMP 2.2 on predator-prey relationships through the introduction of non-native species would be insignificant. The estimated catch levels are similar to recent catches in these areas, indicating a similar level of effort and thus a similar potential for fishing vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms.

- **Persistent Past Effects.** For decades the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the reasonably foreseeable future. In addition, commercial shipping, including cruise ships and barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When considering sources of exotic species external to the domestic groundfish industry in combination with FMP 2.2, it is conceivable that viable populations could become established in the BSAI and/or GOA in the future, producing a conditionally significant adverse cumulative effect (Table 4.1-7). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that may enable exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA.

Energy Removal

- **Direct/Indirect Effects.** The effects of FMP 2.2 on energy removal are expected to be insignificant. Baseline energy removals, in the form of total catch, are less than one percent of the total ecosystem energy, as estimated by mass-balance modeling, and were determined to have an insignificant impact on the ecosystem. Total retained catch removals under FMP 2.2 would increase but are less than one percent of the total system energy as estimated from mass-balance modeling for the EBS. These estimated energy removals would not have the potential to produce significant changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 4 percent of the cumulative biomass that would be removed annually under this FMP (Table 4.5-81). The State of Alaska directed groundfish and subsistence fisheries will remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (doughnut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that are viewed as only partly comparable systems, and their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 2.2 would have an insignificant cumulative effect on energy removal in the future. The total domestic groundfish catch under this FMP is estimated to remove less than one percent of the total system energy. If the combined total catch of the State of Alaska herring and crab and IPHC halibut fisheries in the future is similar to the 1994-2002 average, the cumulative total catch of these external fisheries plus the BSAI and GOA groundfish fisheries will increase by about 5.3 percent over the estimated total catch for this FMP alone (Table 4.5-81). This additional increment of biomass removal is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability due to expected energy removals by the BSAI and GOA groundfish fisheries (Table 4.1-7).

Energy Redirection

- **Direct/Indirect Effects.** The effects of FMP 2.2 on energy redirection are expected to be insignificant. Projections for total discards are less than one percent of the estimate of unused detritus already going to the bottom under the baseline conditions, as determined from mass-balance modeling of the EBS. They would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability due to fishery discarding and offal production practices (Table 4.1-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and from subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. The pattern of such disposal at sea is not expected to change much in the future. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 2.2 is predicted to have an insignificant cumulative effect on energy redirection. The cumulative effect of FMP 2.2 in combination with external sources is not expected to depart significantly from the comparative baseline condition as to produce long-term changes outside the range of natural variability. At the local level, water quality degradation can be expected from the release of fish processing offal into low-energy environments, such as coves and bays, where nutrients from these wastes can concentrate in sheltered waters and alter local patterns of energy cycling. Although this is not an ecosystem-level effect, it is noted as a consequence of commercial fishing that will continue into the future and that may increase under FMP 2.2. The discharge of offal from fish processing facilities and of graywater and other refuse from marine vessels into Alaskan waters is regulated through EPA and ADEC permitting programs.

Change in Species Diversity

- **Direct/Indirect Effects.** Predicted effects of FMP 2.2 on species diversity are rated as insignificant with respect to all groups except skates, sharks, and grenadiers, for which the potential effects on species diversity are unknown because of the paucity of information on these groups. Under FMP 2.2, bycatch of HAPC biota would increase by about 28 percent in the BSAI and decrease by about 3 percent in the GOA (Table 4.5-81). Area closures would most likely be sufficient to provide protection against species-level extinction for this group of sessile organisms, although more research on coral distributions is needed. Catch amounts of target species, prohibited species, seabirds, and marine mammals under FMP 2.2 would be insufficient to bring these species below minimum population thresholds. Although forage species population levels are not known, their relatively high turnover rates would most likely protect most of them from falling below minimum biologically acceptable limits.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate (including HAPC) species are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated in some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show beneficial correlations with prey abundance, and that cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, beluga whales, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 2.2 , a conditionally significant adverse cumulative effect on species diversity could result from a high level of seabird bycatch by the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may establish a viable population that would change species diversity in a adverse way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible sub-populations of marine mammals from year to year could intensify this effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species.

<u>Change in Functional (Trophic) Diversity</u>

- **Direct/Indirect Effects.** Potential effects on trophic diversity relate to changes in the variety of species within trophic guilds. The greater the diversity of species within guilds, the more resilient the ecosystem is likely to be, because competing species within the same guild can replace or substitute for one another in response to environmental stressors, thereby maintaining the structure of the food web. Under FMP 2.2, the predicted effects of the groundfish fisheries on trophic diversity are rated as insignificant. This reflects the similarity of the expected species composition and amounts of removals, bottom gear effort, and bycatch amounts of HAPC biota under this FMP (Table 4.5-82, Figures H.4-31 and H.4-32 of Appendix H) to the baseline, for which fishing impacts on trophic diversity were determined to be insignificant.

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, little research on this type of effect was conducted in the BSAI and GOA in past decades.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 2.2 could produce a conditionally significant adverse effect on trophic diversity. The condition under which this potential effect could be significant relates to the additive effect of incremental contributions from several possible sources. If the farming of Atlantic salmon along the Pacific coast continues or increases, there is a potential for escaped or released fish to establish one or more viable populations in the reasonably foreseeable future, thus adding a new salmonid to the trophic structure. Other exotic species introduced through commercial shipping and fishing vessels also have the potential to establish viable populations, especially if facilitated by a favorable long-term climatic change, and thus alter trophic diversity. In addition, subsistence mammal harvests, particularly where individual subpopulations are placed consistently under pressure from year to year, have the potential to affect species diversity within piscivore guilds, at least locally. None of these potential external effects is likely to be interactive or synergistic with the direct/indirect effects of FMP 2.2, because different trophic guilds would be affected, but an additive effect is possible.

<u>Change in Functional (Structural Habitat) Diversity</u>

- **Direct/Indirect Effects.** The issue of concern with respect to structural habitat diversity is the removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures used as habitat by other species, including economically important groundfish species and their prey. It is important to ensure that the spatial distribution of areas closed to bottom fishing is broad enough, relative to coral distribution in particular, to allow these organisms to fulfill their functional role. Present (comparative baseline) trawl closures to protect the Steller's sea lion are spread throughout the Aleutian chain, but these closures may be farther inshore than most of the coral. Because the areas that would be closed to trawling under FMP 2.2 would show little change from the comparative baseline conditions, the potential direct/indirect effects of FMP 2.2 are rated as insignificant.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill from commercial shipping could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** The implementation of FMP 2.2 may produce a conditionally significant adverse effect on structural habitat diversity by adversely affecting benthic HAPC biota. Effects of FMP 2.2, rated insignificant because they would show little change from existing circumstances, could be intensified under at least three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could add to the effects of bottom trawling by the groundfish fisheries on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity, and thus the population size, as well as the distribution, of bottom-dwelling invertebrates that provide structural habitat.

Change in Genetic Diversity

- **Direct/Indirect Effects.** If FMP 2.2 were implemented, no target species would fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to present conditions. Fishing pressure would not focus on specific spawning aggregations or systematically target older age classes that tend to have greater genetic diversity. Consequently, the effect of the groundfish fisheries on genetic diversity are expected to be insignificant under FMP 2.2. However, a baseline condition for genetic diversity remains unknown for most species and the actual effects that fishing could exert on genetic diversity under this FMP are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, beluga whales, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 2.2 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would directly involve the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. For this reason, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the future.

4.6.11 Summary of Alternative 2 Analysis

The direct, indirect and cumulative ratings for all resource categories analyzed under this alternative are summarized in Tables 4.6-1 through 4.6-7.

Table number	Resource category	Components	Section 4.6 reference
4.6-1	Target groundfish species	Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) walleye pollock, BSAI and GOA Pacific cod, BSAI and GOA sablefish, BSAI and GOA Atka mackerel, BSAI yellowfin sole, GOA shallow water flatfish, BSAI rock sole, BSAI and GOA flathead sole, BSAI and GOA arrowtooth flounder, BSAI Greenland turbot, GOA deepwater flatfish, BSAI Alaska plaice, BSAI other flatfish, GOA rex sole, BSAI and GOA Pacific ocean perch, GOA thornyhead rockfish, BSAI and GOA northern rockfish, BSAI and GOA shortraker/rougheye rockfish, BSAI other rockfish, GOA slope rockfish, GOA pelagic shelf rockfish, GOA demersal shelf rockfish.	4.6.1
4.6-2	Prohibited, other, forage and non-specified species	Pacific halibut, Pacific salmon and steelhead trout, Pacific herring, crab. Other species category. Forage fish category. Grenadier.	4.6.2 4.6.3 4.6.4 4.6.5
4.6-3	Habitat	BSAI, GOA	4.6.6
4.6-4	Seabirds	Black-footed albatross, laysan albatross, short-tailed albatross, northern fulmar, shearwaters, storm-petrels, cormorants, spectacled eider, Seller's eider, jaegers, gulls, kittiwakes, terns, murres, guillemots, murrelets, auklets, puffins.	4.6.7
4.6-5	Marine mammals	Steller sea lion, northern fur seals, Pacific walrus, harbor seals, spotted seal, bearded seal, ringed seal, ribbon seal, northern elephant, sea otter, blue whale, fin whale, sei whale, minke whale, humpback whale, gray whale, northern right whale, bowhead whale, sperm whale, beaked whales (Baird's, Cuvier's and Stejneger's), Pacific white-sided dolphin, killer whale, beluga whale, harbor porpoise, Dall's porpoise.	4.6.8
4.6-6	Socioeconomics	Harvesting and processing sector (catcher vessels, catcher processors, inshore processors and motherships). Regional socioeconomic profiles (population, processing ownership and activity, catcher vessel ownership and activity, tax revenue, employment and income). Community development quota (CDQ) allocations. Subsistence (subsistence use of groundfish, subsistence use of Steller sea lions, salmon subsistence fisheries, indirect subsistence factors: income and joint production). Environmental justice. Market channels and benefits to United States consumers (product quantity, product year-round availability, product quality, product diversity). Non-market goods (benefits derived from marine ecosystems and associated species).	4.6.9.1 4.6.9.2 4.6.9.3 4.6.9.4 4.6.9.5 4.6.9.6 4.6.9.7
4.6-7	Ecosystem	Forage fish availability, spatial/temporal concentration of fisheries, introduction of non-native species, removal of top predators, energy redirection, energy removal, species diversity, guild diversity, genetic diversity.	4.6.10

4.7 Alternative 3 Analysis

The goal of Alternative 3 is to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles, and, where appropriate and practicable, increased habitat protection and additional bycatch constraints. This alternative is described in detail in Section 2.6.4.

4.7.1 Target Groundfish Species Analysis

This section examines the potential direct, indirect, and cumulative effects that the implementation of Alternative 3 is expected to have on the target groundfish species. The potential effects of two policy "bookends" are analyzed, FMP 3.1 and FMP 3.2. These represent the policy boundaries of Alternative 2. As actually implemented, Alternative 3 could include policy measures anywhere within the range between the two bookends. The impact analyses start with the baseline (2002) status of the BSAI and GOA target groundfish stocks described in Section 3.5.1, including past trends that are likely to persist into the foreseeable future. Then, a computer-based analytic model is used to project how specific characteristics of the target groundfish stocks would respond directly and indirectly to management actions under each FMP. These projections from the model are the predicted direct and indirect effects (impacts) of the FMP on the target groundfish stocks. Section 4.1.5 describes the analytic model and explains how it is applied.

The model output for each target groundfish stock is defined in terms of collected data and calculated measures that are standards used by fisheries managers to regulate the number of fish removed from the sea so that the fisheries will be sustainable over the long-term. These data and measures include the fishing mortality rate (F), the overfishing level (OFL), total and spawning biomass levels (B), the minimum stock size threshold (MSST), maximum sustainable yield (MSY), mean age of the stock in years, and the sex ratio of the stock (number of males compared to number of females). As discussed in the following subsections, relevant data are not always available for all stocks. When data gaps prevent application of the model to a specific stock, the projected direct or indirect effect is evaluated as unknown (U).

Each target groundfish stock is modeled with respect to the following direct and indirect effects:

Direct Effects

Fishing Mortality: This is the rate at which the stock is depleted by direct mortality imposed by removing the fish from the sea.

Change in Biomass Level: This is the change over time in the biomass of the stock, as measured in metric tons (mt). Two measures are used: total biomass, which is the estimated biomass of the entire stock, and spawning biomass, which is the estimated biomass of all of the spawning females in the stock.

Spatial/Temporal Concentration of Catch: This is the degree to which the fishery will concentrate in a particular geographic area during a particular period of time each season. This pattern in space and time can affect fishing mortality and can also influence habitat suitability for spawning, rearing, and feeding.

Direct and/or Indirect Effects

Habitat Suitability: This is the degree to which habitat has the right characteristics to support the target stock at one or more life-history stages (spawning, rearing of juveniles, availability of food at all stages, availability of refuge areas to allow escape from predators at all stages). Habitat suitability can be affected directly, for example by mechanical damage from bottom trawling, or influenced indirectly, for example by the gradual depletion of corals that provide hard substrate.

Prey Availability: This is the extent to which prey species are present in the environment and available as food to the target stock. Like habitat suitability, this measure can be affected directly, for example by the direct removal of prey species by the fishery, or indirectly, for example by a change in the structure of the food web.

To determine their probable significance, the projected direct and indirect effects in each of the impact categories listed above are evaluated against significance criteria. The criteria are designed to be relevant and meaningful in terms of the target groundfish stocks. Each significance criterion includes a threshold value above (or below) which the projected effect would be considered significant. Each criterion also includes a definition of what would constitute a beneficial (positive, +) or adverse (negative, -) effect. The possible evaluations are significant and beneficial (S+), Insignificant (I), significant and adverse (S-), and Unknown (U). Evaluations of Conditionally Significant (CS + or -) are not made for projected direct and indirect effects on target groundfish species, because the model can show only whether the significance threshold is or is not exceeded. The significance criteria used for the target groundfish stocks are presented in Appendix A, Table 4.1-1.

Each of the following subsections presents the model results and rationale for the expected direct and indirect effects of FMPs 3.1 and 3.2 on the target groundfish stocks. The significance ratings for these potential direct and indirect effects are presented in Appendix A, Table 4.7-1. Following the direct and indirect effects discussions on each stock, the expected cumulative effects on that stock are evaluated and discussed. The evaluation of potential cumulative effects builds on the direct and indirect effects evaluations as a starting point, and then brings in natural events and human activities external to fisheries management. The cumulative effects assessment method uses the same impact categories and significance criteria discussed above for direct and indirect effects. This method is described further in Section 4.1.4.

4.7.1.1 Pollock

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA pollock for each of the bookends under Alternative 3. Numerous fishery management actions have been implemented that affect the pollock fisheries in the EBS and GOA. These actions are described in more detail in Sections 3.5.1.1 and 3.5.1.15 of this Programmatic SEIS. Pollock is managed as separate stocks in the BSAI and GOA, and falls under Tier 1 in both the BSAI and GOA groundfish FMPs.

Direct/Indirect Effects of FMP 3.1

Under FMP 3.1, the following measures would be implemented:

- Sharks and skates would be removed from the "Other Species" category and given their own TAC, and criteria for separating individual stocks from stock complexes would be developed.

- The FMP would require that the TAC for each stock or stock complex be set no higher than the ABC.

- MSSTs for stocks in Tiers 1-3 would be specified in the FMPs, and the resources and time frame necessary to specify MSSTs for stocks in Tiers 4-6 would be identified, and a list of Tier 4-6 stocks prioritized for future MSST specification would be developed.

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H. Under FMP 3.1, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.3 million mt in 2004, then stabilize to about 11.6 million mt. The 2003-2007 average total biomass is 11.5 million mt.

In the Aleutian Islands region, the assessments are based on trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Given that under FMP 3.1 there is no directed fishing for pollock in this region (the exploitation level is quite low, <1 percent), the expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof Island.

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,240,000 mt by 2007. The average biomass over this period is expected to be 1,040,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels (Table H.4-23 of Appendix H).

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-1 of Appendix H. Under FMP 3.1, projections indicate that EBS pollock spawning biomass will decrease to about 78 percent of the 2002 level by 2007. The projected average for 2003-2007 is 3.05 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Since under FMP 3.1 these areas are kept at bycatch-only levels, it is expected that the spawning stock size will remain stable or increase in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 240,000 mt by 2007 under FMP 3.1. This is above the estimated B_{msy} level of 210,000 mt although the average from 2003-2007 is 188,000 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase by about 40 percent and average 0.243 for the period 2003-2007. These values are below the $F_{35\%}$ level of 0.448 and the $F_{40\%}$ level of 0.342, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. This pattern in fishing mortality is due to the fact that the projected catch is expected to come closer to the actual ABC in future years. The proportion of SPR conserved under these mortality rates is 51 percent in 2003, decreasing to 46 percent by 2007; the average implied SPR rate of fishing from 2003-2007 is 47 percent (Table H.4-1 of Appendix H). Fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than one percent under FMP 3.1 (Table H.4-2 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.126 in 2003 followed by increases to 0.172 by 2007. The values for $F_{35\%}$ and $F_{40\%}$ are 0.350 and 0.294, respectively. The SPR rate in 2002 is estimated at 55 percent and averages about 60 percent for the period 2003-2007. This fishing mortality rate pattern is due to the fact that under this alternative, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$ (Table H.4-23 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (Jan 20-March). Under FMP 3.1, an average of 1.46 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial/temporal allocations as presented in Section 3.5.1.1. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period.

In the GOA, pollock fishery in a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.1. Under FMP 3.1, an average of 75,700 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 111,300 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery will likely change from the 2002 pattern. The effect of these changes is unknown.

Status Determination

Under FMP 3.1, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For FMP 3.1, GOA pollock spawning biomass is below the B_{msy} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007.

Age and Size Composition

Under FMP 3.1, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.50 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.07 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under FMP 3.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of Alternative 1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under FMP 3.1 (for the period 2003-2007).

Summary of Effects of FMP 3.1 on Pollock

Because the pollock are fished at less than the OFL and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.1 are considered insignificant. Fishing rates are well within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity. Based on extended 20-year projections (with the same model assumptions as used in the base 2003-2007 period), both the EBS and GOA pollock are expected to stabilize with catches lower than the expected long-term F_{ABC} catch levels and spawning biomass levels above the B_{msy} levels (Table 4.7-1).

Cumulative Effects of FMP 3.1

Cumulative effects for EBS pollock are summarized in Table 4.5-1.

EBS Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 3.1 (see Section 4.7.1.1).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the BSAI pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Removals of pollock occur in the Russian pollock fishery, and the catch is not accounted for in the annual harvest rates set for the U.S. fishery. Therefore, the removals can be considered a potential adverse effect on fishing mortality. Catch and bycatch of pollock in the State of Alaska pollock fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is also identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects**. Cumulative effects are identified for mortality of EBS pollock, and the effects are judged to be insignificant. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be insignificant under the FMPs (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the Russian and State of Alaska pollock fisheries. However, the effects of any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under each FMP; and the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.7.1.1).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had a beneficial effect on pollock recruitment by reducing the adult pollock biomass, lingering beneficial effects are identified for change in reproductive success. In addition, past commercial whaling and sealing also removed large predators of pollock adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** The Russian and State of Alaska pollock fisheries have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. On the other hand, removals in these fisheries, with the exception of the herring fishery, could have a potential beneficial effect on pollock recruitment by reducing the adult pollock biomass. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible under FMP 3.1 for the spatial/temporal concentration; and the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see above). However, as discussed under direct/indirect effects, the FMP would have insignificant effects on pollock prey availability.
- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on pollock prey species could have potentially beneficial or potential adverse effects. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown in Table 4.5-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the FMP; and the effects are insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under the FMP, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see direct/indirect effects discussion). However, it is determined that the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects identified for EBS pollock stock include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.1). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the EBS. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the Russian and State of Alaska fisheries, since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; and the effects on the EBS pollock stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

GOA Pollock

Cumulative effects for GOA pollock are summarized in Table 4.5-2.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 3.1 (see Section 4.7.1.1).

- **Persistent Past Effects**. of the foreign, JV, domestic, State of Alaska, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** Catch and bycatch of pollock in the State of Alaska pollock fisheries, and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of GOA pollock, and the effects are judged to be insignificant for each FMP. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMPs 3.1 (see direct/indirect effects discussion above).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.15), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the State of Alaska pollock fisheries. However, any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified; and the effects are considered insignificant. The combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** As the density and quotas of pollock change during the modeled period, the concentration of the pollock fishery will change from the 2002 pattern; it is not possible to predict exactly how the pattern will change. However, for GOA pollock under FMP 3.1, the stock is expected to be above MSST for the years 2003-2007 (see direct/indirect effects discussion). Therefore, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.15) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** State of Alaska pollock fisheries and the State of Alaska shrimp fishery are identified as potential adverse contributors. However, these fisheries are unlikely to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration under FMP 3.1; and the effects are considered to be insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see above). However, as described under direct/indirect effects, the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for EBS pollock, climate changes and regime shifts could have potential adverse or beneficial effects on pollock prey species. Marine pollution has been identified as a reasonably future external contributing factor. The other fisheries shown in Table 4.5-2 are determined to be potential adverse contributors since bycatch and catch of forage species is likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; and the effects are considered insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 3.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see direct/indirect effects discussion). However, it is determined that the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stock include past foreign, JV, and, State of Alaska, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.15). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from these intense efforts (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska pollock and shrimp fisheries, since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock would be either beneficial or adverse as described for EBS pollock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability for FMP 3.1; however, the effects on the GOA pollock stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

Direct/Indirect Effects of FMP 3.2

FMP 3.2 extends several of the measures proposed in Alterative 3.1, including:

- Biological reference points used in the tier system would be made taxon-specific where appropriate (for example, max F_{ABC} for Tier 3 rockfish stocks could be capped at $F_{60\%}$ rather than $F_{40\%}$), and scientifically justifiable methods for adjusting max ABC to account for statistical uncertainty in various tiers would be developed, implemented, and updated as appropriate.

- The OY would be specified separately for each stock or stock complex and set equal to the respective TAC.

- MSSTs would be specified in the FMPs for priority stocks in Tiers 4-6 as the necessary resources became available.

- A set of ecosystem indicators would be formally adopted and used in the TAC-setting process.

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H. Under FMP 3.2, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.1 million mt in 2005, then stabilize to about 11.4 million mt. The 2003-2007 average total biomass is estimated at 11.3 million mt.

In the Aleutian Islands region, the assessments are based trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. If under FMP 3.2 there is no directed fishing for pollock in this region (the exploitation level is quite low, <1 percent), the expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof Island.

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,270,000 mt by 2007. The average biomass over this period is expected to be 1,060,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels (Table H.4-23 of Appendix H).

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-1 of Appendix H. Under FMP 3.2, projections indicate that EBS pollock spawning biomass will decrease to about 78 percent of the 2002 level by 2007. The projected average for 2003-2007 is 2.99 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. If under FMP 3.2 these areas are kept at bycatch-only levels, we expect the spawning stock size to remain stable or increase in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 254,000 mt by 2007 under FMP 3.2. This is above the estimated B_{msy} level of 210,000 mt although the average from 2003-2007 is 195,000 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase by about 33 percent and average 0.249 for the period 2003-2007. These values are below the $F_{35\%}$ level of 0.448 and the $F_{40\%}$ level of 0.342, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. This pattern in fishing mortality is due to the fact that the projected catch is expected to come closer to the actual ABC in future years. The proportion of SPR conserved under these mortality rates is 49 percent in 2003, decreasing to 47 percent by 2007; the average implied SPR rate of fishing from 2003-2007 is 47 percent (Table H.4-1 of Appendix H). If under this FMP pollock are maintained at bycatch-only status, then the fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than one percent under FMP 3.2 (Table H.4-2 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.101 in 2003 followed by increases to 0.142 by 2007. The values for $F_{35\%}$ and $F_{40\%}$ are 0.350 and 0.294, respectively. The SPR rate in 2002 is estimated at 55 percent and averages about 65 percent for the period 2003-2007. This fishing mortality rate pattern is due to the fact that under this alternative, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$ (Table H.4-23 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (January 20-March). Under FMP 3.2, an average of 1.48 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial/temporal allocations as presented in Section 3.5.1.1. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period (provided these regions maintain a bycatch-only status).

In the GOA, pollock fishery in a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.15. Under FMP 3.2, an average of 64,100 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 96,400 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery will likely change from the 2002 pattern. The effect of these changes is unknown.

Status Determination

Under FMP 3.2, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For FMP 3.2, GOA pollock spawning biomass is below the B_{MSY} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007.

Age and Size Composition

Under FMP 3.2, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.50 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.13 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under FMP 3.2.HabitatMediatedImpacts

Any habitat-mediated impacts of FMP 1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under FMP 3.2 (for the period 2003-2007).

Summary of Effects of FMP 3.2 – Pollock

Because the pollock are fished at less than the OFL and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.2 are considered insignificant. Fishing rates are well within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity. Based on extended 20-year projections (with the same model assumptions as used in the base 2003-2007 period), both the EBS and GOA pollock are expected to stabilize with catches lower than the expected long-term F_{ABC} catch levels and spawning biomass levels above the B_{MSY} levels.

Cumulative Effects of FMP 3.2 – EBS Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 3.2 (see Section 4.7.1.1).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the BSAI pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Removals of pollock that occur in the Russian pollock fishery are considered to be a potential adverse contributor while removals in the State of Alaska pollock fisheries are not considered to be contributors to fishing mortality in the cumulative case. Marine pollution is also identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of EBS pollock, and the effects are judged to be insignificant. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be insignificant under the FMP (see Section 4.7.1.1).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are the same as those described for FMP 3.1 and include the Russian and State of Alaska pollock fisheries, and marine pollution.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under the FMP; and the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.7.1.1).

- **Persistent Past Effects.** Past effects under FMP 3.2 are identical to those described for FMP 3.1 and include lingering beneficial effects on reproductive success.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, the Russian and State of Alaska pollock fisheries have the potential to cause adverse effects on genetic structure, and a potentially beneficial effect on pollock recruitment by reducing the adult pollock biomass. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects**. Cumulative effects are possible for the spatial/temporal concentration; and the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see direct/indirect effects discussion above). However, it is determined that the FMPs would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on pollock prey species could have potential beneficial or potential adverse effects (see direct/indirect effects discussion for FMP 3.1). Marine pollution has been identified as a reasonably future external contributing factor, and the other fisheries shown in Table 4.5-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the FMP; and the effects are insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under the FMP, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, as described in the direct/indirect effects section, the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects identified for EBS pollock stock include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.1) Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the EBS. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, adverse effects are possible from the Russian and State of Alaska fisheries and marine pollution. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock could be either beneficial or adverse.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under FMP 3.2; and the effects on the EBS pollock stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

Cumulative Effects of FMP 3.2 – GOA Pollock

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 3.2 (see Section 4.7.1.1).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, State of Alaska, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, catch and bycatch of pollock in the State of Alaska pollock fisheries, and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Marine pollution is identified as having a potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of GOA pollock, and the effects are judged to be insignificant for each FMP. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMP 3.2 (see direct/indirect effects discussion). As modeled under the FMP, the age 2-10+ biomass of GOA pollock is expected to increase (see Section 4.7.1.1). The increase is anticipated primarily because recruitment is expected to improve from recent low levels.

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.15), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described in FMP 3.1, effects on biomass are indicated due to removals in the State of Alaska pollock fisheries. Marine pollution is identified as having a potential adverse contribution to change in biomass, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified; and the effects are considered insignificant. The combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** As the density and quotas of pollock change during the modeled period, the concentration of the pollock fishery will change from the 2002 pattern; it is not possible to predict exactly how the pattern will change. However, for GOA pollock, the stock is expected to be above MSST for the years 2003-2007 (see direct/indirect effects discussion). Therefore, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects**. Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.15) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, the State of Alaska pollock fisheries, and the State of Alaska shrimp fishery and marine pollution are identified as potential adverse contributors.

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration; and the effects are considered to be insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see Section 4.7.1.1). However, it is determined that the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, climate changes and regime shifts could have potentially adverse or beneficial effects on pollock prey species. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in Table 4.5-2 are determined to be potential adverse contributors.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under FMP 3.2; and the effects are considered insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see direct/indirect effects discussion). However, it is determined that the FMPs would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stock include past foreign fisheries, JV, State of Alaska, domestic fisheries, EVOS, climate changes, and regime shifts (see Section 3.5.1.15). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska pollock and shrimp fisheries, since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock would be either adverse or beneficial as described for EBS pollock, although a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; and the effects on the GOA pollock stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

4.7.1.2 Pacific Cod

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA Pacific cod for each of the bookends under Alternative 3. The goal of Alternative 3 is seek to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles, and where appropriate and practicable, increased habitat protection and additional bycatch constraints.

Direct/Indirect Effects of FMP 3.1

<u>Total Biomass</u>

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-3 of Appendix H. Under FMP 3.1, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,124,000 mt in 2007, with a 2003-2007 average value of 2,089,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-24 of Appendix H. Under FMP 3.1, model projections indicate that total GOA biomass is expected to increase steadily to a value of 675,000 mt in 2007, with a 2003-2007 average value of 622,000 mt.

<u>Spawning Biomass</u>

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-3 of Appendix H. Under FMP 3.1, model projections indicate that BSAI spawning biomass is expected to decrease to a value of 403,000 mt in 2003, then increase to a value of 447,000 mt in 2006, then decrease to a value of 445,000 mt in 2007, with a 2003-2007 average value of 432,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomass are shown in Table H.4-24 of Appendix H. Under FMP 3.1, model projections indicate that GOA spawning biomass is expected to decrease to a value of 79,100 mt in 2005, then increase to a value of 85,700 mt in 2007, with a 2003-2007 average value of 83,100 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-3 of Appendix H. Under FMP 3.1, model projections indicate that BSAI fishing mortality will increase to a value of 0.284 in 2003, then decrease to a value of 0.266 in 2005, then increase to a value of 0.271 in 2006, then decrease to a value of 0.265 in 2007, with a 2003-2007 average of 0.272. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for stocks above $B_{40\%}$.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-24 of Appendix H. Under FMP 3.1, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.324 in 2003, then decrease to a value of 0.289 in 2005, then increase to a value of 0.312 in 2007, with a 2003-2007 average of 0.304. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

Certain areas that are currently open to fishing would be closed under FMP 3.1. If these closures had been in place in 2001, it is estimated that the following proportions of the 2001 Pacific cod catch would have been displaced from each sub-region:

Area:	Bering Sea	Aleutian Islands	Western GOA	Central GOA	Eastern GOA
Proportion of catch displaced:	0.033	0.681	0.202	0.122	0.000

Under FMP 3.1, catches of Pacific cod are projected to increase in both the BSAI and GOA, meaning that the imposition of new closed areas will tend to increase the amount of catch taken from the remaining open areas.

Under FMP 3.1, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under FMP 3.1. The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007 (Tables H.4-3 and H.4-24 of Appendix H).

Age and Size Composition

Under FMP 3.1, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 3.1, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this FMP.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 on Pacific cod would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under this FMP.

Summary of Effects of FMP 3.1 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 3.1, both stocks are projected to remain above MSST throughout the period 2003-2007. The biomass of the BSAI stock is projected to be below $B_{40\%}$ in 2003 but above $B_{40\%}$ in 2004-2007, while the biomass of the GOA stock is projected to be below $B_{40\%}$ throughout the period 2003-2007. The biomass of the BSAI stock is expected to show an overall increase during the period 2003-2007 and beyond, while the biomass of the GOA stock is expected to show an overall decrease during the period 2003-2007 and beyond. All catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 3.1 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 3.1 on BSAI or GOA Pacific cod.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 3.1 on fishing mortality and biomass is rated "insignificant," because the projection model indicates that fishing mortality would be less than the OFL and biomass would be above the MSST throughout the period 2003-2007.

Because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on genetic structure under FMP 3.1 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on reproductive success under FMP 3.1 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of groundfish harvest under FMP 3.1 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success in the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of habitat disturbance under

FMP 3.1 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks (Table 4.7-1).

Cumulative Effects of FMP 3.1 – BSAI Pacific Cod

External effects and the resultant cumulative effects associated with FMP 3.1 are depicted in Table 4.5-3 (BSAI cumulative effects). For further information regarding persistent past effects listed below in the text and in the tables, see the past/present effects analysis section of Section 3.5.1.2.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stocks is insignificant under the FMP (see Section 4.7.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects**. Cumulative effects under FMP 3.1 are identified for mortality of BSAI Pacific cod, and the effects are judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stocks is expected to be insignificant under FMP 3.1 (see Section 4.7.1.2).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery in the BSAI. However, these removals are not expected to affect the ability of the stock to maintain maximum stock size. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects**. Cumulative effects for change in biomass are identified under FMP 3.1; and the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, and subsistence use in the BSAI have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible for the spatial/temporal concentration under the FMP; and the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify (see direct/indirect effects discussion). However, it is determined that the FMP 3.1 would have insignificant effects on Pacific cod prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown in Table 4.5-3 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is rated as insignificant (see Section 4.7.1.2).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod stocks include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described above for prey availability, impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stocks could be either beneficial or adverse depending on water temperatures. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under the FMP; and are considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST and the effect is judged insignificant.

Cumulative Effects of FMP 3.1 – GOA Pacific Cod

Cumulative effects for GOA Pacific cod are summarized in Table 4.5-4.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stocks is insignificant under FMP 3.1 (see Section 4.7.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stocks. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 3.1 is identified for mortality of GOA Pacific cod, and the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stocks is expected to be insignificant under the FMP 3.1 (see Section 4.7.1.2).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.16), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects**. Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery and in the State of Alaska groundfish fisheries. However, these removals are not expected to affect the ability of the stock to maintain maximum stock size. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effects for change in biomass is identified for the FMP; and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.16) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment particularly in the GOA where the state groundfish fishery is very localized, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, subsistence use, and the State of Alaska groundfish fisheries all have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration under the FMP; and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.1 would have insignificant effects on Pacific cod prey availability (see Section 4.7.1.2).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for the Bering Sea stock, the effects of climate changes and regime shifts on Pacific cod prey species in the GOA could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in Table 4.5-4 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the FMP; and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 3.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the effect is rated as insignificant (see Section 4.7.1.2).

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod stocks include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.16). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described for the Bering Sea stock , impacts on habitat from climate changes and regime shifts on GOA Pacific cod stocks could be either beneficial or adverse and marine pollution could be a potential adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under the FMP; and are considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST and the effect is judged insignificant.

Direct/Indirect Effects of FMP 3.2

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-3 of Appendix H. Under FMP 3.2, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,155,000 mt in 2007, with a 2003-2007 average value of 2,105,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-24 of Appendix H. Under FMP 3.2, model projections indicate that total GOA biomass is expected to increase steadily to a value of 688,000 mt in 2007, with a 2003-2007 average value of 631,000 mt.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-3 of Appendix H. Under FMP 3.2, model projections indicate that BSAI spawning biomass is expected to decrease to a value of 403,000 mt in 2003, then increase to a value of 457,000 mt in 2007, with a 2003-2007 average value of 438,000 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-24 of Appendix H Under FMP 3.2, model projections indicate that GOA spawning biomass is expected to decrease to a value of 82,400 mt in 2005, then increase to a value of 90,100 mt in 2007, with a 2003-2007 average value of 85,900 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-3 of Appendix H. Under FMP 3.2, model projections indicate that BSAI fishing mortality will increase to a value of 0.277 in 2003, then decrease to a value of 0.249 in 2006, then increase to a value of 0.256 in 2006, then decrease to a value of 0.252 in 2007, with a 2003-2007 average of 0.259. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for stocks above $B_{40\%}$.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-24 of Appendix H. Under FMP 3.2, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.282 in 2003, then decrease to a value of 0.260 in 2005, then increase to a value of 0.280 in 2007, with a 2003-2007 average of 0.271. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

Certain areas that are currently open to fishing would be closed under FMP 3.2. If these closures had been in place in 2001, it is estimated that the following proportions of the 2001 Pacific cod catch would have been displaced from each sub-region:

Area:	Bering Sea	Aleutian Islands	Western GOA	Central GOA	Eastern GOA
Proportion of catch displaced:	0.257	0.477	0.372	0.217	0.560

Under FMP 3.2, catches of Pacific cod are projected to increase in both the BSAI and GOA, meaning that the imposition of new closed areas will tend to increase the amount of catch taken from the remaining open areas.

Under FMP 3.2, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under FMP 3.2. The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007 (Tables H.4-3 and H.4-24 of Appendix H).

Age and Size Composition

Under FMP 3.2, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 3.2, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this FMP.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.2 on Pacific cod would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under this FMP.

Summary of Effects of FMP 3.2 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 3.2, both stocks are projected to remain above MSST throughout the period 2003-2007. The biomass of the BSAI stock is projected to be below $B_{40\%}$ in 2003 but above $B_{40\%}$ in 2004-2007, while the biomass of the GOA stock is projected to be below $B_{40\%}$ throughout the period 2003-2007. The biomass of the BSAI stock is expected to show an overall increase during the period 2003-2007 and beyond, while the biomass of the GOA stock is expected to show an overall decrease during the period 2003-2007 but an overall increase farther into the future. All catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 3.2 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 3.2 on BSAI or GOA Pacific cod.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 3.2 on fishing mortality and biomass is rated insignificant, because the projection model indicates that fishing mortality would be less than the OFL and biomass would be above the MSST throughout the period 2003-2007.

Because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on genetic structure under FMP 3.2 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on reproductive success under FMP 3.2 are expected to be not much greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of groundfish harvest under FMP 3.2 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success in the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of habitat disturbance under FMP 3.2 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks (Table 4.7-1).

Cumulative Effects of FMP 3.2

Cumulative effects for BSAI Pacific cod are summarized in Table 4.5-3.

BSAI Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stocks is insignificant under FMP 3.2 (see Section 4.7.1.2).

- **Persistent Past Effects**. Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1 in the BSAI, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** Cumulative effects under FMP 3.2 are identified for mortality of BSAI Pacific cod, and the effects are judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stocks is expected to be insignificant under FMP 3.2 (see Section 4.7.1.2).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery in the BSAI. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under FMP 3.2; and the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, the IPHC longline and State of Alaska crab fisheries, and subsistence use in the BSAI have the potential to cause adverse effects. Marine pollution could contribute adversely to genetic changes and reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible for the spatial/temporal concentration under the FMP; and the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.2 would have insignificant effects on Pacific cod prey availability (see Section 4.7.1.2).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in Table 4.5-3 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.2 would have insignificant effects on Pacific cod habitat suitability (see Section 4.7.1.2).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod stocks include past foreign, JV, domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stocks could be either beneficial or adverse, and marine pollution has also been identified as a potential adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under the FMP; and the effects are insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST.

GOA Pacific Cod

Cumulative effects for GOA Pacific cod are summarized in Table 4.5-4.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stocks is insignificant under FMP 3.2 (see Section 4.7.1.2).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stocks. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1 in the GOA, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under FMP 3.2 is identified for mortality of GOA Pacific cod, and the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stocks is expected to be insignificant under FMP 3.2 (see Section 4.7.1.2).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.16), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery and in the State of Alaska groundfish fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass, while climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified for the FMP; and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.16) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, particularly in the GOA where the state groundfish fishery is very localized, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, the IPHC longline and State of Alaska crab fisheries, subsistence use, and the State of Alaska groundfish fisheries all have the potential to cause adverse effects. Marine pollution could also contribute adversely to genetic changes and reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration under the FMP; and the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.2 would have insignificant effects on Pacific cod prey availability (see Section 4.7.1.2).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1 in the GOA, effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in Table 4.5-4 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the FMP; and the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.2 would have insignificant effects on Pacific cod habitat suitability (see Section 4.7.1.2).

- **Persistent Past Effects**. Past effects identified for GOA Pacific cod stocks include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.16). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on GOA Pacific cod stocks could be either beneficial or adverse. Marine pollution has been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects**. A cumulative is identified for habitat suitability under the FMP; and the effect is considered to be insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST.

4.7.1.3 Sablefish

This section provides the direct, indirect and cumulative effects analysis for sablefish for each of the bookends under Alternative 3. Sablefish are managed as one stock in the BSAI and GOA; therefore, BSAI and GOA areas are discussed together in this section.

The goal of Alternative 3 is seek to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles, and where appropriate and practicable, increased habitat protection and additional bycatch constraints. For further information regarding persistent past effects listed below in the text and in the table, see the past/present effects analysis section of Sections 3.5.1.3 and 3.5.1.17. Direct/indirect effects are summarized in Table 4.7-1.

Direct/Indirect Effects of FMP 3.1

Catch/ABC

FMP 3.1 is projected to have an insignificant impact on average sablefish yield compared to the baseline. Similar yields are projected because FMP 3.1 assumptions mostly replicate baseline conditions.

Total Biomass

FMP 3.1 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. FMP 3.1 assumptions mostly replicate baseline conditions. Total biomass increases from 2002-2007 under FMP 1 because long-term average recruitment (1977-present) is used to project biomass and is higher than most recent recruitments (Tables H.4-11 and H.4-30 of Appendix H).

Spawning Biomass

FMP 3.1 is projected to have an insignificant impact on spawning biomass compared to the baseline. FMP 3.1 assumptions mostly replicate baseline conditions. Spawning biomass increases from 2002-2007 under FMP1 because long-term average recruitment (1977-present) is used to project biomass and is higher than recent recruitment (Table H.4-11 of BSAI sablefish and H.4-30 of GOA sablefish found in Appendix H).

Spawning biomass is projected to decrease from 2002-2007 while total biomass is projected to increase during the same interval. Total biomass includes ages 2-30+ while spawning biomass includes ages 6.5-30+ (initial age is average age of first spawning for females) so that spawning biomass trends due to changing recruitment lag total biomass trends. Spawning biomass will likely increase for a longer projection.

Fishing Mortality

Under FMP 3.1, the fishing mortalities imposed on the sablefish stock are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Tables H.4-11 and H.4-30 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 3.1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. FMP 3.1 closed areas are the same as baseline.

Status Determination

Under FMP 3.1, sablefish is not overfished nor approaching an overfished condition.

Age and Size Composition

FMP 3.1 is projected to have an insignificant impact on mean age compared to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

BSAI mean age likely is overestimated. The model assumes that the lower exploitation rate for the BSAI compared to the GOA will translate into greater mean age for the BSAI. However sablefish migration is substantial enough to erase the effects of differential exploitation rates between the GOA and BSAI. The mean age for the GOA best represents the mean age for the BSAI/GOA because sablefish abundance is much greater for the GOA.

Sex Ratio

The sex ratio of the adult population is 40 males: 60 females, based on sex ratio data collected during sablefish longline surveys. This FMP probably would have no significant effect on the sex ratio compared to the baseline.

Habitat Suitability

FMP 3.1 would have no significant effect on habitat suitability compared to the baseline because exploitation rates for FMP1 are similar to baseline.

Predator-Prey Relationships

FMP 3.1 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline, so this FMP should have an insignificant effect on the amount of sablefish biomass available to the ecosystem and the amount of predation due to sablefish.

Cumulative Effects of FMP 3.1

External effects and the resultant cumulative effects associated with FMP 3.1 are depicted in Table 4.5-5.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 3.1 (see Section 4.7.1.3).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska groundfish fisheries are identified for sablefish. Large removals of sablefish occurred, particularly in the JV and domestic fisheries. Catches that were under reported during the late 1980s may have contributed to abundance declines in the 1990s (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of sablefish are predicted to continue in the IPHC longline fishery, and State of Alaska groundfish fishery, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels and do not add additional fishing mortality. Due their highly migratory nature, Canadian fisheries within Canadian waters could be harvesting sablefish considered to be part of the GOA population. These removals are not accounted for in the TAC setting process and can be considered as having a potential adverse contribution to the cumulative case. Likewise, marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to direct sablefish mortality.

- **Cumulative Effects**. A cumulative effect under FMP 3.1 is identified for mortality of sablefish, and the effect is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be insignificant under FMP 3.1 (see direct/indirect effects discussion presented above).

- **Persistent Past Effects.** While past large removals of sablefish and other past effects on biomass have been identified (see Sections 3.5.1.3 and 3.5.1.17), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to catch and bycatch in the IPHC longline and State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to sablefish mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the sablefish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects**. Past effects are not identified for change in genetic structure or reproductive success. While spatial/temporal concentration of catch occurred in the state directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska groundfish fisheries, and Canadian fisheries all have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population or affect recruitment. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.1 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish prey availability (see Section 4.7.1.3).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of sablefish prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on sablefish prey species (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects**. Future external effects of climate changes and regime shifts on sablefish prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Sections 3.5.1.3 and 3.5.1.17). Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown in Table 4.5-5 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the sablefish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions that are difficult to quantify. FMP 3.1 is not expected to impact habitat compared to baseline. Therefore, it is determined that the FMP would have insignificant effects on sablefish habitat suitability (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for sablefish include past foreign, JV, and domestic fisheries; the State of Alaska crab and bait fisheries; IPHC longline; and climate changes and regime shifts (see Sections 3.5.1.3 and 3.5.1.17). Past fishing for sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries,, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described above for prey availability, impacts on habitat from climate changes and regime shifts on the sablefish stock could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, its effect on the sablefish stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is jeopardized.

Direct/Indirect Effects of FMP 3.2

Direct/indirect effects are summarized in Table 4.7-1.

Catch/ABC

Alternative 3.2 is projected to significantly decrease sablefish yield compared to the baseline. In Alternative 3.2, a risk-averse adjustment is applied to F_{ABC}. The amount of adjustment is affected by recruitment variability and uncertainty in abundance estimation. Sablefish abundance is estimated with reasonable certainty, but recruitment is highly variable, so that the adjustment (0.491) is substantial. As a result, projected yield is significantly reduced for Alternative 3.2 (Tables H.4-11 and H.4-30 of Appendix H).

Total Biomass

Alternative 3.2 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. Fishing mortality is lower for this alternative compared to baseline, but not enough to significantly increase total biomass (Tables H.4-11 and H.4-30 of Appendix H).

Spawning Biomass

Alternative 3.2 is projected to have an insignificant impact on spawning biomass compared to the baseline. Fishing mortality is lower for this alternative compared to baseline, but not enough to significantly increase spawning biomass (Table H.4-11 for BSAI sablefish and Table H.4-30 for GOA sablefish found in Appendix H).

Spawning biomass is projected to remain about the same from 2002-2007 while total biomass is projected to increase during the same interval. Total biomass includes ages 2-30+ while spawning biomass includes ages 6.5-30+ (initial age is average age of first spawning for females) so that spawning biomass trends due to changing recruitment lag total biomass trends. Spawning biomass will likely increase for a longer-term projection.

Fishing Mortality

Under Alternative 3.2, the fishing mortalities imposed on the sablefish stock are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Tables H.4-11 and H.4-30 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. Alternative 3.2 is projected to significantly increase the spatial / temporal concentration of fishing mortality compared to the baseline. The proposed closed areas for this alternative cover some of the areas where the sablefish fishery, both longline and trawl, currently operate, thus restricting the fishery to the remaining open areas. Sablefish undergo large migrations (e.g., Heifetz and Fujioka 1991) and substantial genetic mixing is expected for this stock. The degree of spatial/temporal concentration of the fishery is not likely to result in depletion of sub-populations of sablefish if they exist. For this reason, it is not likely that the amount of spatial/temporal concentration of fishing effort would inhibit the stock's ability to remain above the MSST.

Status Determination

Under Alternative 3.2, sablefish is not overfished nor approaching an overfished condition.

Age and Size Composition

Alternative 3.2 is projected to have an insignificant impact on mean age compared to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

BSAI mean age likely is overestimated. The model assumes that the lower exploitation rate for the BSAI compared to the GOA will translate into greater mean age for the BSAI. However sablefish migration is substantial enough to erase the effects of differential exploitation rates between the GOA and BSAI. The mean age for the GOA best represents the mean age for the BSAI/GOA because sablefish abundance is much greater for the GOA.

Sex Ratio

The sex ratio of the adult population is 40 males: 60 females, based on sex ratio data collected during sablefish longline surveys. This alternative probably would have no significant effect on the sex ratio compared to the baseline.

Habitat Suitability

Alternative 3.2 would decrease exploitation rates overall, but also will significantly increase the spatial/ temporal concentration of fishing mortality compared to the baseline. The proposed closed areas in this alternative cover some longline and trawl fishing for sablefish, thus restricting the fishery to the remaining open areas. This would eliminate the local fishing mortality rates on sablefish in the closed areas, but effort also would increase in some areas or times as a result of area closures, thus concentrating the fishery at certain fishing location and increasing fishing mortality rates on sablefish there. Under Alternative 3.2, average catch is projected to decrease by about 1/3 compared to baseline. As long as at least 2/3 of the areas remain open, the remaining catch should not decrease habitat suitability in the open areas and the habitat suitability of closed areas should improve, to the extent that fishing affects habitat suitability.

Predator-Prey Relationships

Alternative 3.2 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline, so this alternative should have an insignificant effect on the amount of sablefish biomass available to the ecosystem and the amount of predation due to sablefish.

Cumulative Effects of FMP 3.2

Eternal effects and the resultant cumulative effects associated with FMP 3.2 are depicted in Table 4.5-5.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 3.2 (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska groundfish fisheries are identified for sablefish. Large removals of sablefish occurred, particularly in the JV and domestic fisheries. Catches that were under reported during the late 1980s may have contributed to abundance declines in the 1990s (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, bycatch and removals of sablefish are predicted to continue in the IPHC longline fishery, and State of Alaska groundfish fishery, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Canadian fisheries within Canadian waters and marine pollution are identified as having a reasonably foreseeable potential adverse contribution. Climate changes and regime shifts are not identified as being contributors to direct sablefish mortality.

- **Cumulative Effects.** A cumulative effect under FMP 3.2 is identified for mortality of sablefish, but the effect is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be insignificant under FMP 3.2 (see Section 4.7.1.3).

- **Persistent Past Effects.** While past large removals of sablefish and other past effects on biomass have been identified (see Sections 3.5.1.3 and 3.5.1.17), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, effects on biomass are indicated due to catch and bycatch in the IPHC longline and State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, but climate changes and regime shifts are not identified as being contributors to sablefish mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the sablefish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure or reproductive success. While spatial/temporal concentration of catch occurred in the state directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As with FMP 3.1, the IPHC longline and State of Alaska groundfish fisheries, and Canadian fisheries all have the potential to cause adverse effects. Marine pollution could also contribute adversely to genetic changes and reduced recruitment.

- **Cumulative Effects**. A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that the FMP would have insignificant effects on sablefish prey availability (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of sablefish prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on sablefish prey species (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** As discussed under FMP 3.1, the effects of climate changes and regime shifts on sablefish prey species could be beneficial or adverse. Marine pollution has been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown in Table 4.5-5 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the sablefish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** It is determined that FMP 3.2 would have insignificant effects on sablefish habitat suitability (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for sablefish include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Sections 3.5.1.3 and 3.5.1.17). Past fishing for sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** As discussed for FMP 3.1, effects are possible from the State of Alaska fisheries, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the sablefish stock could be either beneficial or adverse and marine pollution has been identified as a potential adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, its effect on the sablefish stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is jeopardized.

4.7.1.4 Atka Mackerel

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA Pacific cod for each of the bookends under Alternative 3. The goal of Alternative 3 is to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles, and where appropriate and practicable, increased habitat protection and additional bycatch constraints. Sections 3.5.1.4 and 3.5.1.18 provide further information regarding persistent past effects listed below in the text and in the tables. Direct/indirect effects are summarized in Table 4.7-1.

Direct/Indirect Effects of FMP 3.1

Model projections of future BSAI Atka mackerel catch and biomass levels under FMP 3.1 assume the maximum permissible fishing mortality rate according to Amendment 56 ABC/OFL definitions.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced.

<u>Catch and Fishing Mortality</u>

The average expected yield for BSAI Atka mackerel for the period 2003-2007 is 62,700 mt (Table H.4-17 of Appendix H). The catch and ABC values, which are nearly equivalent in the projections, are expected to decrease through 2006. The average fishing mortality imposed on the BSAI Atka mackerel stock in 2002 is 0.251. Model projections show this value will increase to 0.436 in 2004, then decrease in 2005 and increase to 0.401 in 2007. Overall, the projections show a 60 percent increase in the average fishing mortality from 2002 to 2007. These values are well below the FMSY proxy ($F_{35\%}$) value of 0.564 which is the rate associated with the OFL.

Projections of GOA Atka mackerel under FMP 3.1 indicate that catches will likely average 400 mt through 2007 (Table H.4-38 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g., Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

<u>Total Biomass</u>

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. Under FMP 3.1, model projections indicate that total BSAI Atka mackerel is expected to decline to a value of 415,000 mt by 2005, then increase to a value of 442,000 mt by 2007, with a 2003-2007 average value of 435,000 mt. Overall, the projections show an 8 percent decrease in total biomass from 2002 to 2007 under FMP 3.1.

Spawning Biomass

Spawning biomass of female BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H. Under FMP 3.1, model projections indicate that BSAI spawning biomass is expected to decline to a value of 78,500 mt by 2005, then increase to a value of 88,000 mt by 2007, with a 2003-2007 average value of 88,900 mt. Overall, the projections show about a 26 percent decrease in female spawning biomass from 2002 to 2007 under FMP 3.1. Projected spawning biomass exceeds the proxy BMSY value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, the current network of spatial/temporal closed areas is in place. The closures designated in the Steller sea lion protection measures probably have the largest impact relative to Atka mackerel.

The directed fishery for Atka mackerel is prosecuted by catcher processor bottom trawlers. The patterns of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring in the same few locations each year, at depths that typically range between 100 and 200 m. The localized pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next since local populations in the Aleutians appear to be replenished by immigration and recruitment. In addition, management measures are in place which have the effect of spreading out the harvest in time and space . The overall BSAI TAC is allocated to three management areas (western, central, and Bering Sea/eastern Aleutians). The regional TACs are further allocated to two seasons and there are limits to the amount of catch that can be taken inside of Steller sea lion critical habitat. Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, these measures provide protection to Atka mackerel by reducing the risk of localized depletion through effort limitations and reductions. The temporal/spatial concentration of the catch under FMP 3.1 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself about its MSST.

Status Determination

Model projections of future catches of BSAI Atka mackerel are below the OFL in all years under FMP 3.1 (Table H.4-17 of Appendix H). Female spawning biomass in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is not overfished and is determined to be above its MSST under FMP 3.1.

GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Age and Size Composition

Under FMP 3.1, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.74 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term; however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level, therefore, it is unlikely that the age and size compositions would change in the future under FMP 3.1. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than to the effects of fishing.

Sex Ratio

A 50:50 sex ratio is assumed for the BSAI Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future is unknown.

Habitat Suitability

Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, Steller sea lion protection measures may provide habitat protection for Atka mackerel through effort limitations and reductions. The level of habitat disturbance caused by the fishery under FMP 3.1, does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST.

Predator-Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.1 will not impact prey availability for BSAI and GOA Atka mackerel.

Summary of Effects of FMP 3.1 – Atka Mackerel

The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis as the model projections yielded results that were deemed either significant (beneficial or adverse), insignificant, or unknown.

The ratings use the overfishing mortality rate (F_{OFL}) and the MSST for the fishing mortality effect and the MSST for all other effects, as a basis for the beneficial or adverse impacts of FMP 3.1. Because the mean projected BSAI Atka mackerel fishing mortality rates are below the overfishing mortality rate, and the spawning stock is above its MSST in each of the projection years (2003-2007), the fishing mortality effect is insignificant for FMP 3.1. As noted above, the spawning stock biomass of BSAI Atka mackerel in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is determined to be above its MSST under FMP 3.1. Therefore, for all other effects, it was determined that FMP 3.1 did not jeopardize the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST, and the effects were insignificant.

Relative to the comparative baseline, under FMP 3.1, the BSAI Atka mackerel stock is not overfished. Spawning biomass declines through 2005, after which biomass increases. Long-term projections (10 and 20 year projections) of spawning biomass show a very stable trend in biomass after 2007, with levels just above the 2007 level of 88,900 mt.

The fishing mortality rate and the MSST for GOA Atka mackerel are unknown; thus the effect of fishing mortality is unknown under FMP 3.1. As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration and habitat suitability effects is also unknown under FMP 3.1. Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.1 will not impact prey availability for GOA Atka mackerel and the impact to prey availability is insignificant.

Relative to the comparative baseline, under FMP 3.1, the GOA Atka mackerel stock is likely to remain at low abundance under continued low exploitation as a bycatch fishery only.

Cumulative Effects of FMP 3.1 – BSAI Atka Mackerel

External effects and the resultant cumulative effects associated with FMP 3.1 for BSAI Atka mackerel are shown in Table 4.5-6.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 3.1 (see Section 4.7.1.4).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the BSAI Atka mackerel stock. While large removals of Atka mackerel did occur in the past, there does not appear to be a lingering effect on the BSAI Atka mackerel populations (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as the only external event that could cause effects on the BSAI Atka mackerel population. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 3.1 is identified for mortality of BSAI Atka mackerel, but the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be insignificant under FMP 3.1 (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** While past large removals of Atka mackerel and other past effects on biomass have been identified (see Section 3.5.1.4), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Atka mackerel biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The temporal/spatial concentration of the catch under FMP 3.1 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself about its MSST and the effect is judged insignificant (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. Past commercial whaling and sealing removed large predators of Atka mackerel adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.1 will have an insignificant effect on prey availability for BSAI Atka mackerel (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of Atka mackerel prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the Atka mackerel stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Habitat disturbance caused by the fishery under FMP 3.1, does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST, and the effect is judged insignificant (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects identified for BSAI Atka mackerel stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.4). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, the effect on the BSAI Atka mackerel stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Atka mackerel stock to sustain itself at or above MSST is jeopardized.

Direct/Indirect Effects of FMP 3.2

Model projections of future BSAI Atka mackerel catch and biomass levels under FMP 3.2 assume an uncertainty correction applied to the maximum permissible fishing mortality rate according to Amendment 56 ABC/OFL definitions.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced. Direct/indirect effects are summarized in Table 4.7-1.

Catch and Fishing Mortality

The average expected yield for BSAI Atka mackerel for the period 2003-2007 is 52,300 mt. The catch and ABC values (which are nearly equivalent after 2004) are expected to decrease through 2006. The average fishing mortality imposed on the BSAI Atka mackerel stock in 2002 is 0.251 (Table H.4-17 of Appendix H). Model projections show this value will increase to 0.310 in 2005, then decrease to 0.304 in 2007. Overall, the projections show a 21 percent increase in the average fishing mortality from 2002 to 2007. These values are well below the FMSY proxy ($F_{35\%}$) value of 0.564 which is the rate associated with the OFL.

Projections of GOA Atka mackerel under FMP 3.2 indicate that catches will likely average 200 mt through 2007 (Table H.4-38 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g., Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

Total Biomass

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. Under FMP 3.2, model projections indicate that total BSAI Atka mackerel biomass is expected to decline to a value of 451,000 mt by 2004, then increase to a value of 470,000 mt by 2007, with a 2003-2007 average value of 459,000 mt. Overall, the projections show a 2 percent decrease in total biomass from 2002 to 2007 under FMP 3.2.

Spawning Biomass

Spawning biomass of female BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H. Under FMP 3.2, model projections indicate that BSAI spawning biomass is expected to decline to a value of 93,800 mt by 2005, then increase to a value of 100,800 mt by 2007, with a 2003-2007 average value of 101,900 mt. Overall, the projections show a 15 percent decrease in spawning biomass from 2002 to 2007 under FMP 3.2. Projected spawning biomass exceeds the B_{MSY} proxy value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.2, 20 percent of the EEZ is designated as marine protected areas (MPA). The MPAs are comprised of no take marine reserves (3 percent of EEZ), and no bottom contact areas (17 percent of EEZ). The spatial closures in the Aleutian Islands under FMP 3.2 would likely impact the directed fishery for Atka mackerel. Based on locations of historical Atka mackerel fishing effort, some catches of Atka mackerel are likely to be displaced under FMP 3.2, but it is assumed that these catches could be taken (at least in the short-term) in the remaining open areas. As such, the temporal/spatial concentration of the catch will likely increase under FMP 3.2. Because Atka mackerel are a patchily distributed fish and the harvest is concentrated in specific locations, there is an increased risk of localized depletion that may occur under this FMP. However, FMP 3.2 is not likely to adversely affect the sustainability of the stock (at least in the short-term) either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST.

Status Determination

Model projections of future catches of BSAI Atka mackerel are below the OFL in all years under FMP 3.2 (Table H.4-17 of Appendix H). Estimates of female spawning biomass in each of the projection years (2003-2007), are above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is not overfished and is determined to be above its MSST under FMP 3.2.

GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Age and Size Composition

Under FMP 3.2, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 2.85 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term; however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level, therefore, it is unlikely that the age and size compositions would change in the future under FMP 3.2. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than to the effects of fishing.

Sex Ratio

A 50:50 sex ratio is assumed for the BSAI Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future is unknown.

Habitat Suitability

The spatial closures in the Aleutian Islands under FMP 3.2 would eliminate some Atka mackerel fishery areas while increasing effort in the fewer remaining open areas. The level of habitat disturbance would decrease in the closed areas, but increase in the remaining open areas. However, FMP 3.2 is not likely to adversely affect the sustainability of the stock (at least in the short-term) as measured by the ability of the stock to maintain itself above its MSST. The removal of directed fishing in some areas may lead to habitat improvement, but whether this would translate into improved reproductive success is uncertain.

Predator-Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions which are currently difficult to quantify. Under FMP 3.2, elimination of the directed fishery for Atka mackerel in some areas and increased effort in other areas could impact the amount of Atka mackerel available to the ecosystem. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.2 will not impact prey availability for BSAI and GOA Atka mackerel.

Summary of Effects of FMP 3.2 – Atka Mackerel

The criteria used to estimate the significance of impacts of the FMPs on the BSAI and GOA stock of Atka mackerel are outlined in Section 4.1.1.1. The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis as the model projections yielded results that were deemed either significant (beneficial or adverse), insignificant, or unknown.

The ratings use the overfishing mortality rate (F_{OFL}) and the MSST for the fishing mortality effect and the MSST for all other effects, as a basis for the beneficial or adverse impacts of FMP 3.2. Because the mean projected BSAI Atka mackerel fishing mortality rates are below the overfishing mortality rate, and the spawning stock is above its MSST in each of the projection years (2003-2007), the fishing mortality effect is insignificant for FMP 3.2. As noted above, the spawning stock biomass of BSAI Atka mackerel in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is determined to be above its MSST under FMP 3.2. Therefore, for all other effects, it was determined that FMP 3.2 did not jeopardize the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST, and the effects were insignificant .

Relative to the comparative baseline, under FMP 3.2, the BSAI Atka mackerel stock is not overfished. Projected spawning biomass declines through 2005, after which biomass increases. Long-term projections (10 and 20 year projections) of spawning biomass show a fairly stable trend in biomass after 2007, with levels just above the 2007 level of 100,800 mt.

The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under FMP 3.2. As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration and habitat suitability effects is also unknown under FMP 3.2. Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.2 will not impact prey availability for GOA Atka mackerel and the impact to prey availability is insignificant.

Relative to the comparative baseline, under FMP 3.2, the GOA Atka mackerel stock is likely to remain at low abundance under continued low exploitation as a bycatch fishery only.

Cumulative Effects of FMP 3.2

Cumulative effects for BSAI Atka mackerel are summarized in Table 4.5-6.

BSAI Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 3.2 (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the BSAI Atka mackerel stock. While large removals of Atka mackerel did occur in the past, there does not appear to be a lingering effect on the BSAI Atka mackerel populations (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, marine pollution has been identified as the only external event that could cause effects on the BSAI Atka mackerel population.

- **Cumulative Effects.** A cumulative effect under FMP 3.2 is identified for mortality of BSAI Atka mackerel, but the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be insignificant under FMP 3.2 (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** While past large removals of Atka mackerel and other past effects on biomass have been identified (see Section 3.5.1.4), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As discussed under FMP 3.1, marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified. The effect is determined to be insignificant since the combination of internal and external factors is not likely to decrease increase the Atka mackerel biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** FMP 3.2 is not likely to adversely affect the sustainability of the stock (at least in the short-term) either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST and the effect is judged to be insignificant (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** As described for FMP 3.1, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Past commercial whaling and sealing removed large predators of Atka mackerel adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, marine pollution could contribute adversely to genetic changes and reduced recruitment, and climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; the effect is insignificant for change in the genetic structure of the population because there is no evidence of genetic sub-population structure. The cumulative effect on reproductive success is also judged insignificant.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, the internal effect is judged insignificant (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of Atka mackerel prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. Marine pollution has been identified as a reasonably foreseeable future adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the Atka mackerel stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The reduction of the fishery under this FMP may lead to habitat improvement, but the effect on the stock's ability to maintain itself above its MSST is judged insignificant (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects identified for BSAI Atka mackerel stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.4). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, the effect on the BSAI Atka mackerel stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Atka mackerel stock to sustain itself at or above MSST is jeopardized.

Cumulative Effects of FMP 3.1 and FMP 3.2 – GOA Atka mackerel

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced. Therefore, the internal effects of the FMP are unknown for all categories with the exception of prey availability. Cumulative effects for GOA Atka mackerel are summarized in Table 4.5-7.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Atka mackerel stock is unknown under FMP 3.1 and FMP 3.2. The fishing mortality rate and the MSST for GOA Atka mackerel are unknown, thus the effect of fishing mortality is unknown under FMP 3.1.

- **Persistent Past Effects.** Past effects of the past foreign, JV, and domestic fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, JV, and domestic fisheries, have had a lingering effect on the GOA Atka mackerel population that has not yet recovered (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the population is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under FMP 3.1and FMP 3.2 is identified for mortality of GOA Atka mackerel, but the significance of the effect is unknown. GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Atka mackerel stock is unknown FMP 3.1 and FMP 3.2. Current reliable estimates of total and spawning biomass are unknown for GOA Atka mackerel.

- **Persistent Past Effects.** Past effects of the past foreign, JV, and domestic fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, JV, and domestic fisheries, have had a lingering effect on the GOA Atka mackerel population that has not yet recovered (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the population is affected. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; however, the significance of the effect is unknown.

Spatial/Temporal Concentration of Catch

  - Change in Genetic Structure of Population
  - Change in Reproductive Success

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration effects is also unknown under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. The past highly localized fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Also, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Also, climate changes and regime shifts could impact spawning success since a shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 3.1and FMP 3.2 will not impact prey availability for GOA Atka mackerel and the impact to prey availability is determined to be insignificant.

- **Persistent Past Effects.** While lingering population level effects on the invertebrate prey of Atka mackerel from past foreign, state, and domestic fisheries, EVOS are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Atka mackerel prey species could be either beneficial or adverse depending on the direction of change. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is unknown since the direction of external effects is unknown.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the habitat suitability effects is also unknown under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA Atka mackerel stocks include past foreign, JV, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.18). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from the climate changes and regime shifts on the GOA Atka mackerel could be either favorable or unfavorable depending on the direction of change. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, its significance on the BSAI Atka mackerel stock is unknown.

4.7.1.5 Yellowfin Sole and Shallow Water Flatfish

Numerous fishery management actions have been implemented that affect the yellowfin sole fisheries in the BSAI. These actions are described in more detail in Section 3.5.1.5 of this Programmatic SEIS. Yellowfin sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species by the National Standard Guidelines.

Eight flatfish species inhabit shallow waters and are managed in the shallow water flatfish assemblage in the GOA. They include: northern and southern rock sole, yellowfin sole, starry flounder, butter sole, English sole, Alaska plaice and sand sole. Survey results from 2001 indicate that over half of the estimated biomass (54 percent) of this assemblage are northern and southern rock sole. The shallow water group is managed as Tier 4 and Tier 5 species in the GOA (Turnock *et al.* 2001). For further information regarding persistent past effects listed below in the text, see the past/present effects analysis section of Section 3.5.1.19.

BSAI Yellowfin Sole – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

The total biomass of yellowfin sole at the start of 2002 is estimated to be 1,552,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 3.1, model projections indicate that the total BSAI biomass is expected to decline to 1,530,000 in 2005 and then increase to 1,538,000 in 2007, an abundance level slightly less than one percent of the 2002 value. The 2003-2007 average total biomass is 1,536,000 mt. Under FMP 3.2, model projections indicate that the total BSAI biomass is expected to decline to 1,420,000 in 2007, an abundance level nearly 9 percent less than the 2002 value. The 2003-2007 average value is 1,467,000 mt.

Spawning Biomass

Spawning biomass of female yellowfin sole at the start of 2002 is estimated to be 450,700 mt. Model projections of future yellowfin sole spawning biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 3.1, model projections indicate that female spawning biomass is expected to decline over 7 percent of the 2002 value to 417,500 mt by 2007, with a 2003-2007 average value of 436,500 mt. Under FMP 3.2, model projections indicate that female spawning biomass is expected to decline 19 percent of the 2002 value to 364,500 mt by 2007, with a 2003-2007 average value of 402,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 336,900 mt throughout the 5 year projection under both FMP 3.1 and FMP 3.2.

Fishing Mortality

The average annual fishing mortality imposed on the yellowfin sole stock in 2002 is 0.064. Under FMP 3.1, model projections show this value will steadily increase to 0.091 in 2007. Under FMP 3.2, model projections show this value will increase to 0.115 in 2003-2005 and decrease to 0.109 in 2007. These values are well below the F_{MSY} proxy value of 0.138, the rate associated with the OFL (Table H.4-4 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated that the baseline 2002 fishery. It is estimated that 5 percent of the catch allowed under this FMP would be redistributed relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of BSAI yellowfin sole are below the OFLs in all years under FMP 3.1 and FMP 3.2. The yellowfin sole stock is above the MSST level in 2002.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 6.3 years. Under FMP 3.2, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 6.1 years. This compares with a mean age in the equilibrium unfished BSAI stock of 8.0 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of yellowfin sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on yellowfin sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Yellowfin Sole

Table 4.5-8 summarizes the effects of FMP 3.1 and FMP 3.2 on BSAI yellowfin sole. The rating of conditionally significant (either beneficial or adverse) is not applicable in this analysis as the model projections yielded results that were determined either significant (beneficial or adverse), insignificant, or unknown.

The ratings utilize FOFL and the MSST as a basis for beneficial or adverse impacts of fishing mortality and change in reproductive success for each FMP. A thorough description of the rationale for the MSST can be found in the National Standard Guidelines 50 CFR Part 600 (FR Vol. 63, No. 84, 24212-24237). Under FMP 3.1 and FMP 3.2, the spawning stock biomass of BSAI yellowfin sole is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the stock is expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.7-1).

Relative to the 2002 comparative baseline, the yellowfin sole stock is projected to continue to not be overfished under these FMPs. Under FMP 3.1, the 20 year projection indicates that the female spawning stock is expected to decline until 2010 to B_{ABC} abundance levels and will increase thereafter through the end of the projection in 2023. Under FMP 3.2, the 20 year projection indicates that the female spawning stock is expected to decline until 2010 to an abundance level higher than B_{MSY} levels and will increase thereafter through the end of the projection to B_{ABC}.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI yellowfin sole are summarized in Table 4.5-8.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI yellowfin sole is rated as insignificant under FMP 3.1 and FMP 3.2 (see Direct/Indirect Effects discussion). The annual fishing mortality values are below the F_{MSY} proxy value of 0.138. Therefore, FMP 3.1 and FMP 3.2 are likely to result in insignificant impacts to these stocks.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of yellowfin sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI yellowfin sole, and is rated as insignificant. Fishing mortality at projected levels is below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** It is expected that FMP 3.1 or FMP 3.2 will result in insignificant impacts to these stocks (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the yellowfin sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Section 3.5.1.5 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI yellowfin sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the spawning biomass is above the B_{MSY} value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
   – Change in Genetic Structure of Population
   – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI yellowfin sole catch.

- **Reasonably Foreseeable Future External Effects.** As described for biomass, effects on the reproductive success of yellowfin sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as having a potential adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI yellowfin sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the yellowfin sole catch; these effects are ranked as insignificant. The spatial/temporal distribution of yellowfin sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI yellowfin sole is ranked as insignificant (see Direct/Indirect Effects discussion).

- **Persistent Past Effects**. Past effects are identified for the change in prey availability of the BSAI yellowfin sole stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted. Please see Section 3.5.1.5 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** As described for biomass, effect of the climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse. Marine pollution has also been identified as having a potential adverse contribution since.

- **Cumulative Effects.** Cumulative effects are identified for change in prey availability; however, these effects are considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI yellowfin sole is ranked as insignificant (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for BSAI yellowfin sole include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past contributions of the foreign, JV, and domestic fisheries gear impacts are described in Sections 3.5.1.5 and Section 3.6.

- **Reasonably Foreseeable Future External Effects.** As described above, the effects of the climate changes and regime shifts on the BSAI yellowfin sole stock are potentially beneficial or adverse.

- **Cumulative Effects**. Cumulative effects are identified for BSAI yellowfin sole habitat suitability; however, these effects are considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the yellowfin sole stock to sustain itself at or above the MSST is jeopardized.

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – GOA Shallow Water Flatfish

Total and Spawning Biomass

Estimated total and spawning biomass is not available for GOA shallow water flatfish.

Fishing Mortality

The catch of GOA shallow water flatfish in 2002 was estimated to be 6,800 mt. Model projections of future catch are shown in Table H.4-27 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to decrease from 4,800 mt in 2003 to 3,500 mt in 2007. The 2003-2007 average value is 4,200 mt. Under FMP 3.2, model projections indicate that the catch is expected to decrease to 4,100 mt in 2004 and then further decrease to 2,900 mt in 2007. The 2003-2007 average is 3,500 mt.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial temporal characteristics of the annual GOA shallow water flatfish harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated that the baseline 2002 fishery. It is estimated that under this FMP, the catch of Alaska plaice and butter sole would be mostly displaced from the western area (84 percent and 100 percent, respectively) but less in the central area (29 percent and 7 percent) relative to the 2001 catch distribution.

Status Determination

The available information for flatfish species in the shallow water complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species in the National Standard Guidelines. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition projections are not available for GOA shallow water flatfish.

Sex Ratio

The sex ratio of shallow water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on shallow water flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Shallow Water Flatfish

With the exception of the direct/indirect effects of mortality, the direct and indirect effects of FMP 3.1 and FMP 3.2 on GOA shallow water flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the 5 year projection under these FMPs. The predicted catches are well below the OFL for this stocks, therefore, the effects of FMP 3.1 and FMP 3.2 on shallow water flatfish through mortality is insignificant (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects of GOA shallow water flatfish are summarized in Table 4.5-9.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shallow water flatfish is rated as insignificant under FMP 3.1 and FMP 3.2 (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past JV and domestic fisheries have been identified as having lingering past adverse effects on the GOA shallow water flatfish complex (see Section 3.5.1.19).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shallow water flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since shallow water flatfish species bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA shallow water flatfish, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** Since the total and spawning biomass estimates for GOA shallow water species is unavailable, the effects of FMP 3.1 and FMP 3.2 on change in biomass is unknown (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** The past JV and domestic fisheries are identified as having past lingering adverse effects on the biomass levels of GOA shallow water flatfish (see Section 3.5.1.19).

- **Reasonably Foreseeable Future External Events.** As described above for mortality, effects on biomass are indicated due to the potential adverse contributions of marine pollution. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the shallow water flatfish species biomass level. However, the State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for change in biomass of GOA shallow water flatfish, but is rated as unknown. Fishing mortality at projected levels is well below the OFL for this stock. It is unknown if the combined effects of internal removals and removals are likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** It is unknown how the spatial/temporal distribution of the annual GOA shallow water flatfish harvest will be affected under FMP 3.1 and FMP 3.2 relative to the 2002 baseline year.

- **Persistent Past Effects.** Past effects have not been identified for the change in genetic structure or the change in reproductive success of GOA shallow water flatfish.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the reproductive success of shallow water flatfish species due to climate changes and regime shifts are potentially beneficial or adverse as described for mortality. Marine pollution has been identified as having a potential adverse contribution, and the State of Alaska scallop fishery has been identified as a non-contributing factor.

- **Cumulative Effects.** A cumulative effect is possible for change in genetic structure and reproductive success of GOA shallow water flatfish, but are rated as unknown. It is unknown if the combined effects of internal removals and removals due to reasonably foreseeable future external events are likely to jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the GOA shallow water flatfish is determined to be unknown (see Direct/Indirect Effects discussion).

- **Persistent Past Effects**. Past effects are identified for the change in prey availability of the GOA shallow water flatfish stock complex and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.1.19 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potentially beneficial or adverse as described above for mortality. Marine pollution has also been identified as having a potential adverse contribution, and the State of Alaska scallop fishery is identified as a non-contributing factor.

- **Cumulative Effects.** Cumulative effects for change in prey availability are unknown. The predation-mediated impacts of FMP 3.1 and FMP 3.2 on shallow water flatfish are governed by a complex web of indirect interactions which are currently difficult to quantify.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA shallow water flatfish complex is considered to be unknown (see Direct/Indirect Effects discussion).

- **Persistent Past Effects.** Past effects identified for GOA shallow water flatfish include climate changes and regime shifts as described for prey availability. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Sections 3.5.1.19 and 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potentially beneficial or adverse as discussed above for mortality. Marine pollution has also been identified as having a potential adverse contribution. The State of Alaska scallop fishery is also identified as a potential adverse contributor to GOA shallow water flatfish habitat suitability (see Section 3.6).

- **Cumulative Effects.** Cumulative effects are identified for GOA shallow water flatfish habitat suitability; however, these effects are unknown. It is unknown if the combination of internal and external habitat disturbances will to lead to a detectable change in spawning or rearing success such that the ability of the GOA shallow water flatfish stock to maintain current population levels is jeopardized.

4.7.1.6 Rock Sole

Rock sole is described in more detail in Section 3.5.1.6 of this Programmatic SEIS. Rock sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

The total biomass of rock sole at the start of 2002 is estimated to be 970,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-7 of Appendix H. Under FMP 3.1, model projections indicate that the total BSAI biomass is expected to decline to 706,000 mt by 2007, an abundance level 27 percent less than the 2002 value. The 2003-2007 average total biomass is 778,000 mt. Under FMP 3.2, model projections indicate that the total BSAI biomass is expected to decline to 755,000 in 2007, an abundance level 25 percent less than the 2002 value. The 2003-2007 average value is 791,000 mt.

Spawning Biomass

Spawning biomass of female rock sole at the start of 2002 is estimated to be 331,000 mt. Model projections of future rock sole spawning biomass estimates are shown in Table H.4-7 of Appendix H. Under FMP 3.1, model projections indicate that female spawning biomass is expected to decline 47 percent of the 2002 value to 161,300 mt by 2007, with a 2003-2007 average value of 244,100 mt. Under FMP 3.2, model projections indicate that female spawning biomass is expected to decline 41 percent of the 2002 value to 195,100 mt by 2007, with a 2003-2007 average value of 249,600 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 136,700 mt throughout the 5 year projection under FMP 3.1 and FMP 3.2.

Fishing Mortality

The average annual fishing mortality imposed on the rock sole stock in 2002 is 0.064. Under FMP 3.1, model projections show this value will steadily increase to 0.107 in 2007. Under FMP 3.2, model projections show this value will steadily increase to 0.099 by 2007. These values are well below the F_{MSY} proxy value of 0.21, the rate associated with the OFL (Table H.4-7 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI rock sole harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP or what the effect of hot-spot management of PSC would have on fishing behavior.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Fishing would be restricted to previous areas so it is unlikely that fishing effort would become more diffuse over the Bering Sea shelf. It is estimated that 24 percent of the catch would be spatially displaced under this FMP relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of BSAI rock sole are below the OFLs in all years under FMP 3.1 and FMP 3.2 and the female spawning stock size is below the MSST. The rock sole stock is above the MSST level in 2002.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 4.8 years. Under FMP 3.2, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 4.9 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of rock sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 or FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 or FMP 3.2 on rock sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1and FMP 3.2 – BSAI Rock Sole

Under FMP 3.1 and FMP 3.2, the spawning stock biomass of BSAI rock sole is expected to be above the MSST through 2007. Since the fishing mortality rate does not exceed F_{OFL} and the spawning stock size is currently above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.7-1).

Relative to the 2002 comparative baseline, the rock sole stock is projected to continue to not be overfished under these FMPs. Under FMP 3.1, the 20 year projection indicates that the female spawning stock is expected to decline until 2010. From 2010-2012 the stock will be below B_{MSY} before increasing through the end of the projection to levels above B_{ABC} by 2014. Under FMP 3.2, the 20 year projection indicates that the female spawning stock is expected to decline until 2010 to near B_{ABC} levels and will increase thereafter through the end of the projection in 2023.

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI rock sole are summarized in Table 4.5-10.

Mortality

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of fishing mortality on the BSAI rock sole is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rock sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI rock sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonable foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on the BSAI rock sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the rock sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.6 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI rock sole, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonable foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the BSAI rock sole. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of BSAI rock sole. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of rock sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI rock sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rock sole catch, and is ranked as insignificant. The spatial/temporal distribution of rock sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonable foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in prey availability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do effect the availability of some forage species (i.e. capelin); however, studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in habitat suitability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI rock sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.6.

- **Reasonably Foreseeable Future External Effect.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI rock sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the rock sole stock to sustain itself at or above the MSST is jeopardized.

4.7.1.7 Flathead Sole

Flathead sole are described in more detail in Sections 3.5.1.7 and 3.5.1.20 of this Programmatic SEIS. Flathead sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2002, flathead sole were managed independent of the other flatfish complex in the GOA. Until recently, GOA flathead sole were managed under Tier 4; beginning in 2004 flathead sole will be managed under Tier 3. However, GOA flathead sole were modeled under the Tier 4 category for this analysis.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

Total biomass of BSAI flathead sole at the start of 2003 is estimated to be 513,000 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 3.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 492,000 mt in 2006, then increase to 503,000 mt in 2008, with a 2003-2008 average value of 499,000 mt. Under FMP 3.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 491,000 mt in 2006, then increase to 504,000 mt in 2008, with an average of 499,000 mt from 2003-2008.

Spawning Biomass

Spawning biomass of BSAI flathead sole at the start of 2003 is estimated to be 231,200 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 3.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 168,300 mt in 2008, with a 2003-2008 average value of 197,300 mt. Under FMP 3.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 169,100 mt in 2008, with a 2003-2008 average value of 197,300 mt.

Fishing Mortality

The projected fishing mortality imposed on the BSAI flathead sole stock is 0.045 in 2003, increasing to 0.072 in 2008, with an average from 2003-2008 of 0.055 under FMP 3.1. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 81 percent in 2003 and decreases to 73 percent in 2008, with an average of 78 percent from 2003-2008 (Table H.4-8 of Appendix H).

Under FMP 3.2, the projected fishing mortality imposed on the BSAI flathead sole stock is approximately 0.047 in 2003, increasing to 0.053 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 80 percent in 2003 and decreases to 76 percent in 2008, with an average of 78 percent from 2003-2008 (Table H.4-8 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, a projected average of 11,540 mt of BSAI flathead sole are caught annually from 2003 to 2008, with 3,250 mt (28 percent) of the harvest occurring in the EBS shelf Pacific cod fishery, 2,720 mt (24 percent) of the harvest occurring in the walleye pollock fishery, and 2,420 mt (21 percent) of the harvest occurring in the yellowfin sole fishery. The directed flathead sole fishery contributes only 1,200 mt (10 percent).

The average annual projected harvest of flathead sole under FMP 3.2 was 11,100 mt, of which the yellowfin sole fishery (3,400 mt, 31 percent), Pacific cod (2,900 mt, 26 percent), and walleye pollock (2,500 mt, 23 percent) contribute most of the harvest. The directed flathead sole fishery contributes an average annual harvest of 1,100 mt, or 10 percent. It is estimated that 16 percent of the catch under this FMP will be displaced relative to the catch distribution in 2001.

Status Determination

Under FMP 3.1 and FMP 3.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI flathead sole are below ABC and OFL levels from 2003 to 2008.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-8 of Appendix H), is 4.57 years. Under FMP 3.2, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-8 of Appendix H), is 4.58 years. This compares with a mean age in the equilibrium unfished stock of 5.39 years.

Sex Ratio

The sex ratio of BSAI flathead sole is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Flathead Sole

Because the BSAI flathead sole are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.1 and FMP 3.2 are considered insignificant. Fishing rates are below accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.7-1).

Relative to the 2002 comparative baseline, the flathead sole stock is projected to continue to not be overfished under these FMPs. Under FMP 3.1 and FMP 3.2, the twenty year projection indicates that the female spawning stock expected to decrease until 2009 at which time it will be begin to steadily increase throughout the end of the projection.

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

Cumulative effects of BSAI flathead sole are summarized in Table 4.5-11.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI flathead sole is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI flathead sole, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass Level</u>

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on the BSAI flathead sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the flathead sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.7 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI flathead sole, and is rated as insignificant. Projected spawning biomass is projected to be above the MSST for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

<u>Spatial/Temporal Concentration of Catch</u>
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI flathead sole catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch, and is ranked as insignificant. The spatial/temporal distribution of flathead sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects are not identified for the change in prey availability of the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.7.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI flathead sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at or above the MSST is jeopardized.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

Estimates of total and spawning biomass are currently unavailable for this species.

Fishing Mortality

The catch of GOA flathead sole in 2002 was estimated to be 2,000 mt. Model projections of future catch are shown in Table H.4-28 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to decrease to 1,300 mt in 2004-2007. The 2003-2007 average value is also 1,300 mt (65 percent of the 2002 catch). Under FMP 3.2, model projections indicate that the catch is expected to decrease to 1,300 mt in 2003 and further decrease to 1,100 by 2007. The 2003-2007 average is 1,300 mt (53 percent of the 2002 catch).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA flathead sole harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated that the baseline 2002 fishery.

Status Determination

The available information for GOA flathead sole requires that they are classified into the Tier 4 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are currently unavailable for this species.

Sex Ratio

The sex ratio of flathead sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on flathead sole would be governed by a complex web of indirect interactions which are currently difficult to quantify.

Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1and FMP 3.2 – GOA Flathead Sole

The direct and indirect effects of FMP 3.1 and FMP 3.2 on GOA flathead sole cannot be determined from the MSST criteria used for stocks in management category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stock is over the 5 year projection under these FMPs. The predicted catches are well below the OFL for this stock, therefore, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on flathead sole through mortality (Table 4.7-1).

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

Cumulative effects of GOA flathead sole are summarized in Table 4.5-12.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA flathead sole is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Removals by these fisheries have had a lingering adverse effect on GOA flathead sole (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole. The State of Alaska scallop fishery has also been identified as a non-contributing factor since GOA flathead sole bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA flathead sole, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in biomass level is rated as unknown since MSST is unable to be determined at this time.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Large removals of flathead sole by these fisheries is determined to have had a lingering effect on the GOA flathead sole stock (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the flathead sole biomass level. For more information on climate changes and regime shifts (see Sections 3.5.1.20 and 3.10). The State of Alaska scallop fishery is identified as a non-contributing factor for change in biomass level since flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA flathead sole, but is unknown. The MSST is not able to be determined and the total and spawning biomass estimates are currently unavailable. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 the effect of the spatial/temporal concentration of catch is unknown since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA flathead sole stock. However, climate changes and regime shifts have been identified as having a beneficial or adverse effect on GOA flathead sole reproductive success (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA flathead sole. The State of Alaska scallop fishery has been identified as a non-contributing factor to change in genetic structure and change in reproductive success since GOA flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch; however, this effect is unknown. The spatial/temporal distribution of flathead sole catch is not expected to change significantly. It is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA flathead sole stock and include climate changes and regime shifts. For more information on the effects of climate changes and regime shifts on the GOA flathead sole stock (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole prey availability. The State of Alaska scallop fishery gear could impact flathead sole benthic prey availability and/or quality.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to sustain itself at current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects identified for GOA flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.20.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole habitat suitability. For information on the effects of fishery gear on EFH, see Section 3.6.

- **Cumulative Effects.** A cumulative effect is identified for GOA flathead sole habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at current population levels.

4.7.1.8 Arrowtooth Flounder

BSAI and GOA arrowtooth flounder are described in more detail in Sections 3.5.1.8 and 3.5.1.21 of this Programmatic SEIS. Arrowtooth flounder is managed as its own stock under the BSAI and GOA groundfish FMPs under the Tier 3 management category, thus MSSTs are defined for these species.

BSAI Arrowtooth Flounder – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

The total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-6 of Appendix H. Under FMP 3.1, model projections indicate that the total BSAI biomass is expected to decline to 598,000 mt by 2007, an abundance level 26 percent less than the 2002 value. The 2003-2007 average total biomass is 675,000 mt. Under FMP 3.2, model projections indicate that the total BSAI biomass is expected to decline to 605,000 mt in 2007, an abundance level 25 percent less than the 2002 value. The 2003-2007 average value is 679,000 mt.

Spawning Biomass

Spawning biomass of female BSAI arrowtooth flounder at the start of 2002 is estimated to be 475,900 mt. Model projections of future BSAI arrowtooth flounder spawning biomass estimates are shown in Table H.4-6 of Appendix H. Under FMP 3.1, model projections indicate that female spawning biomass is expected to decline 30 percent of the 2002 value to 330,000 mt by 2007, with a 2003-2007 average value of 388,100 mt. Under FMP 3.2, model projections indicate that female spawning biomass is expected to decline 30 percent of the 2002 value to 335,000 mt by 2007, with a 2003-2007 average value of 390,800 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 182,900 mt throughout the 5 year projection under both FMP 3.1 and FMP 3.2.

Fishing Mortality

The average annual fishing mortality imposed on the BSAI arrowtooth flounder stock in 2002 is 0.015. Under FMP 3.2, model projections show this value will steadily increase to 0.24 in 2007. Under FMP 3.2, model projections show this value will slowly increase to 0.018 by 2007. These values are well below the F_{MSY} proxy value of 0.38, the rate associated with the OFL (Table H.4-6 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI arrowtooth flounder harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated that the baseline 2002 fishery. It is estimated that 12 percent of the Bering Sea will be displaced under this FMP relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of BSAI arrowtooth flounder are below the OFLs in all years under FMP 3.1 and FMP 3.2. The arrowtooth flounder stocks are above the MSST level throughout the 5 year projection, as in the 2002 baseline year.

Age and Size Composition

Under FMP 3.1 and FMP 3.2, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-6 of Appendix H), is 4.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.4 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the BSAI have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on BSAI arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Arrowtooth Flounder

Under FMP 3.1 and FMP 3.2, the spawning stock biomass of BSAI arrowtooth flounder is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under FMP 3.1 and FMP 3.2 are considered insignificant (Table 4.7-1).

Relative to the 2002 comparative baseline, the BSAI arrowtooth flounder stocks are projected to continue to not be overfished under these FMPs. The 20 year projection indicates that both female spawning stocks are expected to remain above B_{ABC} levels through the end of the projection in 2023.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects of BSAI arrowtooth flounder are summarized in Table 4.7-1.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI arrowtooth flounder is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of arrowtooth flounder. The IPHC longline fishery is identified as a potential adverse contributor to BSAI arrowtooth flounder mortality since arrowtooth flounder are caught as bycatch in this fishery. Finally, the State of Alaska herring fishery is identified as a non-contributing factor to BSAI arrowtooth flounder mortality since bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI arrowtooth flounder, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** Total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections indicate that the BSAI arrowtooth flounder are above their respective MSST for all years. Therefore, it is expected that FMP 3.1 and FMP 3.2 will result in insignificant effects to these stocks.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the arrowtooth flounder biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.8 and 3.10). The IPHC longline fishery has been identified as a potential adverse contributor to BSAI arrowtooth flounder biomass level since bycatch is expected to occur in this fishery. Finally, the State of Alaska herring fishery is identified as a non-contributing factor since arrowtooth flounder bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI arrowtooth flounder, but is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI arrowtooth flounder. Climate changes and regime shifts are identified as having had potential adverse or beneficial effects on the reproductive success of BSAI arrowtooth flounder (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of arrowtooth flounder due to climate changes and regime shifts are potential beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI arrowtooth flounder. The IPHC longline fishery is identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since the removals are not expected to be significant. The State of Alaska herring fishery is also identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch; however, these effects are ranked as insignificant. The spatial/temporal distribution of arrowtooth flounder catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI arrowtooth flounder is ranked as insignificant. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 and FMP 3.2; however, since the diet of arrowtooth flounder consists of many species, it is unlikely that the groundfish fisheries would sufficiently change the prey availability such that is jeopardizes the ability of the stock to sustain itself above the MSST.

- **Persistent Past Effects.** Past effects identified include the past foreign, JV, and domestic fisheries, State of Alaska groundfish fisheries, State of Alaska herring fisheries and climate changes and regime shifts (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potential beneficial or adverse. Some forage species (i.e. capelin and herring), shrimp and pollock respond to variations in water temperatures which vary with the climate. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non- contributing factor to prey availability since the bycatch of prey species is not expected in this fishery. The State of Alaska herring fishery is identified as a potential adverse contributor to prey availability by reducing the availability of herring.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, these effects are considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI arrowtooth flounder is ranked as insignificant. Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. However, it is determined that FMP 3.1 and FMP 3.2 would have insignificant effects on arrowtooth flounder habitat suitability.

- **Persistent Past Effects.** Past effects identified for BSAI arrowtooth flounder include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.8.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potential beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery and the State of Alaska herring fishery are both identified as non-contributing factors to BSAI arrowtooth flounder habitat suitability. The impacts from the fishery gear is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for BSAI arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

GOA Arrowtooth Flounder – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

The total biomass of GOA arrowtooth flounder at the start of 2002 is estimated to be 1,816,000 mt. Model projections of future total GOA biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 3.1, model projections indicate that the total GOA biomass is expected to increase to 2,085,000 mt by 2007, an abundance level 15 percent more than the 2002 value. The 2003-2007 average total biomass is 1,981,000 mt. Under FMP 3.2, model projections indicate that the total GOA biomass is expected to increase to 2,096,000 in 2007, an abundance level 15 percent more than the 2002 value. The 2003-2007 average value is 1,987,000 mt.

Spawning Biomass

Spawning biomass of female GOA arrowtooth flounder at the start of 2002 is estimated to be 1,113,800 mt. Model projections of future GOA arrowtooth flounder spawning biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 3.1, model projections indicate that female spawning biomass is expected to increase 4 percent of the 2002 value to 1,154,900 mt by 2007, with a 2003-2007 average value of 1,142,000 mt. Under FMP 3.2, model projections indicate that female spawning biomass is expected to increase 4 percent of the 2002 value to 1,163,000 mt by 2007, with a 2003-2007 average value of 1,146,000 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 432,700 mt throughout the 5 year projection under FMP 3.1 and FMP 3.2.

Fishing Mortality

The average annual fishing mortality imposed on the GOA arrowtooth flounder stock in 2002 is 0.017. Under FMP 3.1, model projections show this value will be 0.011 in 2007, and 0.01 thereafter. Under FMP 3.2, model projections show this value will be 0.008 the first three years of the projection and 0.007 in 2006 and 2007. These values are well below the F_{MSY} proxy value of 0.165, the rate associated with the OFL (Table H.4-29 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA arrowtooth flounder harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated that the baseline 2002 fishery. It is estimated that 25 percent and 29 percent of the GOA western region and GOA central region catch, respectively, will be displaced under this FMP relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of GOA arrowtooth flounder are below the OFLs in all years under FMP 3.1 and FMP 3.2. The arrowtooth flounder stocks are above the MSST level throughout the 5 year projection, as in the 2002 baseline year.

Age and Size Composition

Under FMP 3.1 and FMP 3.2, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-29 of Appendix H), is 5.0 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.1 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the GOA have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on GOA arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Arrowtooth Flounder

Under FMP 3.1 and FMP 3.2, the spawning stock biomass of GOA arrowtooth flounder is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime (Table 4.7-1).

Relative to the 2002 comparative baseline, the GOA arrowtooth flounder stocks are projected to continue to not be overfished under these FMPs. The 20 year projection (Table H.4-29 of Appendix H) indicates that both female spawning stocks are expected to remain above B_{ABC} levels through the end of the projection in 2023.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects of GOA arrowtooth flounder are summarized in Table 4.5-14.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA arrowtooth flounder is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure and reproductive success of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch, and is rated as insignificant. The spatial/temporal distribution of arrowtooth flounder catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the GOA arrowtooth flounder is rated as insignificant.

- **Persistent Past Effects.** Past effects identified include climate changes and regime shifts (see Section 3.5.1.21).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey availability are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for habitat suitability of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Reasonably Foreseeable Future External Effects**. Future external effects on habitat suitability are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for GOA arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

4.7.1.9 Greenland Turbot and Deepwater Flatfish

BSAI Greenland turbot and GOA deepwater flatfish are described in more detail in Sections 3.5.1.9 and 3.5.1.22 of this Programmatic SEIS. Greenland turbot is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. The reference fishing mortality rate and ABC for the GOA deepwater flatfish management group are determined by the amount of population information available. ABCs for Dover sole were calculated using Tier 5. Greenland turbot and deepsea sole are in Tier 6 because no reliable biomass estimates exists.

BSAI Greenland Turbot – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 3.1, model projections indicate that the total BSAI biomass is expected to decline to 86,000 mt by 2007, an abundance level 19 percent less than the 2002 value. The 2003-2007 average total biomass is 92,000 mt. Under FMP 3.2, model projections indicate that the total BSAI biomass is expected to decline to 103,000 in 2007, an abundance level 2.5 percent less than the 2002 value. The 2003-2007 average value is 101,000 mt.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 3.1, model projections indicate that female spawning biomass is expected to decline 31 percent of the 2002 value to 46,800 mt by 2007, with a 2003-2007 average value of 54,100 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,600 mt from 2003-2006 and then drop below this level in 2007.

Under FMP 3.2, model projections indicate that female spawning biomass is expected to decline 10 percent of the 2002 value to 61,100 mt by 2007, with a 2003-2007 average value of 62,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,600 mt throughout the 5 year projection.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Under FMP 3.1, model projections show this value will increase to 0.19 in 2004 before decreasing to 0.162 in 2007.

Under FMP 3.2, model projections indicate this value will steadily increase to 0.066 by 2007. These values are well below the F_{MSY} proxy value of 0.48, the rate associated with the OFL (Table H.4-5 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated that the baseline 2002 fishery. It is estimated that 6 percent of the catch would be spatially displaced under this FMP relative to the 2001 catch distribution.

Status Determination

Model projections of future catches of BSAI Greenland turbot are below the OFLs in all years under FMP 3.1 and FMP 3.2. The Greenland turbot female spawning stock is above the MSST level in all 5 years of the projection, as in the baseline year 2002.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.6 years. Under FMP 3.2, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.9 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on Greenland turbot would be governed by a complex web of indirect interactions which are currently difficult to quantify.

Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 and FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Greenland Turbot

Under FMP 3.1 and FMP 3.2, the spawning stock biomass of BSAI Greenland turbot is expected to be above the MSST. The stock is currently above the MSST and the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under FMP 3.1 and FMP 3.2 are considered insignificant.

Relative to the 2002 comparative baseline, the Greenland turbot stock is projected to continue to not be overfished under these FMPs. Under FMP 3.1, the 20 year projection indicates that the female spawning stock is expected to decline until 2007 to less than B_{MSY} levels for two years (2007 and 2008), but will increase thereafter through the end of the projection in 2023. By 2011, it is projected that the female spawning stock biomass will be above B_{ABC}. Under FMP 3.2, the 20 year projection indicates that the female spawning stock is expected to decline until 2007 but will remain above B_{ABC} levels and will increase thereafter through the end of the projection in 2023.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects of BSAI Greenland turbot are summarized in Table 4.5-15.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on the change in biomass level is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the Greenland turbot biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Sections 3.5.1.9 and 3.10).

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the female spawning biomass is above the B_{MSY} value from 2003-2006. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the spatial/temporal concentration of BSAI Greenland turbot catch. Climate changes and regime shifts are suspected of having an effect on the reproductive success of the Greenland turbot stock (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Greenland turbot catch and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI Greenland turbot stock. Past foreign, JV, and domestic fisheries have been identified as having influenced the availability of Greenland turbot prey, mainly pollock which is their main prey item in the BSAI. Climate changes and regime shifts have also been identified as influencing Greenland turbot prey availability (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI Greenland turbot include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of Greenland turbot, largely through the impacts of fishing gear on benthic habitats (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Greenland turbot habitat suitability and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Greenland turbot stock to sustain itself at or above the MSST is jeopardized.

GOA Deepwater Flatfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

The catch of GOA deepwater flatfish in 2002 was estimated to be 600 mt. Model projections of future catch are shown in Table H.4-25 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to increase to 1,000 mt in 2005-2007 with a 2003-2007 average value of 1,100 mt. Under FMP 3.2, model projections indicate that the catch is expected to increase to 900 mt in 2004-2007 and the 2003-2007 average is also 900 mt.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA deepwater flatfish harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

It is unknown what goals, objectives and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated that the baseline 2002 fishery. It is estimated that the Dover sole catch would be displaced 2 percent in the western area and 23 percent in the central area under this FMP relative to the 2001 catch distribution.

Status Determination

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 5 or Tier 6 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratio of deepwater flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on deepwater flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Deepwater Flatfish

The direct and indirect effects of FMP 3.1 and FMP 3.2 on GOA deepwater flatfish cannot be determined from the MSST criteria used for stocks in management category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the 5 year projection under these FMPs. The predicted catches under FMP 3.1 and FMP 3.2 are well below the OFL for this stock, therefore the direct/indirect effects of mortality on GOA deepwater flatfish are considered insignificant (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects of GOA deepwater flatfish are summarized in Table 4.5-16.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA deepwater flatfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA deepwater flatfish stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of deepwater flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA deepwater flatfish, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Total and spawning biomass estimates are unavailable for the deepwater flatfish species, therefore, the effects of FMP 3.1 and FMP 3.2 on the change in biomass level are unknown.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the GOA deepwater flatfish stock complex.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the deepwater flatfish species biomass level (see Sections 3.5.1.22 and 3.10). The State of Alaska scallop fishery has been identified as a non-contributing factor for change in biomass level since deepwater flatfish species bycatch is not expected to occur.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA deepwater flatfish, but is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown for the stock since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts which are suspected of having an effect on the reproductive success of the deepwater flatfish stock complex (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor to change in genetic structure and reproductive success since bycatch of GOA deepwater flatfish species is not expected to occur.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the GOA deepwater flatfish catch; however, this effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the GOA deepwater flatfish complex is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA deepwater flatfish stock complex and include climate changes and regime shifts (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery has been identified as a potential adverse contributor to benthic prey availability (see Section 3.6).

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to maintain current populations.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA deepwater flatfish complex is unknown.

- **Persistent Past Effects.** Past effects identified for GOA deepwater flatfish include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of deepwater flatfish, largely through the impacts of fishing gear on benthic habitats (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery has been identified as a potential adverse contributor to habitat suitability (see Section 3.6).

- **Cumulative Effects.** A cumulative effect is identified for GOA deepwater flatfish habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the deepwater flatfish stock complex to maintain current population levels is jeopardized.

4.7.1.10 Alaska Plaice and Other Flatfish and Rex Sole

BSAI Alaska plaice and other flatfish and GOA rex sole are described in more detail in Sections 3.5.1.10 and 3.5.1.23 of this Programmatic SEIS.

BSAI Alaska Plaice – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

Total biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 1,083,000 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4-9 of Appendix H. Under FMP 3.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,124,000 mt in 2008, with a 2003-2008 average value of 1,105,000 mt. Under FMP 3.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,119,000 mt in 2008, with a 2003-2008 average value of 1,100,000 mt.

Spawning Biomass

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 276,000 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4-9 of Appendix H. Under FMP 3.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 284,700 mt in 2008, with a 2003-2008 average value of 279,400 mt.

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 275,500 mt. Under FMP 3.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 282,300 mt in 2008, with a 2003-2008 average value of 277,200 mt.

Fishing Mortality

Under FMP 3.1, the projected fishing mortality imposed on the BSAI Alaska plaice stock is 0.017 in 2003, decreasing to 0.016 in 2005, and increasing 0.019 in 2008, with an average from 2003-2008 of 0.018. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 92 percent in 2003 and decreases to 91 percent in 2008, with an average of 92 percent from 2003-2008 (Table H.4-9 of Appendix H).

Under FMP 3.2, the projected fishing mortality imposed on the BSAI Alaska plaice stock is approximately 0.023 in 2003, declining to 0.018 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 89 percent in 2003 and increases to 92 percent in 2008, with an average of 91 percent from 2003-2008 (Table H.4-9 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, a projected average of 9,740 mt of BSAI Alaska plaice are caught annually from 2003 to 2008, with 7,100 mt (73 percent) of the harvest occurring in the EBS shelf yellowfin sole fishery.

The average annual projected harvest of Alaska plaice under FMP 3.2 was 11,200 mt, with 9,500 mt (85 percent) of the harvest occurring in the EBS shelf yellowfin sole fishery. It is estimated that 12 percent of the catch under this FMP will be displaced relative to the 2001 catch distribution due to area closures.

Status Determination

Under FMP 3.1 and FMP 3.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below ABC and OFL levels from 2003 to 2008.

Age and Size Composition

Under FMP 3.1 and FMP 3.2, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections (Table H.4-9 of Appendix H), is 4.40 years. This compares with a mean age in the equilibrium unfished stock of 4.51 years.

Sex Ratio

The sex ratio of BSAI Alaska plaice is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Alaska Plaice

Because the BSAI Alaska plaice are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.1 and FMP 3.2 are considered insignificant. Fishing rates are below accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.7-1).

Relative to the 2002 comparative baseline, the Alaska plaice stock is projected to continue to not be overfished under these FMPs. The 20-year projection indicates that the female spawning stock is expected to remain at a high and stable level well above B_{ABC}.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI Alaska plaice are summarized in Table 4.5-17.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Alaska plaice stock is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor to mortality of BSAI Alaska plaice. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as contributors to mortality since a change is not expected to be significant in magnitude sufficient to cause mortality.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, a cumulative effect is identified for BSAI Alaska plaice mortality and is considered insignificant. Alaska plaice are fished above the ABC and OFL values. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Alaska plaice stock is expected to be insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution events are identified as potential adverse contributors to BSAI Alaska plaice change in biomass level. Acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to change in biomass level, since recruitment is affected by climate changes and regime shifts through a combination of prey availability and habitat suitability effects.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Alaska plaice change in biomass and it is rated as insignificant. The combination of internal and external factors are not expected to reduce Alaska plaice biomass such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effects on BSAI Alaska plaice spatial/temporal characteristics.

- **Persistent Past Effects.** No persistent past effects have been identified for the genetic structure of the BSAI Alaska plaice population. Although, climate changes and regime shifts have been identified as having a potential beneficial or adverse effect on BSAI Alaska plaice reproductive success. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment tends to be favored.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contribution to BSAI Alaska plaice genetic structure and reproductive success. Acute and/or chronic events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and could also result in reduced recruitment. Climate changes and regime shifts have been identified as potential beneficial or adverse contributors to the reproductive success of BSAI Alaska plaice, but as non-contributing factors to the genetic structure of Alaska plaice. The reproductive success is affected through a combination of climate induced changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect has been identified for the spatial/temporal concentration of BSAI Alaska plaice and is rated as insignificant. The combined internal and external events are not expected to significantly alter the reproductive success or genetic structure such that it jeopardizes the capacity of the stock to maintain itself above MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effects on BSAI Alaska plaice prey availability.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having potential adverse or beneficial effects on BSAI Alaska plaice prey availability. Little research has been conducted on benthic invertebrates, the main prey species of Alaska plaice, therefore the magnitude and direction of the effects imposed by climate changes and regime shifts are unknown.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor to the prey availability of BSAI Alaska plaice. Acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above the MSST. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to BSAI Alaska plaice prey availability. However, as stated above, since little research has been conducted on the effects of climate changes on benthic invertebrates, the magnitude and direction of the changes are unknown.

- **Cumulative Effects.** A cumulative effect has been identified for the BSAI Alaska plaice change in prey availability and is rated as insignificant. The combination of internal and external removals of prey species is not expected to decrease prey availability such that the BSAI Alaska plaice stock is unable to maintain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effects on Alaska plaice habitat suitability.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries have been identified as having adverse effects on BSAI Alaska plaice habitat. See Sections 3.5.1.10 and 3.6 for more information on the effects of fishing gear on flatfish habitat. Climate changes and regime shifts are also identified as having a potential adverse or beneficial effect on Alaska plaice habitat (see Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to BSAI Alaska plaice habitat suitability. Acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success of Alaska plaice. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions to BSAI Alaska plaice habitat suitability. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment is favored.

- **Cumulative Effects.** A cumulative effect for BSAI Alaska plaice change in habitat suitability is identified and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the BSAI Alaska plaice stock to maintain itself at or above the MSST is jeopardized.

BSAI Other Flatfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

Estimates of total and spawning biomass are not available for these species.

Fishing Mortality

The catch of BSAI other flatfish in 2002 was estimated to be 2,600 mt. Model projections of future catch are shown in Table H.4-10 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to decrease from the 2002 value to 2,100 mt in 2003 and then increase to 2,300 mt in 2007 (14 percent decrease from 2002). The 2003-2007 average catch is 2,100 mt. Under FMP 3.2, model projections indicate that the catch is expected to decrease from the 2002 value to 2,200 mt in 2003 and then further decline to 1,900 mt in 2007 (26 percent decrease from 2002). The 2003-2007 average catch is 2,000 mt.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI other flatfish harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

It is unknown what goals, objectives, and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated that the baseline 2002 fishery.

Status Determination

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratios of the species in the BSAI other flatfish category are assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on other flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Other Flatfish

The direct and indirect effects of FMP 3.1 and FMP 3.2 on BSAI other flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the five-year projection under these FMPs. The predicted catches of BSAI other flatfish under FMP 3.1 and FMP 3.2 are well below the OFL for this stock. Therefore, the effects of FMP 3.1 and FMP 3.2 on BSAI other flatfish through mortality are considered insignificant (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI other flatfish are summarized in Table 4.5-18.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other flatfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects have not been identified for BSAI other flatfish mortality.

- **Reasonably Foreseeable Future External Effects**. Future external effects on mortality are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other flatfish and is rated as insignificant. Fishing mortality rates for projected years are well below the other flatfish OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Past effects have not been identified for the BSAI other flatfish change in biomass level effect indicator.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI Alaska plaice under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other flatfish, but the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the spatial/temporal characteristics are the same as those described for BSAI Alaska plaice under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics are the same as those described for BSAI Alaska plaice under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other flatfish catch; however, this effect is unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** The effects on change in prey availability are the same as those described for BSAI Alaska plaice under these FMPs.

- **Reasonably Foreseeable Future External Effects**. The effects on change in prey availability are the same as those described for BSAI Alaska plaice under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects**. Past effects identified for the habitat suitability of BSAI other flatfish are the same as those described for BSAI Alaska plaice under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for habitat suitability are the same as those described for BSAI Alaska plaice under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for BSAI other flatfish habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

GOA Rex Sole – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

Estimates of total and spawning biomass are not available for this species.

Fishing Mortality

The catch of GOA rex sole in 2002 was estimated to be 3,000 mt. Model projections of future catch are shown in Table H.4-26 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to increase to 3,300 mt for each year 2003-2007. The 2003-2007 average value is 3,300 mt. Under FMP 3.2, model projections indicate that the catch is expected to increase to 3,100 mt in 2003-2006 and then decrease to 3,000 mt in 2007. The 2003-2007 average is 3,100 mt.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA rex sole harvest would be affected under FMP 3.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

It is unknown what goals, objectives, and criteria would be developed under FMP 3.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated that the baseline 2002 fishery. It is estimated that 51 percent of the catch in the western area would be displaced under this FMP and 38 percent in the central area relative to the 2001 catch distribution.

Status Determination

The available information for GOA rex sole requires that they are classified into the Tier 5 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for this species.

Sex Ratio

The sex ratio of rex sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 on rex sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Rex Sole

The direct and indirect effects of FMP 3.1 and FMP 3.2 on GOA rex sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stock is over the five-year projection under these FMPs. The predicted catches of rex sole are well below the OFL for this stock. Therefore, FMP 3.1 and FMP 3.2 have insignificant effects on GOA rex sole through mortality (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for GOA rex sole are summarized in Table 4.5-19.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA rex sole is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Large removals of rex sole by the past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on GOA rex sole stocks. See Section 3.5.1.23 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts are considered non-contributing factors since the change in water temperatures would not likely be of sufficient magnitude to result in mortality of rex sole. The State of Alaska scallop fishery has also been identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA rex sole and is rated as insignificant. Fishing mortality rates for projected years are well below the rex sole OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Large removals of rex sole by past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on GOA rex sole stocks. See Section 3.5.1.23 for details regarding these effects.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts have also been identified as having an indirect potential beneficial or adverse effect on the rex sole biomass level. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and the temperatures cooler, recruitment tends to be weak. The State of Alaska Scallop Fishery is identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole. For more information on climate changes and regime shifts (see Sections 3.5.1.23 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA rex sole, but the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects are not identified for genetic structure of the population; however, climate changes and regime shifts are identified as having persistent past effects on the reproductive success of the GOA rex sole stock. See Sections 3.5.1.23 and 3.10 for more information of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the genetic structure of rex sole include the potential adverse effects of marine pollution since an acute and/or chronic pollution event could alter the genetic structure of the population by causing localized mortality. The State of Alaska scallop fishery and climate changes and regime shifts have both been identified as non-contributing factors to the change in genetic structure of rex sole stocks. These events are not expected to cause localized depletions that would alter the genetic sub-population structure of rex sole stock. Change in reproductive success of rex sole due to climate changes and regime shifts are identified as having a potential beneficial or adverse effect. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could also the reproductive success of GOA rex sole. Again, the State of Alaska scallop fishery has been identified as a non-contributing factor since the scallop fishery is not expected to contribute to rex sole removals.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rex sole catch; however, this effect is unknown since the MSST is not possible to be determined. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had effected the prey availability of the GOA rex sole stock. The actual effect of climate changes and regime shifts on rex sole prey availability is unknown, but could have had a potential beneficial or adverse effect. See Sections 3.5.1.23 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects**. Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The State of Alaska scallop fishery has been identified as having a potential adverse effect on rex sole prey availability since the habitat disturbances caused by dredging could influence the availability of benthic prey.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for GOA rex sole include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. Habitat disturbances caused by the past foreign, JV, and domestic fisheries have also been identified as having persistent past effects on the GOA rex sole stock See Sections 3.5.1.23 and 3.10 for more information regarding the past fisheries and climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as having potential adverse effects on rex sole habitat suitability that may cause changes in the spawning or rearing success of the stock.

- **Cumulative Effects.** A cumulative effect is identified for GOA rex sole habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

4.7.1.11 Pacific Ocean Perch

Pacific ocean perch (*Sebastes alutus*) are managed under Tier 3 in the BSAI and GOA.

BSAI Pacific Ocean Perch – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

Total biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 374,000 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 of Appendix H. Under FMP 3.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 399,000 mt in 2008, with a 2003-2008 average value of 386,000 mt. Under FMP 3.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 409,000 mt in 2008, with a 2003-2008 average value of 391,000 mt.

Spawning Biomass

Spawning biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 135,500 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 of Appendix H. Under FMP 3.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 140,200 mt in 2008, with a 2003-2008 average value of 137,200 mt. Under FMP 3.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 144,800 mt in 2008, with a 2003-2008 average value of 139,600 mt.

Fishing Mortality

Under FMP 3.1, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is 0.033 in 2003, decreasing to 0.026 in 2005, and increasing 0.032 in 2008, with an average from 2003-2008 of 0.030 (Table H.4-12 of Appendix H). Under FMP 3.2, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is approximately 0.023 in each year from 2003 to 2008. The proportion of spawner biomass per recruit conserved under this fishing mortality rate is 60 percent (Table H.4-12 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, a projected average of 10,000 mt of BSAI Pacific ocean perch are caught annually from 2003 to 2008, with 4,900 mt (49 percent) of the harvest occurring in the eastern Aleutian Islands. The harvest in this area occurs largely from the directed fishery, although the Atka mackerel fishery is projected to harvest 1,000 mt annually from 2003-2008.

As with FMP 3.1, the eastern Aleutians Islands contributes the largest proportion of the BSAI Pacific ocean perch catch. The average annual projected catch from 2003-2008 was 7,900 mt, of which 3,600 mt (46 percent) occurred in the eastern Aleutian Islands. The directed Pacific ocean perch fishery accounted entirely for the Pacific ocean perch harvest in this area in 2003 and 2004, but from 2005-2006 the Atka mackerel fishery was projected to harvest 1,000 mt of Pacific ocean perch annually from this region. A series of no-take reserves is also specified under FMP 3.2, but comparison with the recent spatial distribution of the fishery indicates that substantial areas would remain open for Pacific ocean perch fisheries.

Status Determination

Under FMP 3.1, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Pacific ocean perch are below ABC and OFL levels from 2003 to 2008. The projected spawning stock biomass is projected to be greater than the B_{MSY} ($B_{35\%}$) level of 120,200 mt in each year of the projection, so BSAI Pacific ocean perch are above the MSST level under FMP 3.1.

Under FMP 3.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Pacific ocean perch are at the ABC level from 2003 to 2005, and slightly below the ABC level from 2006 to 2008. The projected spawning stock biomass is projected to be greater than the B_{MSY} ($B_{35\%}$) level of 120,200 mt in each year of the projection, so BSAI Pacific ocean perch are above the MSST level under FMP 3.2.

Age and Size Composition

Under FMP 3.1, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections, is 10.41 years. Under FMP 3.2, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-12 of Appendix H), is 10.53 years. This compares with a mean age in the equilibrium unfished stock of 14.01 years.

Sex Ratio

The sex ratio of BSAI Pacific ocean perch is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 and FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1 and FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 and FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Pacific Ocean Perch

Because the BSAI Pacific ocean perch are fished at less than the ABC and are above the minimum stock size threshold, the direct and indirect effects under FMP 3.1 and FMP 3.2 are considered insignificant. A significant feature of FMP 3.2 is the use of the $F_{60\%}$ fishing rate for BSAI Pacific ocean perch, lowering the fishing mortality rate, the ABC, and the projected harvest. Fishing rates are within accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.7-1).

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI Pacific ocean perch are summarized in Table 4.5-20.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific ocean perch stock is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to BSAI Pacific ocean perch mortality since bycatch in this fishery is not expected. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific ocean perch mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific ocean perch stock is expected to be insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute significantly to BSAI Pacific ocean perch mortality since bycatch is not expected in this fishery. Therefore, the IPHC longline fishery is also not expected to cause significant changes in biomass levels. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to Pacific ocean perch change in biomass levels as a function of reproductive success.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the BSAI Pacific ocean perch population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure . However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.11) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery are not expected to contribute to changes in genetic structure or reproductive success of BSAI Pacific ocean perch since bycatch of BSAI Pacific ocean perch is not expected to occur. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. Generally, changes in climate changes that lead to increased advection of the Alaska current are believed to increase euphausiid production, a major prey item of BSAI Pacific ocean perch. Climate changes and regime shifts are not considered to contribute to changes in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific ocean perch prey species (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific ocean perch prey species are identified as potential beneficial or adverse contributors. In general, it is believed that climate changes and regime shifts that lead to the increased advection of the Alaska current also increase production of euphausiids, a major prey item of BSAI Pacific ocean perch. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect identified for prey availability is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for BSAI Pacific ocean perch stocks include past foreign, JV, and domestic fisheries, IPHC longline fisheries and climate changes and regime shifts (see Section 3.5.1.11). Intense bottom trawling on Pacific ocean perch habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries are also identified as having adverse effects on Pacific ocean perch habitat, although these fishing gear impacts are considered to be less significant than those associated with trawl gear (see Section 3.6 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both beneficial and adverse effects on Pacific ocean perch habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is identified as making adverse contributions to Pacific ocean perch habitat through fishing gear impacts. As stated above, these impacts are expected to be of lesser magnitude than those effects associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific ocean perch stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect identified for habitat suitability is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

GOA Pacific Ocean Perch – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass and Fishing Mortality

Under FMP 3.1 the PSC limits for Pacific halibut are reduced by ten percent. If GOA Pacific ocean perch are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could reduce catch of GOA Pacific ocean perch as well. Bycatch model results for FMP 3.1 show catches comparable to FMP 1 for GOA Pacific ocean perch and therefore appear reasonable. Average fishing mortality during the years 2003-2008 is expected to be less than F_{OFL} (0.060) (Table H.4-36 of Appendix H).

FMP 3.2 would reduce catch of GOA Pacific ocean perch because it changes the biological reference point for determining rockfish ABCs from $F_{40\%}$ to $F_{60\%}$. Under FMP 3.2 the PSC limits for Pacific halibut are also reduced by 30 percent. If the GOA Pacific ocean perch are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could reduce catch of GOA Pacific ocean perch as well. Bycatch model results for FMP 3.2 show catches reduced from FMP 1 for GOA Pacific ocean perch and therefore appear reasonable. Average fishing mortality during the years 2003-2008 is expected to be less than F_{OFL} (0.060) (Table H.4-36 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effects that FMP 3.1 has on the spatial/temporal concentration of Pacific ocean perch catch depends on the decisions made by the NPFMC. The spatial distribution of catch would not be affected by proposed closures, and the apportionment of catch among management areas should provide some protection against localized depletion. Concentrating fishery effort into a short season would likely continue unless the NPFMC implemented some "rights-based" management scheme. If the Pacific ocean perch trawl fishery has a large bycatch of Pacific halibut, then under FMP 3.1 the spatial/temporal concentration of fishing effort may also be affected by PSC limits on Pacific halibut bycatch.

As with FMP 3.2, the effects that FMP 3.2 has on the spatial/temporal concentration of Pacific ocean perch catch depends on the decisions made by the NPFMC. The spatial distribution of catch would not be affected by proposed closures and apportionment of catch among management areas should provide some protection against localized depletion. The implementation of fishery rationalization should also spread the fishery out in time and space. FMP 3.2 may also potentially have a large effect on the spatial concentration of Pacific ocean perch catch if 20 percent of the GOA is set aside as no take reserves or as MPAs. Pacific ocean perch catches are taken in directed fisheries where the effort is highly localized and concentrated in slope areas. Much of this effort occurs in proposed closed areas. Therefore, if the proposed MPAs are closed to all bottom trawling, then the spatial concentration of fishing effort would likely shift from the closure areas to remaining open areas. The effect of shifting effort away from the closed areas is unclear.

Under FMP 3.2 the spatial/temporal concentration of fishing effort may also be affected by Pacific halibut bycatch considerations if they substantially change the distribution of fishing effort.

Status Determination

Under FMP 3.1, the projected B2003 of 112,700 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B2005 of 112,100 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Under FMP3.2, the projected B2003 of 113,500 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected B2005 of 116,700 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition

Under FMP 3.1 and FMP 3.2, the age composition of GOA Pacific ocean perch may be changed under fishing pressure as in FMP 1. Size composition of GOA Pacific ocean perch might change in proportion to the change in age composition. Age and size composition could also change if Pacific halibut bycatch considerations substantially change the distribution of fishing effort.

Sex Ratio

No information is available to suggest that the sex ratio would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Under FMP 3.1 and FMP 3.2, damage to epifauna by bottom trawls may adversely impact juvenile Pacific ocean perch habitat. FMP 3.1 and FMP 3.2 may also beneficially affect habitat for GOA Pacific ocean perch because it maintains the eastern GOA closure to trawling. FMP 3.2 may also have a beneficial effect on the habitat of GOA Pacific ocean perch because it proposes to set aside 20 percent of the GOA as no take reserves or as marine protected areas (MPAs). If the proposed MPAs are closed to all bottom trawling, then they could provide additional refugia for Pacific ocean perch in these areas and or provide protection from the potential effects of trawling on juvenile rockfish habitat in these areas.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Pacific Ocean Perch

Under FMP 3.1 and FMP 3.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 3.1 and FMP 3.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability are believed to have an insignificant impact on stock sustainability. Section 3.5.1.24 provides further detail on the past/present effects analysis for GOA Pacific ocean perch (Table 4.7-1).

Cumulative Effects Analysis of FMP 3.1 and FMP 3.2

Cumulative effects are summarized for GOA Pacific ocean perch in Table 4.5-21.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific ocean perch stock is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA Pacific ocean perch is rated as insignificant. Pacific ocean perch are fished below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific ocean perch stock is expected to be insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of GOA Pacific ocean perch and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Cumulative Effects.** A cumulative effect identified for prey availability is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have insignificant effects on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under this FMP.

- **Cumulative Effects.** A cumulative effect identified for habitat suitability is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

4.7.1.12 Thornyhead Rockfish

GOA thornyhead rockfish are described in more detail in Section 3.5.1.23 of this Programmatic SEIS. Until recently thornyhead rockfish is managed as its own stock under the GOA groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2004, thornyhead rockfish will be managed under Tier 5; however, thornyhead rockfish were modeled under the Tier 3 category for this analysis.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total Biomass

Total (ages 5 through 55+) biomass of GOA thornyheads at the start of 2002 is estimated to be 54,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-37 of Appendix H. Under FMP 3.1, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly increase to a value of 55,000 mt by 2007, with a 2003-2007 average value of 55,000 mt. Under FMP 3.2, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then slowly increase to a value of 57,000 mt by 2007, with a 2003-2007 average value of 56,000 mt.

Spawning Biomass

Spawning biomass of female GOA thornyheads at the start of 2002 is estimated to be 23,500 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-37 of Appendix H. Under FMP 3.1, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and increasing to 24,300 mt by 2007, with a 2002-2007 average value of 23,900 mt. Under FMP 3.2, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2004, and increasing to 25,200 mt by 2007, with a 2002-2007 average value of 24,400 mt.

Fishing Mortality

The average fishing mortality imposed on the GOA thornyhead stock in 2002 is projected to be 0.032 under current management. Under FMP 3.1, fishing mortality is projected to decrease to 0.025 in 2003 and decrease further to 0.020 in 2007. Under FMP 3.2, fishing mortality is projected to decrease to 0.013 in 2003 and decrease further to 0.012 in 2007. These values are well below the F_{MSY} proxy value of 0.102 which is the rate associated with the OFL (Table H.4-37 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Thornyhead catch is approximately evenly divided between longliners and trawlers under status quo management. There is nothing about FMP 3.1 or FMP 3.2 that is expected to change this. Longline catches are spatially dispersed along the continental shelf break throughout the GOA (Figure 4.5-1), and temporally dispersed due to the nature of the IFQ sablefish fishery. For example, longline thornyhead catches in 2000 occurred year round, with peaks in April and September which did not exceed 60 mt per week. Trawler catch has been more concentrated in time, with some catches of 20-40 mt per week happening in late spring and a single large peak of 160 mt per week in 2000 during July, coincident with the rockfish trawl fishery. Between 1997 and 1999, trawl thornyhead catches appear to have become more concentrated in space (Figure 4.5-2). The distribution of thornyheads from surveys did not appear to change over the same time period (Figure 4.5-3). This apparent concentration may be the indirect result of changes in the trawl fisheries for deepwater flatfish and rockfish since thornyheads are not a primary target of trawl fisheries. However, it should be noted that the overall catch of thornyheads is low relative to both the estimated biomass and the ABC, such that this apparent concentration of catch is unlikely to have any adverse population effects.

Status Determination

The GOA thornyhead stock is not overfished. At 23,500 mt, spawning stock biomass is expected to be well above both $B_{35\%}$ level (14,681 mt) as well as the $B_{40\%}$ level (16,045 mt) in the year 2002 and will remain above $B_{40\%}$ in all projection years under FMP 3.1 and FMP 3.2.

Age and Size Composition

Under FMP 3.1, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.16 years. Under FMP 3.2, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.35 years. This compares with a mean age in the equilibrium unfished GOA stock of 12.67 years.

Sex Ratio

The sex ratio of GOA thornyheads is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Under FMP 3.1 and FMP 3.2, all current management measures would be maintained. The level of habitat disturbance under FMP 1 (and FMP 3.1 and FMP 3.2) does not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

In the GOA, shortspine thornyheads prey on benthic invertebrates; according to the AFSC food habits database, much of their diet in the 1990s has been composed of shrimp. Thornyheads are rare in the diets of other groundfish, birds, or marine mammals in the GOA according to the present limited information. Therefore, the effects of status quo federal groundfish fisheries on trophic interactions involving GOA thornyheads are expected to be minor. The current levels and distribution of groundfish harvest do not appear to impact prey availability for thornyheads such that it affects the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Thornyhead Rockfish

The GOA thornyhead stock appears to be healthy and stable under current management, and catches have generally been below the estimated ABCs because thornyheads are taken as bycatch in other directed fisheries. To the best of our knowledge, thornyheads are widely distributed in the deeper habitats of the GOA, where fishing impacts have historically been low. As long as catches remain at or near the currently observed low levels, as predicted under FMP 3.1 and FMP 3.2, we do not expect any significant population effects to thornyheads (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects are summarized for GOA thornyhead rockfish in Table 4.5-22.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA thornyhead rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. The removals of thornyhead rockfish that occurred in these fisheries have had a lingering adverse effect on the populations (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of thornyhead rockfish. The IPHC longline fishery is identified as a potential adverse contributor to thornyhead rockfish mortality since they are caught as bycatch in this fishery. However, the State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA thornyhead rockfish is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 will result in insignificant effects to these stocks.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. Past removals by these fisheries have had a lingering adverse effect on the GOA thornyhead rockfish populations (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effect son change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the thornyhead rockfish biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.23 and 3.10). The IPHC longline fishery is identified as a potential adverse contributor to the thornyhead rockfish biomass level since they are caught as bycatch in this fishery. The State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect identified for the change in biomass level of GOA thornyhead rockfish is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

<u>Spatial/Temporal Concentration of Catch</u>

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA thornyhead rockfish. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of GOA thornyhead rockfish. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the thornyhead rockfish stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of thornyhead rockfish due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA thornyhead rockfish. The IPHC longline fishery removals could be sufficiently concentrated as to alter the genetic structure and reproductive success of GOA thornyhead rockfish populations and is therefore identified as a potential adverse contributor. The State of Alaska shrimp fishery is identified as a non-contributing factor since bycatch of thornyhead rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect identified for the spatial/temporal concentration of the thornyhead rockfish catch is ranked as insignificant. The spatial/temporal distribution of thornyhead rockfish catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do effect the availability of some prey species (i.e. shrimp); however, studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor since bycatch of GOA thornyhead rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to prey availability since removal of shrimp, the main prey species of GOA thornyhead rockfish, occurs in this fishery.

- **Cumulative Effects.** A cumulative effect identified for change in prey availability is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA thornyhead rockfish include climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery has been identified as a potential adverse contributor to GOA thornyhead rockfish habitat suitability. See Section 3.6 for information on the impacts of fishery gear on EFH. The State of Alaska shrimp fishery is identified as a non-contributing factor since habitat degradation by the shrimp fishery gear is not expected to occur.

- **Cumulative Effects.** A cumulative effect identified for GOA thornyhead rockfish habitat suitability is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the thornyhead rockfish stock to sustain itself at or above the MSST is jeopardized.

4.7.1.13 Rockfish

Rockfish are discussed in more detail in Sections 3.5.1.12 through 3.5.1.14 and 3.5.1.24.

BSAI Northern rockfish

Until recently, BSAI northern rockfish were managed as a sub-assemblage of the BSAI other red rockfish group under Tier 5 management category. As of 2004, northern rockfish in the BSAI are managed separated under Tier 3 and the red rockfish group no longer exists. However, for the purposes of this analysis, northern rockfish have been modeled under the Tier 5 category. Direct/indirect effects are summarized in Table 4.7-1.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for this species.

Fishing Mortality

The catch of BSAI northern rockfish in 2003 was estimated as 6,400 mt. Projected catches from 2003-2008 are shown in Table H.4-15 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to decrease to 5,300 mt in 2006, then increase to 5,600 mt in 2008. The 2003-2008 average catch is 5,700 mt. Under FMP 3.2, model projections indicate that the catch is expected to decrease to 4,000 mt in 2006, and remain at this level through 2008. The 2003-2008 average catch is 3,600 mt.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, model projections indicate that the average harvest of 5,700 mt from 2003-2008 occurs largely in the eastern Aleutian Islands (3,100 mt, 55 percent), with 1,200 mt (22 percent) occurring in the central Aleutian Islands and 1,100 mt (19 percent) coming from the western Aleutian Islands. The harvest of northern rockfish in the each of these areas is taken largely in the Atka mackerel fishery.

Under FMP 3.2, model projections indicate that the average harvest of 3,600 mt from 2003-2008 occurs largely in the eastern Aleutian Islands (1,500 mt, 40 percent), with 1,200 mt (34 percent) occurring in the central Aleutian Islands and 700 mt (20 percent) coming from the western Aleutian Islands. The harvest of northern rockfish in the each of these areas is taken largely in the Atka mackerel fishery.

Status Determination

The catch rates are below the ABC and OFL values for all years. The MSST cannot be determined.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for this species. The sex ratio of BSAI northern rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Northern Rockfish

An age-structured population model for BSAI northern rockfish is not available, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI northern rockfish are fished at less than the OFL and the effects of mortality under FMP 3.1 are considered insignificant. Since the MSST is unable to be calculated, the spatial/temporal distribution of catch and the other direct/indirect effects are unknown.

A significant feature of FMP 3.2 is the lowering of ABC levels for rockfish. For northern rockfish, the ABC was assumed to be 4,100 mt, a decrease from the baseline value of 9,500 mt in 2002. Because the BSAI northern rockfish are fished at less or equal to the ABC, the effects or mortality under FMP 3.2 are considered insignificant. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity; however, since the MSST is unable to be calculated, the other direct/indirect effects are unknown.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI northern rockfish are summarized in Table 4.5-23.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI northern rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.12).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of northern rockfish. The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect identified for mortality of BSAI northern rockfish is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.12).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the northern rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.12 and 3.10). The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI northern rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI northern rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI northern rockfish (see Sections 3.5.1.12 and Section 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of northern rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of northern rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI northern rockfish. The IPHC longline fishery has been identified as a non-contributing factor to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the northern rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI northern rockfish stock. The actual effect of climate changes and regime shifts on northern rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect. See Section 3.5.1.12 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of northern rockfish prey species occurs in this fishery. See Section 3.5.1.12 for more information on the trophic interactions of BSAI northern rockfish species.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI northern rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in northern rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on northern rockfish species habitat suitability, possibly having disrupted northern rockfish species spawning and/or rearing habitats. See Section 3.5.1.12 for more information on the past events that have effected northern rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the northern rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt northern rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the northern rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

BSAI Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these stocks.

Fishing Mortality

The catch of BSAI shortraker/rougheye rockfish in 2003 was estimated as 800 mt. Projected catches from 2003-2008 are shown in Table H.4-16 of Appendix H. Under FMP 3.1, model projections indicate that the catch is expected to range between 700 and 800 mt from 2003-2008, with an average of 800 mt. Under FMP 3.2, the projected catch of BSAI shortraker/rougheye rockfish in each year from 2003 to 2008 was 400 mt.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, model projections indicate that the average harvest of 800 mt from 2003-2008 is relatively evenly spread among the three Aleutian Islands subareas, with between 26 percent and 32 percent of the harvest occurring in each subarea. The harvest in the western and eastern Aleutian Islands occurs largely in the Pacific ocean perch trawl fishery, whereas the harvest in the central Aleutian Islands occurs largely in the Pacific cod longline fishery.

Under FMP 3.2, model projections indicate that the average harvest of 400 mt from 2003-2008 occurs largely in the western and eastern Aleutian Islands, with 36 percent and 33 percent of the harvest occurring in these two areas, respectively. The harvest in these two areas occurs largely in the Pacific ocean perch trawl fishery.

Status Determination

The catch rates are below the ABC and OFL values for all years. The MSST for this stock cannot be determined.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. The sex ratio of BSAI shortraker/rougheye rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 3.1 of FMP 3.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Shortraker/Rougheye Rockfish

An age-structured population model for BSAI shortraker/rougheye rockfish is not available, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI shortraker/rougheye rockfish are fished at less than the ABC and effects of mortality under FMP 3.1 are considered insignificant. Since the MSST cannot be determined, the spatial/temporal distribution of catch and the other direct/indirect effects are unknown.

A significant feature of FMP 3.2 is the lowering of ABC levels for rockfish. For shortraker/rougheye rockfish, the ABC was assumed to be 400 mt. Because the BSAI shortraker/rougheye rockfish are fished at less or equal to the ABC, the effects of mortality under FMP 3.2 are considered insignificant. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity; however, since the MSST is not able to be calculated, the other direct/indirect effects are unknown (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI shortraker/rougheye rockfish are summarized in Table 4.5-24.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI shortraker/rougheye rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect identified for mortality of BSAI shortraker/rougheye rockfish is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.13 and 3.10). The IPHC longline fishery and the State of Alaska shrimp fishery are identified as a non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI shortraker/rougheye rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI shortraker/rougheye rockfish (see Sections 3.5.1.13 and Section 3.10).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the reproductive success of shortraker/ rougheye rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of shortraker/rougheye rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery have been identified as non-contributing factors to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the shortraker/rougheye rockfish catch; however, this effect is unknown since the MSST is not possible to be determined.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI shortraker/rougheye rockfish stock. The actual effect of climate changes and regime shifts on shortraker/rougheye rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect. See Sections 3.5.1.13 and 3.10 for more information on climate changes and regime shifts.

- **Reasonable Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of shortraker/rougheye rockfish prey species occurs in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to BSAI shortraker/rougheye prey availability since shrimp is on e of the main prey species of rougheye rockfish. See Section 3.5.1.13 for more information on the trophic interactions of BSAI shortraker/rougheye rockfish species.

- **Cumulative Effects.** A cumulative effect identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in habitat suitability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI shortraker/rougheye rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in shortraker/rougheye rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on shortraker/ rougheye rockfish species habitat suitability, possibly having disrupted shortraker/rougheye rockfish species spawning and/or rearing habitats. The State of Alaska shrimp fishery is identified as a non-contributing factor to shortraker/rougheye rockfish habitat suitability since habitat degradation by shrimp fishery gear is not expected to occur. See Section 3.5.1.13 for more information on the past events that have effected shortraker/rougheye rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the shortraker/rougheye rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt shortraker/rougheye rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, this effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the shortraker/rougheye rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

BSAI Other Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

Under FMP 3.1, the projected catch of Aleutian Islands other rockfish in 2003 to 2008 ranged from 200 mt to 300 mt, with and average of 300 mt. The projected harvest of EBS other rockfish from 2003 to 2008 was 100 mt in each year. Projected catches from 2003-2008 are shown in Tables H.4-13 and H.4-14 of Appendix H. These projections suggest that direct fishing mortality on other rockfish stocks will be very low relative to the OFL and that such harvest levels will not present any significant impact to the species ability to maintain current population levels.

Under FMP 3.2, the projected catch of the Aleutian Islands other rockfish category was 200 mt in 2003 and 100 mt annually from 2004 to 2008. The projected harvest of EBS other rockfish species was estimated at approximately 50 mt in each year from 2003 to 2008. Projected catches from 2003-2008 are shown in Tables H.4-13 and H.4-14 of Appendix H. These projections suggest that direct fishing mortality on other rockfish stocks will be very low relative to the current OFLs and that such harvest levels will not present any significant impact to the species ability to maintain current population levels.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 3.1, in the Aleutian Islands, 89 percent of the average harvest of 300 mt occurs in the cental and western Aleutian Islands, taken largely in the Atka mackerel and Pacific cod trawl fisheries and the Pacific cod and sablefish longline fisheries. In the EBS, the average catch of 100 mt is taken largely in the Pacific cod and Greenland turbot bottom trawl fisheries and the sablefish and Greenland turbot longline fisheries. Under FMP 3.2, in the Aleutian Islands, 89 percent of the average harvest of 130 mt occurs in the cental and western Aleutian Islands, taken largely in the Atka mackerel and Pacific cod trawl fisheries. In the EBS, the average catch of 50 mt is taken largely in the Pacific cod and pollock trawl fisheries. We would expect no significant change in the spatial/temporal concentration of catch as a result of reduced other rockfish TACs.

Status Determination

The fishing mortality rate is below the ABC and OFL for all years. The MSST is unable to be determined.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. Estimated sex ratios are not available for these species.

Habitat-Mediated Impacts

Any habitat-related impacts of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude whether existing habitat conditions would undergo any significant change under FMP 3.1 or FMP 3.2.

Predation-Mediated Impacts

As with habitat suitability impacts, any effect on predator-prey relationships of FMP 3.1 and FMP 3.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude whether trophic interactions would undergo any significant change as a result of the FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – BSAI Other Rockfish

An age-structured population model for either the EBS or Aleutian Islands other rockfish category is not available, and projections of future catch ABC and OFL levels were made by carrying over the 2002 baseline values into the future. Under these assumptions, BSAI other rockfish are fished at less than the ABC and the direct and indirect effects under FMP 3.1 are considered either insignificant through mortality. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity; however, since the MSST is unable to be calculated, the other direct/indirect effects are unknown.

A significant feature of FMP 3.2 is the lowering of ABC levels for rockfish. For Aleutian Island and EBS other rockfish, the ABC was assumed to 200 mt and 400 mt, respectively. Because the BSAI other rockfish species are fished at less or equal to the ABC, and that the projected catches fall well below the OFLs, the direct and indirect effects under FMP 3.2 are considered either insignificant through mortality. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity; however, since the MSST is unable to be calculated, the other direct/indirect effects are unknown (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for BSAI other rockfish are summarized in Table 4.5-25.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those considered for BSAI shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects**. Future external effects on mortality are the same as those considered for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other rockfish is rated as insignificant. Fishing mortality at projected levels is below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Past effects on the change in biomass level are the same as those indicated for BSAI shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are the same as those indicated for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other rockfish, but is the effect is unknown. It is unknown whether the combined effect of internal external and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of the spatial/temporal concentration of catch is rated as unknown.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal characteristics of BSAI other rockfish catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of other rockfish are the same as those considered for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other rockfish catch, but this effect is unknown since it is not possible to calculate the MSST. However, the spatial/temporal concentration of the fishery is not expected to change significantly.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the change in prey availability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in prey availability are the same as those described for BSAI shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability are the same as those described for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** A cumulative effect identified for the change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1, the change in habitat suitability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in habitat suitability are the same as those considered for BSAI shortraker/rougheye rockfish under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability are the same as those considered for BSAI shortraker/rougheye rockfish under this FMP.

- **Cumulative Effects.** Cumulative effects of the combined FMP indirect effects and the external effects is unknown. It is unknown whether the combined effect will make the other rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

GOA Northern Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass and Fishing Mortality

Under FMP 3.1 the PSC limits for Pacific halibut are reduced by ten percent. If the GOA northern rockfish are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could reduce catch of GOA northern rockfish as well. Average fishing mortality during the years 2003-2008 is expected to be less than F_{OFL} (0.066) (Table H.4-35 of Appendix H).

FMP 3.2 would reduce catch of GOA northern rockfish because it changes the biological reference point for determining rockfish ABCs from $F_{40\%}$ to $F_{60\%}$. Under FMP 3.2 the PSC limits for Pacific halibut are also reduced by 30 percent. If the GOA northern rockfish are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could reduce catch of GOA northern rockfish as well. Average fishing mortality during the years 2003 - 2008 is expected to be less than F_{OFL} (0.066) (Table H.4-35 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effects that FMP 3.1 has on the spatial/temporal concentration of northern rockfish catch depend on the decisions made by the NPFMC. The spatial distribution of catch would not be affected by proposed closures, and apportionment of catch among management areas should provide some protection against localized depletion. Concentrating fishery effort into a short season would likely continue unless the NPFMC implemented some "rights-based" management scheme. Under FMP 3.1 the spatial/temporal concentration of fishing effort may also be affected by Pacific halibut bycatch considerations if they substantially change the distribution of fishing effort. Under FMP 3.1, the potential for localized depletion of the stock exists if fishing occurs year after year on localized aggregations of northern rockfish.

The effects that FMP 3.2 has on the spatial/temporal concentration of northern rockfish catch depends on the decisions made by the NPFMC. The spatial distribution of catch would not be affected by proposed closures and apportionment of catch among management areas should provide some protection against localized depletion. The implementation of fishery rationalization should also spread the fishery out in time and space. FMP 3.2 may also potentially have a large effect on the spatial concentration of northern rockfish catch if 20 percent of the GOA is set aside as no take reserves or as MPAs. Northern rockfish catches are taken in directed fisheries where the effort is highly localized and concentrated in slope areas. Much of this effort occurs in proposed closed areas. Therefore, if the proposed MPAs are closed to all bottom trawling, the spatial concentration of fishing effort would likely shift from the closure areas to remaining open areas. The effect of shifting effort away from the closed areas is unclear but since fishing effort is highly localized the spatial distribution of catch is likely to change.

Under FMP 3.2 the spatial/temporal concentration of fishing effort may also be affected by Pacific halibut bycatch considerations if they substantially change the distribution of fishing effort.

Status Determination

Under FMP 3.1 and FMP 3.2, the projected B2003 of 42,700 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected

B2005 of 40,400 mt for FMP 3.1, and 40,800 mt for FMP 3.2 are greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition and Sex Ratio

Under FMP 3.1 and FMP 3.2, the age composition of GOA northern rockfish may be affected by fishing mortality as in FMP 1. Size composition of GOA northern rockfish might change in proportion to the change in age composition. Age and size composition could also change if Pacific halibut bycatch considerations substantially change the distribution of fishing effort. No information is available to suggest that sex ratio would change under FMP 3.1 or FMP 3.2.

Habitat-Mediated Impacts

Under FMP 3.1 and FMP 3.2 damage to epifauna by bottom trawls may adversely impact juvenile northern rockfish habitat.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under FMP 3.1 and FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Northern Rockfish

Under FMP 3.1 and FMP 3.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 3.1 and FMP 3.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability, are believed to have an insignificant impact on stock sustainability (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for GOA northern rockfish are summarized in Table 4.5-26.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA northern rockfish stock is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries are identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to northern rockfish mortality.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA northern rockfish is rated as insignificant. Northern rockfish are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the GOA northern rockfish stock is expected to be insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries is identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Bycatch in the IPHC longline fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to northern rockfish change in biomass levels as a function of change in reproductive success (see below).

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the northern rockfish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal characteristics of GOA northern rockfish should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure . However, there are lingering past effects due to climate changes and regime shifts. See Section 3.5.1.24 for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** As noted above, the IPHC longline fishery has already been accounted for by domestic groundfish management and is not expected to contribute to changes in genetic structure or reproductive success of northern rockfish. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. The magnitude and direction of the change in reproductive success with water temperatures is currently unknown. Climate changes and regime shifts are not considered to be contributors to change in genetic structure.

- **Cumulative Effects.** A cumulative effect identified for the spatial/temporal characteristics of GOA northern rockfish is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effect on northern rockfish prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on northern rockfish prey species (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since northern rockfish prey species bycatch is not expected to occur. Climate changes and regime shifts are identified as making potential beneficial or adverse contributions on prey availability, although the magnitude and the direction of change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect identified for prey availability is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the northern rockfish stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** FMP 3.1 and FMP 3.2 would have an insignificant effect on northern rockfish habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA northern rockfish stocks include past foreign, JV, and domestic fisheries, IPHC longline fishery and climate changes and regime shifts (see Section 3.5.1.24). Intense bottom trawling on northern rockfish habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries have also been identified as having adverse effects on northern rockfish habitat, although these effects are not expected to have been as intense as those effects associated with trawl gear. See Section 3.6 for additional information on the effects of trawling on benthic habitat. Climate changes and regime shifts have had both beneficial and adverse effects on northern rockfish habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has been identified as an adverse contributing factor since the fishery gear could disrupt spawning and/or rearing habitats. Although, as state above, the impacts associated with longline gear are not as significant as those associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the GOA northern rockfish stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect identified for habitat suitability is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the northern rockfish stock to sustain itself at or above MSST is jeopardized.

GOA Shortraker/Rougheye Rockfish − Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter.

Fishing Mortality

FMP 3.1 is more precautionary in its approach than FMP 1, FMP 2.1, and FMP 2.2. However, for most measures in regards to shortraker/rougheye it remains very similar to FMP 1 and the baseline situation. One would therefore expect the catch projections for shortraker/rougheye in this bookend would be very similar to those in FMP 1. The projections, however, are consistently higher for FMP 3.1, which does not appear reasonable (Table H.4-34 of Appendix H).

FMP 3.2 is considerably more precautionary in its approach than the baseline situation or FMPs 1, 2.1, 2.2, and 3.1. FMP 3.2 has a major impact on catch of shortraker/rougheye because it includes a measure that changes the biological reference point for determining ABCs of rockfish in Tiers 1 through 4 (which includes rougheye rockfish) from the $F_{40\%}$ baseline to $F_{60\%}$. Using $F_{60\%}$ would reduce the ABC value for shortraker/rougheye, which would almost certainly result in a decrease in catch. Therefore, FMP 3.2 would greatly reduce the risk of overfishing shortraker/rougheye. One other measure in FMP 3.2 that would affect catch of shortraker/rougheye is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of shortraker/rougheye, thereby providing even greater protection against overfishing. The model projections for FMP 3.2 show shortraker/rougheye catches about 50 percent less than those taken by the fishery in recent years. The projections appear reasonable given the stringent precautionary measures of this bookend (Table H.4-34 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Whether this bookend would have substantial effects on the spatial or temporal concentration of shortraker/rougheye catch would somewhat depend on decisions made by the NPFMC after the bookend was implemented. ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. IFQs and fishing cooperatives may be established "as needed," but since specific recommendations concerning such "rights-based" management are not included in the FMP, it is difficult to evaluate how they would impact shortraker/rougheye. If the NPFMC decided to not establish IFQs and/or cooperatives for trawlers, the shortraker/rougheye trawl catch would continue to be concentrated into relatively short open seasons. Similar to the baseline and FMP 1, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

FMP 3.2 would have a large effect on the spatial/temporal concentration of shortraker/rougheye catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because FMP 3.2 sets aside 20 percent of the GOA as either no-take reserves or as MPAs. No-take reserves in the proposal cover various portions of the continental slope in the GOA that are inhabited by shortraker/rougheye. These include reserves off Cape Ommaney in southeast Alaska, off Portlock and Albatross Banks near Kodiak Island, off the entrance to Shelikof Strait, and other reserves south of the Alaska Peninsula and eastern Aleutian Islands, all of which correspond to important fishing grounds (both trawl and longline) for shortraker/rougheye (Fritz *et al.* 1998). Much of the past commercial catch for shortraker/rougheye has been taken on these grounds, so FMP 3.2 would likely displace this catch to other localities. Whether this displacement would result in spreading out the catches over a wider area, or would merely concentrate the catch in new localities, is unknown. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource.

Another important effect of FMP 3.2 is that all fisheries would become "rationalized", which would result in establishment of IFQs or cooperatives for all the trawl fisheries. The existence of IFQs or fishing cooperatives would mean fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called "race for fish" would be a thing of the past, and catches of shortraker/rougheye could extend over a longer time period. This would allow better management oversight of the catch and reduce the risk of over-harvesting.

Status Determination

The catch rates are below the ABC and OFL values. The MSST cannot be determined.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter. There is no information on the sex ratio of shortraker/rougheye, although sex ratio for many other species of Sebastes has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 3.1 and FMP 3.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, FMP 3.1 may impact habitat for shortraker/rougheye because it closes the eastern GOA to trawling. This closure prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of shortraker/rougheye, an undamaged benthic habitat may benefit these species. For example, observations from a manned submersible in the eastern GOA have found shortraker and/or rougheye rockfish associated with boulders along steep slopes (Krieger and Ito 1999) and with colonies of Primnoa coral (Krieger and Wing 2002). The eastern GOA trawl closure presumably causes a reduction in the alteration or destruction of these habitats, which may have a beneficial effect on shortraker/rougheye in this region.

Because FMP 3.2 creates a series of no-take reserves across the GOA, it may provide substantial habitat benefits to shortraker/rougheye. At present, shortraker/rougheye can be taken as bycatch on longlines anywhere in the GOA, although they cannot be caught by trawling in the eastern GOA because of the no-trawl closure in that region. FMP 3.2 retains the eastern GOA trawl closure, but it also adds a number of no-take reserves throughout the GOA in which all fishing activities are prohibited.

Predation-Mediated Impacts

Pacific cod and to a lesser extent walleye pollock are species that are known to prey on shrimp, a major prey item of rougheye rockfish, so any changes in their abundance as a result of FMP 3.1 and FMP 3.2 hypothetically could affect the food supply of shortraker/rougheye. To protect Steller sea lions, FMP 3.1 has two measures that could reduce the catch and increase the abundance of Pacific cod and walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for two species. Catch projections for walleye pollock in FMP 3.2 indicate catches would be reduced compared to FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1, and abundance of walleye pollock would somewhat increase. However, whether a change in abundance of Pacific cod or walleye pollock would actually affect the food supply for shortraker/rougheye is unknown, as there is no quantitative information on trophic interactions between all these species. Moreover, shortraker and rougheye rockfish reside in deeper depths than Pacific cod or walleye pollock, so they may not be competing for the same spatial aggregations of food.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Shortraker/Rougheye Rockfish

The effects of FMP 3.1 and FMP 3.2 on shortraker/rougheye in the GOA are summarized in Table 4.7-1.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for GOA shortraker/rougheye rockfish are summarized in Table 4.5-27.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shortraker/rougheye rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects**. Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery are identified as non-contributing factors since bycatch of rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA shortraker/rougheye rockfish is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the change in biomass level are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery and State of Alaska shrimp are identified as non-contributing factors to GOA slope rockfish biomass level since bycatch is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/ temporal characteristics of GOA shortraker/rougheye rockfish under FMP 3.1 and FMP 3.2 are unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA shortraker/rougheye rockfish; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on shortraker/rougheye rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA shortraker/rougheye rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors to the change in genetic structure and reproductive success of GOA shortraker/rougheye rockfish since bycatch in these fisheries is unlikely to occur.

- **Cumulative Effects.** A cumulative effect for the spatial/temporal characteristics of the GOA shortraker/rougheye rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA shortraker/rougheye rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on shortraker/rougheye rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery is identified as a non-contributing factor to shortraker/rougheye rockfish prey availability since bycatch of shortraker/rougheye rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since shrimp is a main prey item of rougheye rockfish.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA shortraker/rougheye rockfish; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA shortraker/rougheye rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA shortraker/rougheye rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to shortraker/rougheye rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. The IPHC longline fishery has been identified as a potential adverse contributor to shortraker/rougheye rockfish habitat suitability due to impacts from fishery gear. The State of Alaska shrimp fishery is a non-contributing factor since habitat degradation from shrimp fishery gear is not expected to occur. See Section 3.6 for more information on the impacts of fishery gear on EFH.

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA shortraker/rougheye rockfish, the effect is currently unknown due to lack of scientific information.

GOA Slope Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

The average exploitable biomass for the other slope rockfish groups are placed in Tier 5 where ABC is determined by F = 0.75M. Sharpchin are assessed under Tier 4 where OFL is calculated by F = M.

Total and Spawning Biomass

No projections are possible for these two parameters, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Fishing Mortality

FMP bookend 3.1 is more precautionary in its approach than FMPs 1, 2.1, and 2.2. However, for most measures in regards to slope rockfish it remains very similar to the baseline FMP 1. For example, the eastern GOA trawl closure is retained in this bookend, which means most of the GOA population of slope rockfish will not be vulnerable to fishing. The model projections for FMP 3.1, however, show ABCs much less than those for FMP 1, whereas the catches for FMP 3.1 are a little higher than those for FMP 1. Therefore, the model results do not seem plausible (Table H.4-31 of Appendix H).

FMP 3.2 is considerably more precautionary in its approach than the baseline situation or FMPs 1, 2.1, 2.2, and 3.1. FMP 3.2 primarily affects catch of slope rockfish in two ways: 1) it retains the eastern GOA trawl closure and also includes various smaller areas located throughout the GOA as "no-take" reserves, in which no fishing of any gear type can take place; and 2) it includes a measure that changes the biological reference point for determining rockfish ABCs from the $F_{40\%}$ baseline to a more conservative value, $F_{60\%}$. Both of these effects from FMP 3.2 would result in a decreased catch for slope rockfish and greatly reduce any risk of overfishing these species. As in FMPs 1, 2.2, and 3.1, the eastern GOA trawl closure protects most of the GOA biomass of slope rockfish from any significant fishing pressure. The smaller no-take reserves would serve to increase this protection even further. At present, changing the biological reference point for slope rockfish species to $F_{60\%}$ would affect just sharpchin rockfish, because the latter is the only slope rockfish species that is in Tier 4 and has the age data required to calculate $F_{60\%}$. Sharpchin rockfish; however, comprise almost 40 percent of the current exploitable biomass for slope rockfish; therefore, using $F_{60\%}$ for sharpchin rockfish would still result in a considerably lower overall ABC for slope rockfish. The model projections for FMP 3.2 show slope rockfish catches about the same as those for FMP 1 (the present management regime). Given the stringent precautionary measures of this bookend, one would expect the slope rockfish catches for FMP 3.2 to be somewhat less than the model indicates (Table H.4-31 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The main spatial effect of FMP 3.1 and FMP 3.2 on slope rockfish would be caused by the bookend's retention of the eastern GOA trawl closure, which would mean most of the GOA population of slope rockfish would not be vulnerable to fishing. If FMP 3.1 was implemented, the only slope rockfish catch would be taken by trawl west of the closure area and by longline mostly in the eastern GOA. There have been no studies to determine stock structure for any species of slope rockfish, and it is unknown if subpopulations exist. However, because most of the biomass of slope rockfish occurs in the eastern GOA, localized depletion is unlikely under FMP 3.1 . Whether FMP 3.1 would have much effect on the temporal concentration of slope rockfish catch would depend on decisions made by the NPFMC after this bookend was implemented. FMP 3.1 states that IFQs and fishing cooperatives may be established "as needed," but since specific recommendations concerning such "rights-based" management are not included in the FMP, it is difficult to evaluate how they would impact slope rockfish. If the NPFMC decided to not establish IFQs and/or cooperatives for rockfish trawlers, most of the slope rockfish catch could continue to be concentrated into a relatively short open season. Similar to the baseline FMP 1, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

No-take reserves located throughout the GOA, in which no fishing of any kind would be permitted, are also part FMP 3.2 and would serve to increase protection of slope rockfish even further. For example, the bookend includes a no-take reserve off Cape Ommaney in southeast Alaska, and this would prevent any catch of slope rockfish by longlines in this productive fishing area. There have been no studies to determine stock structure for any species of slope rockfish, and it is unknown if subpopulations exist. However, because most of the biomass of slope rockfish occurs in the eastern GOA, localized depletion is unlikely under this FMP.

FMP 3.2 would also have an important temporal effect on rockfish trawl fisheries, as all these fisheries would become "rationalized" through the establishment of IFQs or cooperatives. The existence of IFQs or fishing cooperatives would mean rockfish trawl fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called "race for fish" would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the trawl fishery and reduce the risk of over-harvesting slope rockfish.

Status Determination

No projections are possible for the fishing mortality rate or MSST, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. There is no information on the sex ratio of slope rockfish, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 3.1 or FMP 3.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, FMP 3.1 greatly impacts habitat for slope rockfish because it closes the eastern GOA to trawling. This creates a de facto no-take zone or refugium for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species. Nearly all the biomass of slope rockfish is found in the eastern GOA, which means the trawl closure in this region protects most of the GOA population from any fishing pressure.

Similar to FMP 1 and the baseline situation in past years, FMP 3.2 impacts habitat for slope rockfish mainly because it closes the eastern GOA to trawling. This creates a de facto no-take zone or refugium for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species. Nearly all the biomass of slope rockfish is found in the eastern GOA, which means the trawl closure in this region protects most of the GOA population from any fishing pressure. FMP 3.2 also creates a series of no-take reserves across the GOA, which establishes de jure refugia for all species, including slope rockfish. These no-take reserves, although much smaller and of less impact to slope rockfish than the eastern GOA trawl closure, may provide additional habitat benefits to slope rockfish.

Predation-Mediated Impacts

No studies have been done in Alaska to determine the food habits for any of the slope rockfish species. Many of the abundant species, such as sharpchin, harlequin, and redstripe rockfish, are relatively small in size and may be plankton-feeders, but this is conjecture. There is also no documentation of predation on slope rockfish, although larger fishes such as Pacific halibut that are known to prey on other rockfish presumably also prey on slope rockfish. Because of this lack of information, the effect of FMP 3.1 and FMP 3.2 on predator-prey relationships for slope rockfish is unknown.

Summary of Effects of FMP 3.1 and FMP 3.2– GOA Slope Rockfish

The effects of FMP 3.1 and FMP 3.2 on slope rockfish in the GOA are summarized in Table 4.7-1.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for GOA slope rockfish are summarized in Table 4.5-28.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA other slope rockfish is rated as insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries and State of Alaska groundfish fisheries have been identified as having had an adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of other slope rockfish. The State of Alaska groundfish fisheries is identified as a non-contributing factor since catch and bycatch of slope rockfish species is already accounted for by the domestic groundfish fishery management. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA other slope rockfish is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had an adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the other slope rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.24 and 3.10. The State of Alaska groundfish fisheries are identified as non-contributing factors to GOA slope rockfish biomass level. Although catch and bycatch do occur in these fisheries, the removals are already accounted for by the domestic groundfish fishery management.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA other slope rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal characteristics of GOA slope rockfish under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA slope rockfish; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on slope rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA slope rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The State of Alaska groundfish fishery is identified as a non-contributing factor to the change in genetic structure and reproductive success of GOA slope rockfish. Although catch and bycatch of slope rockfish species occurs in these fisheries, they are not expected to contribute to localized depletion such that it leads to a detectable reduction in genetic diversity or reproductive success. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect for the spatial/temporal characteristics of the GOA slope rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA slope rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on slope rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to slope rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to slope rockfish prey availability since bycatch of slope rockfish prey species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA slope rockfish; however, the effect is unknown due to lack of scientific information.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, State of Alaska groundfish fisheries and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA slope rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA slope rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to slope rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. The State of Alaska groundfish fishery and the IPHC longline fishery have been identified as potential adverse contributors to slope rockfish habitat suitability due to impacts from fishery gear. See Section 3.6 for more information on the impacts of fishery gear on EFH.

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA slope rockfish, the effect is currently unknown due to lack of scientific information.

GOA Pelagic Shelf Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

<u>Total and Spawning Biomass</u>

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish. Until recently, an age-structured model had not been finalized for dusky rockfish; beginning in 2004, dusky rockfish will be managed under Tier 3. However, dusky rockfish has been modeled under the Tier 4 catgeory for the purposes of this analysis.

Fishing Mortality

FMP 3.1 is more precautionary in its approach than FMPs 1, 2.1, and 2.2. However, for most measures in regards to PSR it remains very similar to FMP 1 and the baseline situation. One measure in FMP 3.1 that could affect catch of PSR is that PSC limits for Pacific halibut are reduced 10 percent. In at least one instance in recent years, the PSR fishery has been closed early with substantial TAC remaining so that excessive bycatch of halibut would be prevented. Hence, if FMP 3.1 were adopted, an indirect effect might be to reduce catches of PSR if means were not found to control or prevent Pacific halibut bycatch. The model projections for FMP 3.1 show catches about 25 percent less than those for FMP 1, which may be plausible given the reduced PSC limits for Pacific halibut (Table H.4-32 of Appendix H).

FMP 3.2 is considerably more precautionary in its approach than the baseline situation or FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. FMP 3.2 has a major impact on catch of PSR because it includes a measure that changes the biological reference point for determining rockfish ABCs from the $F_{40\%}$ baseline to $F_{60\%}$. Using $F_{60\%}$ would significantly reduce the ABC value for PSR, which would almost certainly result in a decrease in catch. Therefore, FMP 3.2 would greatly reduce the risk of overfishing PSR. One other measure in FMP 3.2 that could affect catch of PSR is that PSC limits for Pacific halibut are reduced 30 percent. In at least one instance in recent years, the PSR fishery has been closed early with substantial TAC remaining so that excessive bycatch of halibut would be prevented. Hence, if FMP 3.2 were adopted, an indirect effect might be to reduce catches of PSR if means were not found to control or prevent Pacific halibut bycatch. The model projections for FMP 3.2 show PSR catches about 50 percent less than those for FMP 1 (the present management regime), and the projected catches are 70-80 percent less than has been taken by the fishery in recent years. The projections appear reasonable given the stringent precautionary measures of this bookend (Table H.4-32 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Whether FMP 3.1 would have substantial effects on the spatial or temporal concentration of PSR catch would somewhat depend on decisions made by the NPFMC after the bookend was implemented. ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. IFQs and fishing cooperatives may be established “as needed,” but since specific recommendations concerning such “rights-based” management are not included in the FMP, it is difficult to evaluate how they would impact PSR. If the NPFMC decided to not establish IFQs and/or cooperatives for rockfish trawlers, the PSR fishery could continue to be concentrated into a relatively short open season. Similar to the baseline, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

FMP 3.2 would have a large effect on the spatial/temporal concentration of PSR catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because FMP 3.2 sets aside 20 percent of the GOA as either no-take reserves or as MPAs. No-take reserves in the proposal cover portions of Portlock and Albatross Banks, which are some of the major fishing grounds for dusky rockfish (Reuter 1999). Much of the past fishing effort for dusky rockfish has been concentrated on these two banks, so FMP 3.2 would likely displace this effort to other localities. Whether this displacement would result in spreading out the fishing effort over a wider area, or would merely concentrate the effort in new localities, is unknown. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource.

Another important effect of FMP 3.2 is that all fisheries would become "rationalized", which would result in establishment of IFQs or cooperatives for the trawl fisheries. The existence of IFQs or fishing cooperatives would mean fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called "race for fish" would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the fishery and reduce the risk of over-harvesting PSR species.

Status Determination

The catch rates are below the ABC and OFL values. The MSST cannot be determined for this stock.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish. There is no information on the sex ratio of PSR, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 3.1 and FMP 3.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, FMP 3.1 impacts habitat for PSR because it retains the eastern GOA trawl closure. This creates a de facto no-take zone or refugium for PSR in this area, as trawls are generally the only effective gear for capturing these species. Although biomass estimates from trawl surveys indicate that the trawl closure area in the eastern GOA only contains about 10-15 percent of the Gulf-wide biomass of dusky biomass, this is still large enough that it may provide enhanced protection to the dusky rockfish resource. Use of refugia as a conservation measure could be particularly effective for rockfish species, as most are generally believed to be sedentary in nature and not undergo extensive migrations. The closed areas may allow increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the Gulf-wide population. The trawl closure also prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of PSR, an undamaged benthic habitat likely provides a benefit to these species. For example, observations from manned submersibles in the eastern GOA have found adult dusky rockfish associated with colonies of Primnoa coral (Krieger and Wing 2002) and with large vase-type sponges. Prevention of possible damage by bottom trawls to these "living substrates" may increase the amount of protective cover available to dusky rockfish to escape predation and thus have a beneficial impact on the stocks. Juvenile dusky rockfish may also be associated with epifauna such as corals or sponges that provide structural relief on the bottom. If so, reducing the damage to this epifauna by bottom trawls may increase survival of juvenile fish.

Because FMP 3.2 creates a series of no-take reserves across the GOA, it may provide substantial habitat benefits to PSR. At present, the only de facto no-take reserve affecting PSR is the eastern GOA region that has been closed to trawling for the past several years. FMP 3.2 retains the eastern GOA trawl closure, and it also adds several no-take reserves in the central and western GOA.

Predation-Mediated Impacts

The major prey of dusky rockfish appears to be euphausiids, based on the limited food information available for this species (Yang 1993). Euphausiids are also the major prey of walleye pollock, which means dusky rockfish and walleye pollock may be competing for the same food resource. Thus, any measures in FMP 3.1 or FMP 3.2 that affect the commercial catch of walleye pollock could have an subsequent indirect effect on dusky rockfish by increasing or decreasing the amount of euphausiids available to dusky rockfish. To protect Steller sea lions, FMP 3.1 (similar to FMP 1 and the baseline situation in past years) has two measures that may reduce catch of walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for walleye pollock. Catch projections for walleye pollock in FMP 3.2 indicate catches would be reduced compared to FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. This would lead to an obvious increase in abundance of walleye pollock and possibly have an adverse effect on the food supply for dusky rockfish. Hypothetically, these measures could increase the abundance of walleye pollock, resulting in the consumption of more euphausiids and having an adverse effect on the food supply for dusky rockfish. How adverse this effect would really be; however, is unknown, as there is little or no quantitative information on trophic interactions between dusky rockfish and walleye pollock or data on whether they even feed on the same spatial aggregations of euphausiids.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Pelagic Shelf Rockfish

The effects of FMP 3.1 and FMP 3.2 on PSR in the GOA are summarized in Table 4.7-1.

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for the GOA PSR complex are summarized in Table 4.5-29.

Mortality

- **Direct/Indirect Effects.** The effect of the fisheries on the mortality of the GOA PSR complex is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA PSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR mortality since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA PSR, is rated as insignificant. PSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effect of fisheries on the biomass level under FMP 3.1 and FMP 3.2 is unknown since the MSST cannot be determined.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery has been identified as a non-contributing factor to GOA PSR biomass levels since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect identified for change in biomass; however, the effect is unknown since total and spawning biomass levels and MSST are currently unavailable.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA PSR under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA PSR; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on PSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery has been identified as a non-contributing factor to GOA PSR genetic structure and reproductive success since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA PSR complex is possible; however, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability of GOA PSR under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on PSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a potential adverse contributor to GOA PSR prey availability. The catch of shrimp in the shrimp fishery is expected to continue in the future. Marine pollution is identified as a potential adverse contributor to PSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA PSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability of GOA PSR under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries have been identified as having past persisting adverse effects on GOA PSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA PSR habitat suitability (see Sections 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR habitat suitability since the gear associated with this fishery is not expected to cause a significant impact to the benthic habitat. See Sections 3.5.1.24 and 3.6 for more information on the effects of fishery gear on EFH. Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA PSR, the effect is currently unknown due to lack of scientific information.

GOA Demersal Shelf Rockfish – Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Total and Spawning Biomass

Reliable total and spawning biomass statistics are not available for demersal shelf rockfish species.

Fishing Mortality

Under FMP 3.1, there would be few effects on DSR species in the short-term, and for all intensive purposes this management plan would be similar to the current GOA FMP. As described previously for FMP OFL has been set at 540 mt (NPFMC 2002a). The 2003 TAC was set equal to the ABC, or 390 mt; so management of DSR in the eastern GOA already complies with this FMP 3.1 requirement. Over the long-term, this FMP would initiate the collection of scientific information necessary to specify a MSST for DSR. Currently DSR fall into Tier 4 and no minimum stock size threshold exists for this species assemblage. Obtaining the information necessary to elevate DSR into a higher Tier and specifying MSST would certainly benefit DSR species and provide opportunities for refining management measures to more fully achieve policy objectives.

Under FMP 3.1, DSR species are taken in a small directed fishery with hook and line gear and as bycatch in the halibut longline fishery. Reported catch of DSR has been relatively constant over the last 5 years with landings ranging from 226 mt to 363 mt in large part due to very conservative management practices (Table H.4-33 of Appendix H). Estimated bycatch mortality of DSR in the halibut fishery has ranged about 130 mt to 355 mt annually. A DSR bycatch limit (10 percent) is established during the halibut season to limit mortality of DSR in this fishery. ADF&G requires full retention of DSR in state waters and the NPFMC has also recently approved a management measure that requires full retention of DSR species. Once approved by NOAA Fisheries, the measure will improve catch statistics and reduce discards and waste. These measures would continue in FMP 3.1.

Under FMP 3.1, we expect both the TAC and reported landings to remain stable at present levels. A more precautionary management policy will likely have no significant impact on the ability of DSR to sustain current population levels. Fishing mortality will remain below the OFL under this FMP.

The projected catch of DSR in the eastern GOA would be lower under FMP 3.2 as a result of a more conservative exploitation rate for DSR species. The DSR ABC would now be based on a F60 rate, that would translate to about 200 mt (Table H.4-33 of Appendix H). Assuming TAC would be set below this figure, the effect would be less fishing mortality of DSR. Reduced mortality of DSR would likely benefit the population over time. Such a reduced TAC would eliminate the directed fishery for DSR in the eastern GOA. All DSR would be placed on "bycatch-only" status. A TAC of 200 mt would provide only enough quota to permit retention of DSR as bycatch in the halibut fishery. This level of fishing mortality will not have a significant impact on the ability of DSR species to maintain the current population.

Spatial/Temporal Concentration of Fishing Mortality

Although management of this assemblage has been conservative, and overall the population appears stable, a decline in the density estimates in the Fairweather Grounds under FMP 3.1 may be an indication that localized overfishing is occurring (O'Connell *et al.* 2002). The TAC for the eastern GOA is partitioned by management district based on biomass density and known habitat. The current harvest strategy indicates that 2 percent of the exploitable biomass is taken per year and that this level of exploitation is sustainable. However, fishing effort on the Fairweather Grounds appears to be concentrated in areas of best habitat and high density and it may be that local overfishing occurs. The question is whether such potential for localized overfishing would continue under FMP 3.1. The answer is that it could, but the probability is reduced due to the likelihood that TAC will be adjusted downward as better information is obtained on DSR bycatch. Improved scientific information on DSR species would result in improved management that could lead to catch restrictions or other measures designed to prevent localized overfishing. It is presumed that a more precautionary management policy would provide benefits to DSR. As a result, we conclude that FMP 3.1 would generate no significantly adverse impact on DSR stocks.

Reduced fishing mortality and improved catch data on DSR species under FMP 3.2 would likely result in the development of measures that would protect localized DSR stocks from overfishing. Other components of FMP 3.2 include establishing a network of MPAs along the continental shelf and slope of Alaska. Such closures could affect traditional fishing grounds and require fishermen to fish in different areas. It is presumed that such a program would be carefully designed to address important habitat features and areas where localized overfishing concerns exist. Through these measures, a more precautionary management policy could provide benefits to DSR, but such benefits cannot be determined at the present time.

Status Determination

The MSST cannot be determined for this stock complex.

Age and Size Composition and Sex Ratio

Age and size composition data is not available for GOA DSR species. The sex ratio of GOA DSR species is unknown.

Habitat-Mediated Impacts

Any habitat suitability impacts of FMP 3.1 and FMP 3.2, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing, would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient at the present time to conclude that existing habitat suitability indices would undergo any significant change under FMP 3.1 or FMP 3.2. However, FMP 3.1 and FMP 3.2 would initiate a federal Marine Protected Area (MPA) program and it is likely that certain areas of the eastern GOA would be candidates for MPA designation. Such a program, by design, could mitigate adverse effects of fishing by protecting areas important to DSR species.

Predation-Mediated Impacts

As with habitat suitability indices, any effects to predator-prey relationships of FMP 3.1 and FMP 3.2 management would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that predator-prey relationships would undergo any significant change under FMP 3.1 or FMP 3.2.

Summary of Effects of FMP 3.1 and FMP 3.2 – GOA Demersal Shelf Rockfish

An age-structured population model for DSR rockfish is not used for DSR. Projections of future catch ABC and OFL levels were made by carrying forward the 2002 baseline values into the future. Under these assumptions, DSR rockfish stocks remain stable and are fished at less than the ABC in the eastern GOA, and the direct and indirect effects under FMP 3.1 are considered either insignificant or unknown (Table 4.7-1).

Additional information is needed to determine whether current abundance levels are truly sustainable over the long-term, including improved time series of catch (and bycatch) by species, and age and size composition data. FMP 3.1 would prioritize and initiate a research program that would address the data limitations described above. Better estimates of important life history parameters including growth rates, maturity schedule, and natural mortality rate would likely result in improved management and greater confidence that current mortality levels are not adversely affecting DSR.

A significant feature of FMP 3.2 is the lowering of ABC levels for DSR. For the eastern GOA, the DSR ABC would be reduced from 390 mt to approximately 200 mt. A TAC set below 200 mt would only provide sufficient resource to permit retention of DSR as bycatch in the halibut fishery. Because DSR are will be fished at less or equal to the ABC, mortality under FMP 3.2 is considered insignificant to DSR species. The spatial/temporal distribution of catch, change in biomass, change in prey availability and habitat suitability are determined to be unknown (Table 4.7-1).

Cumulative Effects of FMP 3.1 and FMP 3.2

Cumulative effects for the GOA DSR complex are summarized in Table 4.5-30.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA DSR complex is insignificant under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR mortality since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA DSR is rated as insignificant. DSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effect of the fisheries on the change in biomass level under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR biomass levels since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect identified for change in biomass; however, the effect is unknown since total and spawning biomass levels are currently unavailable.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA DSR under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA DSR; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on DSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and IPHC longline fisheries have been identified as non-contributing factors to GOA DSR genetic structure and reproductive success. Catch/bycatch of these fisheries is already accounted for by the domestic groundfish management or is not expected to occur (as in the case of the State of Alaska herring and shrimp fisheries). Marine pollution is identified as a potential adverse contributor to GOA DSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA DSR complex is possible; however, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability of GOA DSR under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on DSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as potential adverse contributors to GOA DSR prey availability. Catch of herring in the herring fishery and the catch of shrimp in the shrimp fishery are expected to continue in the future. The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to GOA DSR prey availability since bycatch of DSR prey species in not expected to occur. Marine pollution is identified as a potential adverse contributor to DSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA DSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in habitat suitability of GOA DSR under FMP 3.1 and FMP 3.2 is unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries and the IPHC longline fisheries have been identified as having past persisting adverse effects on GOA DSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA DSR habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as non-contributing factors to GOA DSR habitat suitability since the gear associated with these fisheries are not expected to cause a significant impact to the benthic habitat. The State of Alaska groundfish fisheries and the IPHC longline fisheries are identified as potential adverse contributors to DSR habitat suitability. See Sections 3.5.1.24 and 3.6 for more information on the effects of fishery gear on EFH. Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

- **Cumulative Effects** Although a cumulative effect is possible for habitat suitability of GOA DSR, the effect is currently unknown due to lack of scientific information.

4.7.2 Prohibited Species Alternative 3 Analysis

4.7.2.1 Pacific Halibut

Pacific halibut are managed by the IPHC. Halibut bycatch in federal groundfish fisheries is controlled by the use of PSC limits. IPHC provides for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery.

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – Pacific Halibut

Direct and indirect effects for Pacific halibut include mortality, and changes in reproductive success and prey availability. These effects, which are associated with changes in catch, are considered insignificant because annual quota setting processes implemented by IPHC account for all removals of halibut including bycatch in other fisheries. Thus, if changes to the baseline condition of the stock occur, they are reflected in the quotas set for the directed fishery. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. Halibut are opportunistic predators with a wide range of prey species, and no significant change to prey structure is expected as a result of FMP 3.1 or 3.2. No evidence of fishery impact to habitat of halibut has been shown, so this effect will not be considered in the cumulative effects analysis that follows.

Under FMP 3.1, halibut PSC caps would be reduced slightly (0-10 percent). Halibut bycatch mortality in the BSAI and GOA combined would decrease slightly from the present 6,800 mt by perhaps a few hundred mt. Reductions in halibut are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. This decrease could allow a corresponding increase in halibut catches by the directed fishery. Total removals would continue to be limited by IPHC to protect the halibut resource.

Under FMP 3.2, halibut PSC caps would be reduced moderately (10 to 30 percent). Halibut bycatch mortality in the BSAI and GOA combined would decrease moderately from the present 6800 mt by 1,000-2,000 mt. This would allow a corresponding increase in halibut catches by the directed fishery. Total removals would continue to be limited by IPHC.

Cumulative Effects Analysis FMP 3.1 – Pacific Halibut

A summary of the cumulative effects analysis associated with FMP 3.1 is shown in Table 4.5-31. For further information on persistent past effects included in this analysis, see Section 3.5.2.1 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 3.1 because current management of halibut by IPHC accounts for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects**. The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 3.1. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 3.1.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 3.1. Halibut are opportunistic predators with a wide range of prey species, and no significant change to prey structure is expected as a result of FMP 3.1.

- **Persistent Past Effects.** No persistent past effects impacting prey availability for halibut have been identified.

- **Reasonably Foreseeable Future External Effects.** Halibut are opportunistic predators with a wide range of prey species. Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability for Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1.

Cumulative Effects Analysis FMP 3.2 – Pacific Halibut

A summary of the cumulative effects analysis associated with FMP 3.2 is shown in Table 4.5-31. For further information on persistent past effects included in this analysis, see Section 3.5.2.1 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 3.2, because current management of halibut by IPHC accounts for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects.** The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 3.2. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 3.2.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut, since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.2.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 3.2. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of FMP 3.2.

- **Persistent Past Effects.** No persistent past effects impacting prey availability for halibut have been identified.

- **Reasonably Foreseeable Future External Effects.** Halibut are opportunistic predators with a wide range of prey species. Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability for Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.2.

4.7.2.2 Pacific Salmon or Steelhead Trout

Pacific salmon are managed by the ADF&G, which also manages the salmon sport fisheries and permitted subsistence harvesting. They ensure that escapement goals are met for the spawning population in order to maintain sustained yields from the stock as a whole. Annual harvest levels are responsive to fluctuations in run sizes.

For reasons discussed in Section 4.5.2.2, ESA-listed Pacific Northwest chinook salmon and steelhead trout were not specifically considered in this cumulative effects analysis.

Management of Alaskan salmon stocks is challenging due to the lack of precise information on total returns, and the inability to predict future returns to most rivers or tributaries with any degree of certainty. In most cases, total return and escapement levels are not known. As a result of this lack of information, estimates of significant impacts of bycatch on various runs are unreliable. Another factor to consider in salmon management is the Alaska subsistence preference law. This law requires that commercial, recreational, and personal use fisheries be restricted, before restriction of subsistence fisheries. Therefore, management of all fisheries for these stocks in state waters incorporates conservative measures.

A summary of assumptions included in the impact analysis of the FMPs is presented in Section 4.5.2.2. The cumulative effects analyses were based on two groupings of Alaska salmon in BSAI and GOA: chinook salmon and other salmon.

Direct/Indirect Effects FMP 3.1 and 3.2 – Pacific Salmon or Steelhead Trout

Direct and indirect effects for chinook salmon and other salmon in BSAI and GOA include mortality, changes in prey availability, genetic structure of population, and reproductive success.

<u>BSAI – Chinook Salmon</u>

Under FMP 3.1, chinook salmon bycatch in the BSAI varies from approximately 26,000 fish in 2003, to 24,000 fish in 2008. Assuming 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 14,000 to 18,000 fish during the next six years. This harvest represents approximately 4.7 to 6.0 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Such bycatch levels are not detectable in natal streams, would have little or no effect on commercial or subsistence harvests and escapement, and are not expected to significantly impact the sustainability of the stock.

Under FMP 3.2, chinook salmon bycatch in the BSAI varies from approximately 23,000 fish in 2003, to 19,000 fish in 2006 - 2008. Assuming 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 11,000 to 16,000 fish during the next six years. This harvest represents approximately 3.7 to 5.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This FMP results in a minor to moderate (10 to 25 percent) reduction in western Alaska chinook salmon catches by approximately 2,000 fish per year. Reductions in BSAI chinook salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. Such bycatch levels are not detectable in natal streams, would have no detectable effects on commercial or subsistence harvests or escapement, and are not expected to impact the sustainability of the stock.

BSAI – Other Salmon

Under FMP 3.1, bycatch of other salmon in the BSAI varies from approximately 69,000 fish in 2003 down to 62,000 fish in 2008. Assuming 96 percent of other salmon bycatch is chum salmon, and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 12,000 to 13,000 fish during the next six years. This harvest represents approximately 1.1 to 1.2 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. Such bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests and escapement, and are not expected to impact the sustainability of the stock.

Under FMP 3.2, bycatch of other salmon in the BSAI varies from approximately 61,000 fish in 2003 down to 48,000 fish in 2007. Assuming 96 percent of this other salmon bycatch is chum salmon, and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 9,000 to 12,000 fish during the next six years. This harvest represents approximately 0.8 to 1.1 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This FMP results in bycatch ranging from minor to moderate reductions (10 to 25 percent) to no change (less than ten percent) in western Alaska chum salmon catches of approximately 1,000 to 2,000 fish per year. Reductions in BSAI other salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. Such bycatch levels are not detectable in natal streams, would have no detectable effects on commercial or subsistence harvests or escapement, and are not expected to significantly impact sustainability of the stock.

GOA – Chinook Salmon

Under FMP 3.1, chinook salmon bycatch in the GOA varies from approximately 11,000 fish in 2003 to 23,000 fish in 2008. Assuming 58 percent of GOA chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 6,000 to 13,000 fish during the next six years. This harvest represents approximately 2.0 to 4.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This FMP results in minor to moderate (10 to 25 percent) reductions of western Alaska chinook salmon catches of 2,000 to 3,000 fish per year. Such bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests and escapement, and are not expected to have a significant impact on sustainability of the stock.

Under FMP 3.2, chinook salmon bycatch in the GOA varies from approximately 8,000 fish in 2003 to 18,000 fish in 2008. Assuming 58 percent of GOA chinook salmon bycatch is of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 5,000 to 10,000 fish during the next six years. This harvest represents approximately 1.7 to 3.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This FMP results in a significant reduction (>25 percent) in western Alaska chinook salmon catches by approximately 3,000 to 6,000 fish per year. Reductions in GOA chinook salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. Such bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests or escapement, and are not expected to significantly impact sustainability of the stocks.

GOA – Other Salmon

Under FMP 3.1, bycatch of other salmon in the GOA varies from approximately 4,000 fish in 2003 to 9,000 fish in 2008. Assuming 56 percent of other salmon bycatch is chum salmon, the bycatch could range from 2,000 to 5,000 fish during the next six years. The proportion of these fish from western Alaska is unknown. Assuming that all of these fish were from western Alaska, this harvest represents approximately 0.2 to 0.5 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This FMP results in a moderate (10 to 25 percent) to significant (>25 percent) reduction of western Alaska chum salmon catches by approximately 1,000 fish per year. However, these bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests and escapement, and are not expected to significantly impact the sustainability of the stock.

Under FMP 3.2, bycatch of other salmon in the GOA varies from approximately 3,000 fish in 2003 to 7,000 fish in 2008. This FMP results in a significant reduction (>25 percent) in western Alaska chum salmon catches of approximately 1,000 to 2,000 fish per year. Reductions in GOA other salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. Such bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests or escapement, and are not expected to significantly impact sustainability of the stock.

Cumulative Effects Analysis FMP 3.1 – Pacific Salmon or Steelhead Trout

A summary of the cumulative effects analysis associated with FMP 3.1 in BSAI and GOA stocks are shown in Table 4.7-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The bycatch levels predicted under this FMP are not detectable in natal streams, would have little or no effect on commercial or subsistence harvests and escapement, and are not expected to significantly impact the sustainability of the stock. Therefore, the potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant under FMP 3.1.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries, while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries exert effects on mortality of western Alaska chinook and other salmon populations. The magnitude of this effect cannot be determined; however, current stock status indicates that salmon runs in western Alaska are depressed. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. In GOA, state commercial, subsistence, and sport fisheries exert effects on mortality of non-western other salmon populations; however, these fisheries are not viewed as having significant impacts to salmon stocks in the GOA, and are not considered contributing factors to mortality of salmon populations as a whole. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State hatchery enhancement programs were initiated in GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI and GOA chinook and BSAI other salmon resulting from internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for FMP 3.1. Combined bycatch potential in the BSAI and GOA fisheries under this FMP could impede the successful recovery of western Alaska depressed stocks and impact sustainability of the stock as a whole. The combined effects of mortality on GOA other salmon resulting from direct catch, bycatch, and future events are considered insignificant under FMP 3.1.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 3.1 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of salmon prey and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, a relationship between state commercial, subsistence, and GOA sport fisheries bycatch of prey and salmon prey availability has not been defined, and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. State hatchery enhancement programs occur in GOA, but do not include prey species of salmon. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 3.1.

<u>Change in Genetic Structure of Population</u>

- **Direct/Indirect Effects.** The potential effects of FMP 3.1 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, salmon bycatch composition has not been determined. Potential effects of state commercial and subsistence fisheries, along with GOA sport fisheries, on genetic structure of salmon populations are unknown. For reasons stated above, land management practices, long-term climate changes, and regime shifts are not considered contributing factors to changes in BSAI and GOA salmon populations. State hatchery enhancement programs in the GOA focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 3.1.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effects of FMP 3.1 on reproductive success for BSAI and GOA chinook and other salmon cannot be determined.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska, it may be inferred that reproductive success has been impacted in certain salmon populations originating in the BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may play a role in the reproductive success of certain salmon populations. Stocks in GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks, and are considered a potential adverse contribution to the population as a whole. Other GOA salmon stocks are considered stable, so potential effects of state commercial, subsistence, and sport fisheries on reproductive success of this stock are considered insignificant for the population. Degradation of watersheds used by spawning salmon that is caused by poor land management practices, could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potential adverse contributions to possible changes in reproductive success of this population. Hatchery enhancement programs in the GOA may help to restore depressed stocks and maintain stable stocks in Alaska, and are considered potentially beneficial to the reproductive success of salmon. Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential in the BSAI and GOA fisheries, the sustainability of BSAI and GOA chinook and BSAI other salmon stocks could be impacted. Fisheries catch may remove spawning adults destined for spawning grounds, and potential combined effects from internal and external events are considered conditionally significant adverse to the reproductive success of BSAI and GOA chinook salmon and BSAI other salmon stocks. Although current stock status of GOA other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) cannot be determined for GOA other salmon stocks under FMP 3.1.

Cumulative Effects Analysis FMP 3.2 – Pacific Salmon or Steelhead Trout

A summary of the cumulative effects analysis associated with FMP 3.2 in BSAI and GOA stocks are shown in Table 4.7-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The bycatch levels predicted under this FMP would not be detectable in natal streams, would have little or no effect on commercial or subsistence harvests and escapement, and are not expected to significantly impact the sustainability of the stock. Therefore, the potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant under FMP 3.2.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries, while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow, and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries exert effects on mortality of western Alaska chinook and other salmon populations. The magnitude of this effect cannot be determined; however, current stock status indicates that salmon runs in western Alaska are depressed. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of BSAI and GOA chinook and BSAI other salmon depressed stocks, and are considered a potential adverse contribution to the population as a whole. Other salmon stocks in the GOA are not expected to be significantly impacted by these fisheries. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State hatchery enhancement programs were initiated in GOA, and have a potential beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI and GOA chinook and BSAI other salmon resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for FMP 3.2. Combined bycatch potential in the BSAI fisheries under this FMP could impede the successful recovery of depressed stocks and impact sustainability of the stock as a whole. The combined effects of mortality on GOA other salmon are considered insignificant under FMP 3.2.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 3.2 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of salmon prey and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, a relationship between state commercial, subsistence, and GOA sport fisheries bycatch of prey and salmon prey availability has not been defined, and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time. State hatchery enhancement programs that occur in GOA do not include prey species of salmon.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 3.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 3.2 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, salmon bycatch composition has not been determined, so potential effects of state commercial and subsistence fisheries on genetic structure of salmon populations are unknown. Significant impacts to genetic structure of salmon populations by land management practices are not expected, and are not considered contributing factors to a possible change in baseline condition. Long-term climate change and regime shifts are not expected to result in direct mortality that would potentially affect genetic structure of BSAI and GOA chinook and other salmon stocks. State hatchery enhancement programs in the GOA focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska are unknown under FMP 3.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 3.2 on reproductive success for BSAI and GOA chinook and other salmon cannot be determined.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska, it may be inferred that reproductive success has been impacted in certain salmon populations originating in the BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may play a role in the reproductive success of certain salmon populations. Stocks in GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks, and are considered a potential adverse contribution to the population as a whole. GOA other salmon stocks are considered stable, so potential effects of state commercial, subsistence, and sport fisheries on reproductive success of this stock are considered insignificant for this population. Degradation of watersheds used by spawning salmon, resulting from poor land management practices, could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potential adverse contributors to possible changes in reproductive success of this population. Hatchery enhancement programs in the GOA may help to restore depressed stocks and maintain stable stocks in Alaska, and are considered potentially beneficial to the reproductive success of salmon.

Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential in the BSAI and GOA fisheries, the sustainability of BSAI and GOA chinook and GOA other salmon stocks could be impacted. Thus, fisheries' catch may remove spawning adults destined for spawning grounds, and potential combined effects from internal and external events are considered conditionally significant adverse to the reproductive success of BSAI and GOA chinook and BSAI other salmon. Although current stock status of GOA other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from past, present, and future events (both human controlled and natural) cannot be determined for GOA stocks under FMP 3.2.

4.7.2.3 Pacific Herring

Pacific herring are managed by the ADF&G. Harvest policy and allocations among gear (user) groups are established by the Alaska Board of Fisheries. Annual harvest quotas are set by ADF&G under an exploitation rate harvest policy. Herring exploitation rates are capped at a maximum level of 20 percent statewide. All directed herring fisheries occur in state waters and are managed by regulatory stocks.

A detailed discussion of the modeling approach used in this analysis is included in Section 4.5.2.3. Given the low herring bycatch levels that are predicted across all FMPs, bycatch removals would not be expected to have significantly different impacts on herring abundance estimates between FMPs.

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – Pacific Herring

Direct and indirect effects for Pacific herring include mortality, changes in reproductive success, prey availability, and habitat. These effects, which are associated with changes in catch, are considered insignificant for the following reasons: bycatch of herring in the groundfish fisheries is low, the fisheries do not target herring prey, and spatial/temporal overlap between the groundfish fisheries and herring habitat is minimal. In addition, annual quota setting processes implemented by ADF&G are responsive to fluctuations in herring biomass.

Cumulative Effects Analysis FMP 3.1 and FMP 3.2 – Pacific Herring

A summary of the cumulative effects analysis associated with Alternative 3 is shown in Table 4.5-34. For further information on persistent past effects included in this analysis, see Section 3.5.2.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA herring is insignificant under FMP 3.1 and FMP 3.2 given the low amounts predicted for herring bycatch, and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. The herring savings areas reduce herring bycatch potential by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Domestic herring fisheries became prominent in the early 1900s, with peak catches occurring in the 1920s and 1930s. Foreign herring harvests became prominent in the BSAI in the late 1950s, with highs in the late 1960s and early 1970s. Overexploitation of herring likely resulted during these years of high catch. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have had long-term impacts on herring populations. In addition, past federal groundfish fisheries bycatch, combined with the directed state fisheries, have exceeded the state's herring harvest policy, and may still exert lingering effects on current herring populations in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur, but are closely managed by ADF&G. Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. State subsistence catch is accounted for in ADF&G herring management plans. These fisheries are not considered contributing factors to changes in herring mortality. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring mortality, especially for those populations that are still recovering from the EVOS in the GOA. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass. Fishing quotas are based on variable exploitation rates that account for declines in stock, and are capped at a maximum rate of 20 percent. Thus, although some persistent past effects may still be present on certain herring populations in the BSAI and GOA, the combined effects of mortality on Pacific herring resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1 and 3.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on reproductive success of BSAI and GOA herring is insignificant under FMP 3.1 and 3.2 due to the low estimates of herring bycatch and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in reproductive success occurs, it would most likely be reflected in corresponding changes to biomass, which are incorporated into ADF&G management plans for Pacific herring.

- **Persistent Past Effects.** As discussed in the analysis of cumulative effects on Pacific herring mortality, years of unregulated foreign harvest of herring and past federal groundfish fisheries bycatch that exceeded the state's herring harvest policy in the past may still exert lingering effects on current herring populations in the BSAI and GOA. Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. It has been found that this type of contamination exposure to adult and larval herring can result in many adverse effects such as: increased rates of egg mortality, larval deformities, and immune system deficiencies. It is presumed that the effects of the EVOS still exist, and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur but are closely managed by ADF&G. Fishing quotas are based on variable exploitation rates that account for declines in stock. State subsistence fisheries catch is also accounted for in ADF&G herring management plans. Thus, these fisheries are not considered contributing factors to changes in herring reproductive success. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring reproductive success, especially for those populations that are still recovering from the EVOS in the GOA. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific herring depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass, and fishing quotas are based on variable exploitation rates that account for declines in stock. Although certain herring populations in the GOA have been impacted by the EVOS, the stock as a whole is considered to be recovering. Thus, some persistent past effects may still be present on certain herring populations in the BSAI and GOA, but the combined effects on Pacific herring reproductive success resulting from direct catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 3.1 and 3.2.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on prey availability for BSAI and GOA herring is insignificant under FMP 3.1 and FMP 3.2 because groundfish fisheries do not target herring prey and current management by ADF&G is responsive to fluctuations in herring biomass, regardless of the cause associated with the change. Thus, if a change in prey availability did occur, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of herring have been identified.

- **Reasonably Foreseeable Future External Effects.** Pacific herring prey primarily on zooplankton which are not affected by state directed herring fisheries or state subsistence fisheries. Thus, these fisheries are not considered contributing factors to changes in prey availability for herring. Future acute and chronic marine pollution could occur, but effects on prey such as zooplankton are unknown. Long-term climate change and regime shifts could have impacts to many species that contribute to the prey structure of Pacific herring. The nature of these impacts depends on the direction of the climatic shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** Potential effects of future natural events, such as marine pollution and climatic shifts, on prey availability for Pacific herring are unknown for FMP 3.1 and FMP 3.2.

<u>Change in Habitat</u>

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on habitat of BSAI and GOA herring is insignificant under FMP 3.1 and FMP 3.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass and spatial/temporal overlap between the fisheries and herring habitat is minimal. However, if the groundfish fisheries were to somehow impact herring habitat, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring. In addition, the herring savings areas reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. The long-term effects of this event to herring habitat are unknown. It is presumed that the effects of the EVOS still exist, and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** No evidence of fishery impact on habitat of herring exists. Thus, fisheries are not considered contributing factors to changes in herring habitat at this time. Future acute and chronic marine pollution could occur and is considered potentially adverse to some herring habitat, especially those that are still recovering from the EVOS in the GOA. Long-term climate change and regime shifts are not expected to significantly change physical habitat of Pacific herring.

- **Cumulative Effects.** Potential impacts of future natural events, such as marine pollution and climatic shifts, in addition to lingering contamination from the EVOS on certain habitat of herring in the GOA exist, but effects are not known for FMP 3.1 and FMP 3.2.

4.7.2.4 Crab

Alaska king, bairdi Tanner crab, and opilio Tanner crab (also called snow crab) fisheries are managed by the State of Alaska, with federal oversight and following guidelines established in the BSAI king and tanner crab FMP (NPFMC 1989). Section 4.5.2.4 contains further information on current stock status and management of crab in Alaska.

For the cumulative effects analysis, crab stocks in BSAI and GOA will be placed in the following groups: bairdi Tanner, opilio Tanner (only BSAI), red king, blue king, and golden king.

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – Crab

Direct and indirect effects for all species of crab in BSAI and GOA include mortality, changes in biomass, reproductive success, prey availability, and habitat. These effects may be attributed to fishing activities (both directed and undirected), but may also be linked to natural events such as long-term climatic change and decadal regime shifts. Significance of these effects is based on the likelihood that population-level changes will result from internal events within the groundfish fishery. An effect that is considered insignificant corresponds to a change that is not likely to result in population-level effects on crab, or that lies within the range of natural variability for the species.

Cumulative Effects Analysis FMP 3.1 and FMP 3.2 – Crab

Summaries of the cumulative effects analysis associated with FMP 3.1 and 3.2 are shown in Table 4.7-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.4 of this Programmatic SEIS.

The foundation of the cumulative effects analysis is the baseline description for each species that includes population status and trends, if known, and the major human and natural influences that have affected the population in the past and that continue up to the present.

For each species, the predicted direct and indirect effects of the groundfish fishery are then analyzed for their contribution to the overall impacts from all sources, including reasonably foreseeable future events resulting from human and natural events external to the fishery. The reasonably foreseeable future events include other U.S. and foreign fisheries, acute and chronic environmental pollution, and natural events such as climatic and oceanographic fluctuations. Cumulative effects are each rated according to the same significance criteria as the direct/indirect effects of the fishery and are based on the potential for population-level effects.

<u>Mortality</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of these crab species do not reflect large deviations from the current baseline condition, even though catch trends do increase and decrease throughout the five-year period. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished.

Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs. Furthermore, additional protection measures could enhance habitat and possible recovery of depressed stocks, but these changes are not expected to significantly affect the crab populations in the BSAI as a whole. The level of crab bycatch predicted for 2003 through 2007 would not be expected to further impede the recovery of these already depressed stocks. Thus, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between state crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures, providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch may persist.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. These fisheries are considered to have a potential adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on the recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the populations is currently considered depressed. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks, and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. It is unclear if additional protection measures and decreased bycatch of crab will mitigate the combined effects of mortality, resulting from direct catch, bycatch, and future external events on depressed stocks. Thus, cumulative effects of FMP 3.1 and FMP 3.2 on BSAI crab stocks cannot be determined at this time.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of golden king crab in BSAI and GOA were combined with those for blue king crab. The BSAI predictions showed increases in catch for FMP 3.1, and decreases in catch for FMP 3.2 over the next five years when compared to current catch rates. Model projections for GOA catch showed decreases in catch for both FMPs compared to current catch in this region. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status. Thus, effects of FMP 3.1 and FMP 3.2 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects.** Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch may persist (see the previous discussion of persistent past effects on crab).

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA are currently unknown. Thus, the potential effects of these fisheries on mortality are not known. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs. Furthermore, additional protection measures could enhance habitat and possible recovery of depressed stocks. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown. Thus, potential combined effects of mortality, resulting from past events, direct catch, bycatch, and future external events cannot be determined at this time for FMP 3.1 and FMP 3.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of bairdi Tanner, red king, and blue king crab in GOA shows decreases from current catch levels for the next five years. However, significance of these predicted changes in catch on mortality is unknown for bairdi Tanner and blue king crab due to lack of survey information for determining current stock status as a whole. Thus, effects of FMP 3.1 and FMP 3.2 on mortality of GOA bairdi Tanner and blue king crab are unknown. GOA red king crab stocks are considered severely depressed according to ADF&G survey information. It is unclear if possible decreases in crab catch proposed under these FMPs will mitigate driving factors of mortality in these stocks. FMP 3.1 and FMP 3.2 are considered insignificant for mortality effects on GOA red king crab populations due to the lack of recovery that has been observed in these stocks to date.

- **Persistent Past Effects.** Adverse past effects of mortality on GOA crab stocks from directed crab catch and bycatch may persist (see previous discussion of persistent past effects on GOA crab).

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of external fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential combined effects of mortality resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 3.1 and FMP 3.2. It is unclear if additional protection measures and decreased bycatch of crab put forth under these FMPs will mitigate the combined effects of mortality on severely depressed red king crab stocks. Cumulative effects of FMP 3.1 and FMP 3.2 on GOA red king crab cannot be determined at this time.

Change in Biomass

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of these crab species do not reflect large deviations from the current baseline condition, although catch trends do increase and decrease throughout the five-year period. Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs. Furthermore, additional protection measures could enhance habitat and possible recovery of depressed stocks, but these changes are not expected to significantly effect the crab populations in the BSAI as a whole. Thus, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on changes in biomass of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. We infer that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch may persist (see previous discussion of persistent past effects on crab).

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are considered to have a potential adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Potential effects of long-term climate change and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. It is unclear if additional protection measures and decreased bycatch of crab will mitigate the combined effects of mortality and subsequent changes to biomass, resulting from past, present, and future events. Thus, cumulative effects of FMP 3.1 and FMP 3.2 on BSAI crab stocks cannot be determined at this time.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current biomass of golden king crab in BSAI and GOA, potential effects of FMP 3.1 and FMP 3.2 on changes to biomass cannot be determined.

- **Persistent Past Effects.** The potential effects of past fishing mortality on biomass of golden king crab stocks in BSAI and GOA cannot be determined because catch composition is unknown, and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA is unknown, and biomass estimates have not been determined. Thus, the potential effects of these fisheries on biomass are not known. Effects of long-term climate change and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs. Furthermore, additional protection measures could enhance habitat and possible recovery of depressed stocks. However, persistent past effects on these crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status and biomass estimates of golden king crab in BSAI and GOA are unknown. Thus, potential combined effects of changes in biomass resulting from direct catch, bycatch, and potential future events cannot be determined at this time for FMP 3.1 and FMP 3.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, predicted catch of bairdi Tanner, red king, and blue king crab in GOA shows decreases from current baseline for the next five years. However, significance of these predicted changes in catch on mortality is unknown for bairdi Tanner and blue king crab due to lack of survey information for determining current stock status as a whole. Thus, effects of FMP 3.1 and FMP 3.2 on biomass of GOA bairdi Tanner and blue king crab are unknown. GOA red king crab stocks are considered severely depressed according to ADF&G survey information, but it is unclear if possible decreases in crab catch proposed under these FMPs will mitigate driving factors of mortality in these stocks. The effects of FMP 3.1 and FMP 3.2 are considered insignificant to potential changes in biomass for GOA red king crab populations due to the lack of recovery that has been observed in these stocks to date.

- **Persistent Past Effects.** Adverse effects of past fishing mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in GOA may still exist, as recovery of depressed stocks has not occurred.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on biomass of bairdi Tanner and blue king crab stocks cannot be determined. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Effects of long-term climate change and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status and biomass estimates are unknown. Thus, potential combined effects of changes in biomass, resulting from past, present, and future events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 3.1 and FMP 3.2. It is unclear if additional protection measures and decreased bycatch of crab put forth under these FMPs, will mitigate the combined effects of mortality and corresponding changes to biomass for severely depressed red king crab stocks. Therefore, cumulative effects of FMP 3.1 and FMP 3.2 on GOA red king crab cannot be determined at this time.

Change in Reproductive Success

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. Changes in reproductive success within BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causation between spawning-recruitment success and depressed stock status cannot be concluded at this time. Therefore, the potential effects of FMP 3.1 and FMP 3.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** As discussed earlier, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Directed crab fishing seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on the recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. A relationship between spawning-recruitment success and other factors impeding reproductive potential to depressed stock status cannot be drawn at this time Thus, potential effects on reproductive success resulting from past events, direct catch, bycatch, and reasonably foreseeable future external events are unknown for FMP 3.1 and FMP 3.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 3.1 and FMP 3.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on reproductive success are unknown.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA are not known. Potential effects on reproductive success, resulting from past events, bycatch, and reasonably foreseeable future external events are unknown for FMP 3.1 and FMP 3.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in GOA, potential effects of FMP 3.1 and FMP 3.2 on changes to reproductive success cannot be determined. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery, while other GOA stocks are still considered depressed. Red king crab populations in GOA are at historic lows according to ADF&G survey information. Changes in reproductive success within GOA crab populations may be an underlying factor in the depressed nature of these stocks. Therefore, the potential effects of FMP 3.1 and FMP 3.2 on changes to reproductive success cannot be determined for bairdi Tanner and red king crab populations in GOA.

- **Persistent Past Effects.** As discussed earlier, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Crab seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of these stocks. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the GOA may still exist, and some stocks are considered depressed with no signs of recovery to date. Thus, potential effects on reproductive success, resulting from direct catch, bycatch, and reasonably foreseeable future external events are unknown for FMP 3.1 and FMP 3.2.

Change in Prey Availability

Bairdi Tanner, Opilio Tanner, Red King, Blue King, and Golden King Crab in BSAI and GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, only BSAI opilio Tanner crab is included in this analysis.

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and it is unclear if FMP 3.1 and FMP 3.2 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of FMP 3.1 and FMP 3.2 on changes in prey availability cannot be determined.

- **Persistent Past Effects.** Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past fisheries is minimal. Thus, past effects on crab prey structure and availability in BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and these fisheries are not considered contributing factors to changes in prey availability. Rebuilding plans currently in effect in BSAI do not address crab prey structure and availability, and are not considered contributing factors to potential changes in prey availability. Long-term climate change and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the possible effects that these changes may have on crab populations throughout BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined and potential changes to prey structure, resulting from past, present, and future events cannot be determined for all species of crab in BSAI and GOA for FMP 3.1 and FMP 3.2.

Change in Habitat

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed, and in some instances overfished. However, a direct link between changes to habitat and the depressed stock status of these crab species in the BSAI cannot be concluded at this time. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks, but recovery has not been shown. Under these proposed FMPs, it is possible that additional protection measures could enhance recovery of crab habitat, but it is impossible to realize the potential population-level effects that may result. Thus, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on changes in habitat of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of trawling and using other types of fishing gear that interact with bottom habitat. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time and offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Possible habitat-related effects have not been determined. Long-term climate change and regime shifts are not expected to directly effect the physical habitat, and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. Although much of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures or those proposed under these FMPs. Thus, potential effects on crab habitat, resulting from past events, internal bycatch, and reasonably foreseeable future external events, cannot be determined for FMP 3.1 and FMP 3.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout BSAI and GOA. Potential effects of FMP 3.1 and FMP 3.2 to crab habitat are unknown.

- **Persistent Past Effects.** As discussed in the analysis of cumulative effects on mortality of bairdi Tanner, opilio Tanner, red king and blue king crab, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as many of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur. They are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for many of the crab stocks under current management plans, and the depressed nature of some golden king crab stocks in GOA currently. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** Some GOA golden king crab stocks are considered depressed, and past effects may still exist as many of these stocks have not shown signs of recovery to date. Although much of the known habitat areas of BSAI and GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures or those proposed under these FMPs. Thus, potential effects on golden king crab habitat, resulting from past, present, and future events, cannot be determined for FMP 3.1 and FMP 3.2, without first establishing the overall population and essential habitat status of this species.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Red king and bairdi Tanner stocks in the GOA are currently considered depressed, while blue king crab stock status is unknown, but presumed to be depressed based on limited survey data. However, a relationship between changes to habitat and depressed stock status cannot be drawn at this time. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks, but recovery of stocks has not been shown. Under these proposed FMPs, it is possible that additional protection measures could enhance recovery of crab habitat, but it is impossible to realize the potential population-level effects that may result. Thus, the potential effects of FMP 3.1 and FMP 3.2 on changes to bairdi Tanner, red king, and blue king crab habitat in GOA are unknown.

- **Persistent Past Effects.** Past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as some of these stocks have not shown signs of recovery to date (see previous discussions of persistent past effects for GOA crab).

- **Reasonably Foreseeable Future External Effects.** State crab, scallop, and subsistence fisheries continue to occur, and are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for some of these stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist, and stocks are considered depressed with no signs of recovery to date. Although much of the known habitat areas of GOA crab is currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures or those proposed under these FMPs. Thus, potential cumulative effects on GOA bairdi Tanner, red king, and blue king crab habitat resulting from past, present, and future events cannot be determined for FMP 3.1 and FMP 3.2.

4.7.3 Other Species Alternative 3 Analysis

The Other Species category consists of the following species:

- Squid (order *Teuthoidea*).
- Sculpin (family *Cottidae*).
- Shark (*Somniosus pacificus, Squalus acanthias, Lamna ditropis*).
- Skate (genera *Bathyraja and Raja*).
- Octopi (*Ocotopus dofleini,Opistholeutis california,* and *Octopus leioderma*).

An aggregate TAC limits the catch of species in this category. Within the Other Species category, only shark are identified to the species level by fishery observers. Furthermore, the accuracy of catch estimates depends on the level of coverage in each fishery. Observer coverage in the BSAI is estimated at 70-80 percent, whereas the GOA has only approximately 30 percent observer coverage. Coverage can vary for certain target fisheries and vessel sizes (Gaichas 2002) (see Section 3.5.3).

Formal stock assessments for Other Species are not currently conducted in the BSAI and GOA, and biomass estimates for the species included in this category are limited and often unreliable. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact Other Species populations, or whether these impacts might be adverse, beneficial, or neutral. There are numerous direct and indirect effects that may impact the current and future status of individual species within this group and/or this group as a whole. These effects are summarized in the section that follows.

Direct/Indirect Effects FMP 3.1 – Other Species

Direct and indirect effects for Other Species, include mortality, changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups is unknown, because information on stock status is lacking. For many non-target species, the differences in catch between the comparative baseline and FMP 3.1 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 3.1, total catch of BSAI squid and Other Species and GOA Other Species, is predicted to increase by several thousand tons per year, due to the predicted increases in catches of the target species with which Other Species are caught. Most of this increase is predicted in the catch of skate and sculpin in both areas. Catch projections for specific groups within BSAI and GOA Other Species are presented below.

<u>Squid</u>

In the BSAI, squid catch is predicted to increase slightly, and then decrease to just above the current level over the five-year projection, likely following trends in the pollock fishery. Squid catch is predicted to double over the five-year projection period in the GOA, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so doubling may not cause different population impacts than current catch levels.

Sculpin

Catches of BSAI sculpin are predicted to remain very close to currently observed catches. GOA sculpin catch is predicted to increase by 100 mt per year over the projection period.

Shark

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of all of these species are predicted to remain stable throughout the projection period under FMP 3.1. As in the BSAI, shark catches in the GOA are partitioned into Pacific sleeper shark, salmon shark, dogfish, and other shark. While all shark catch in the GOA is predicted to be relatively low, catches of other shark are predicted to increase by an order of magnitude, catches of sleeper shark and salmon shark are predicted to decrease slightly, and catches of dogfish will remain relatively similar to current levels.

Skate

The increased catch of skate in the BSAI may reflect increased catches in both longline fisheries for Pacific cod, and in bottom trawl fisheries for cod and flatfish. In the GOA, skate catch is predicted to increase by about 1,000 mt, which is the same order of magnitude as current catches, and may warrant increased management attention if it actually occurrs.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the Other Species complex. In turn, they would be added to the Target Species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined big and longnose skates in the central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway, and improved data collection is expected under this amendment.

Octopi

Octopus catch in the BSAI is predicted to remain stable at 300 to 400 mt per year. The trace amounts of octopus catch reported in the GOA are predicted to decrease over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects Analysis FMP 3.1

A summary of the cumulative effects analysis associated with FMP 3.1 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Other Species is unknown under FMP 3.1. The current baseline condition is unknown. Species-specific catch information is lacking for this complex since species identification does not occur in the fisheries.

- **Persistent Past Effects.** It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline conditions have not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA Other Species are unknown under FMP 3.1. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the Other Species complex is unknown. It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. This possible overexploitation could have impacts to reproductive success, if sex-ratios of these species are significantly altered, or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline conditions and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the Other Species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the Other Species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species within this complex is unknown and persistent past effects have not been identified. The combined effects of changes to reproductive success on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the Other Species population in BSAI and GOA are unknown under FMP 3.1. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the Other Species complex is unknown. It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex is unknown and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the Other Species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA Other Species is unknown under FMP 3.1. The current baseline condition is unknown. Species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries. Formal stock assessments are not conducted for Other Species, and most biomass estimates for BSAI and GOA Other Species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP:

Other Species and Nonspecified Species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline conditions have not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the Other Species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the Other Species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

<u>Change in Habitat</u>

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA Other Species are unknown under FMP 3.1. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the Other Species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Direct/Indirect Effects FMP 3.2 – Other Species

Direct and indirect effects for Other Species include mortality, changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 3.2 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 3.2, total catch of BSAI squid and Other Species is predicted to decrease by several thousand tons per year, and GOA Other Species is predicted to remain in a similar range to current levels. This is due to bycatch reduction incentives included in rationalization programs under this FMP. Most of this decrease in the BSAI is predicted in the catch of skate and sculpin. Catch projections for specific groups within BSAI and GOA Other Species are presented below.

Squid

In the BSAI, squid catch is predicted to decrease slightly below the current level over the five-year projection, likely following trends in the pollock fishery. GOA squid catch is predicted to remain in the same range as current catches for the first several years of the projection period, followed by a gradual increase, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so this increase may not cause different population impacts than current catch levels.

Sculpin

Catches of BSAI sculpin are predicted to decrease slightly (by 500 mt relative to current catches). GOA sculpin catch is predicted remain at currently observed levels over the projection period.

Shark

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Pacific sleeper shark catch is predicted to decrease slightly relative to current catch, while catches of all other shark species are predicted to remain stable throughout the projection period under FMP 3.2.

Skate

The catch of BSAI skate is predicted to decrease by nearly 2,000 mt to about 15,500 mt within the modeled period. The decreased catch of skate is due primarily to bycatch reduction incentives included in rationalization programs under this FMP. In GOA, skate catch is predicted to remain close to currently observed levels.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the Other Species complex. In turn, they would be added to the Target Species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined big and longnose skates in the central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway, and improved collection of data is expected under this amendment.

Octopi

Octopus catch in the BSAI is predicted to remain stable at 200 to 300 mt per year. The trace amounts of octopus catch reported in the GOA are predicted to decrease over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects Analysis FMP 3.2

A summary of the cumulative effects analysis associated with FMP 3.2 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Other Species is unknown under FMP 3.2. The current baseline condition is unknown and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited, while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline conditions have not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the Other Species complex, life history, and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA Other Species are unknown under FMP 3.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the Other Species complex is unknown. It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the Other Species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the Other Species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex is unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the Other Species population in BSAI and GOA are unknown under FMP 3.2. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the Other Species complex is unknown. It is possible under current Other Species management in the BSAI and GOA that a species or even a species group could be disproportionately exploited, while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. This possible overexploitation could have impacts to the genetic structure of the population if the genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex is unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the Other Species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA Other Species is unknown under FMP 3.2. The current baseline condition is unknown, and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries. Formal stock assessments are not conducted for Other Species, and most biomass estimates for BSAI and GOA Other Species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current Other Species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited, while the overall aggregate Other Species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: Other Species and Nonspecified Species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the Other Species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the Other Species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are therefore, unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA Other Species are unknown under FMP 3.2. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the Other Species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and the state sport halibut fishery continue to take Other Species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the Other Species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species also have diverse habitat preferences. Although persistent past effects potentially impacting habitat, could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on Other Species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

4.7.4 Forage Fish

The BSAI and GOA FMPs were amended in 1998 to establish a forage fish species category to prevent the development of directed fisheries on these ecologically important non-target species. Forage fish are described in more detail in Section 3.5.4.

Direct/Indirect Effects of FMP 3.1 – Forage Fish

<u>Total and Spawning Biomass</u>

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. The incidental catch rates predicted for FMP 3.1 are not expected to affect biomass.

<u>Catch/Fishing Mortality</u>

A directed fishery on forage fish species is prohibited by Amendments 36 and 39 in the BSAI and GOA FMPs. However, forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (> 90 percent most years) of the forage fish bycatch is made up of smelt species (*Osmeridae*) from the pollock fishery. In the BSAI region, model projections for FMP 3.1 indicate incidental catch of forage fish would remain low at a level similar to the current catch (Table H.4-22 in Appendix H). Over the next five years the pollock catch in the GOA is projected to grow rapidly under FMP 3.1 (Table H.4-41 in Appendix H). The increased pollock catch under this FMP is projected to lead to greater incidental catches of forage fish.

Fishing mortality of BSAI and GOA forage fish is unknown at this time. As described above, forage fish bycatch and fishing mortality in the BSAI is predicted to remain relatively small under FMP 3.1. The predicted increase in forage fish bycatch in the GOA would intuitively lead to an increase in fishing mortality. However, since the fishing mortality is currently thought to be very low, there is no evidence that this increase will lead to an adverse affect on the population.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. It is unknown how the spatial or temporal concentration of fishing effort is expected to change under FMP 3.1.

Status Determination

The MSST of forage fish species is unknown at this time, but it is unlikely that management practices under FMP 3.1 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. However, it is assumed that the age and size composition of forage fish would not change under FMP 3.1. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest this would change under FMP 3.1.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the given data it would be extremely difficult to accurately assess the predator-prey impacts of FMP 3.1.

Summary of Effects of FMP 3.1- Forage Fish

Information on forage fish species is very limited. Total biomass, spawning biomass and fishing mortality are not estimated in the model used for this analysis. Therefore, only qualitative assessment of the FMP's on these measures can be described.

A directed fishery for forage fish is prohibited by Amendments 36 and 39 in the BSAI and GOA FMPs. Therefore, the only direct effect of FMP 3.1 is incidental take of forage fish in other fisheries.

The model is able to estimate future bycatch of forage fish by averaging the 1997-2001 bycatch matrix. Model output for forage fish bycatch is closely linked to pollock catch. Smelts make up the vast majority of the forage fish bycatch in the BSAI and GOA. The bulk of the smelt bycatch comes from the pollock fishery. Therefore, the projected level of incidental catch of forage fish is highly correlated with the pollock TAC set for the FMP.

Under FMP 3.1 the bycatch of forage fish in the BSAI remains at a low level similar to the current catch (Table H.4-22 in Appendix H). Under FMP 3.1, the GOA bycatch of forage species is projected to increase considerably in the next five years (Table H.4-41 in Appendix H). Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 3.1 is thought to be a relatively small fraction of the biomass and unlikely to effect the abundance of the stock in the BSAI and GOA.

Indirect effects of FMP 3.1 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 3.1.

Cumulative Effects Analysis of FMP 3.1 – Forage Fish

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 3.1.

- **Persistent Past Effects.** Persistent past effects have not been identified for fishing mortality in the BSAI or GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects.** Potential effects on mortality are indicated due to potential adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts are considered non-contributing factors, since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of forage fish (see Sections 3.5.4 and 3.10). Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish mortality; however, the removal of these species is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.

- **Persistent Past Effects.** Persistent past effects have not been identified for the change in biomass in the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future Effects.** Potential effects on biomass are indicated due to the potential adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts have been identified as having potential beneficial or adverse contributions on the forage fish biomass level. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.4 and 3.10. The Alaska subsistence and personal use fisheries have been identified as a potential adverse contributor to the change in biomass level of BSAI and GOA forage fish. Subsistence and personal use fisheries concentrate mostly on the smelt species; however, it is unlikely that these fisheries would have a population level effect.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 3.1 the effect of the spatial/temporal concentration of catch is unknown.

- **Persistent Past Effects.** Persistent past effects are not identified for the genetic structure of the BSAI and GOA forage fish. Climate changes and regime shifts are identified as influencing the reproductive success of BSAI and GOA forage fish. For example, some *Osmeridae* species have shown a decline in recruitment since the late 1970s, coinciding with increased water temperature.

- **Reasonably Foreseeable Future External Effects.** Potential effects on the reproductive success of forage fish due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has been identified as a potential adverse contribution, since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI and GOA forage fish. The Alaska subsistence and personal use fisheries are identified as having potential adverse contributors to the genetic structure and reproductive success of BSAI and GOA forage species. As stated above, these fisheries mainly target smelt species; however, it is unlikely the removals in these fisheries would be large enough, and taken in a localized manner, such that would jeopardize the capacity of the stocks to maintain current population levels.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect is unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.1, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects.** Persistent past effects are identified for the change in prey availability of the BSAI and GOA forage fish stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted. See Sections 3.5.4 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Potential effects of climate change and regime shifts on the BSAI and GOA forage fish stock can be either beneficial or adverse. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. Marine pollution has been identified as a potential adverse contribution, since acute and/or chronic pollution events could reduce prey availability or prey quality, and thus jeopardize the stocks ability to maintain current population levels. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to the prey availability of BSAI and GOA forage fish. However, the catch/bycatch of these species is expected to be minimal and unlikely to have a population level impact.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability; however, this effect is unknown. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.1, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects.** Persistent past effects identified for BSAI and GOA forage fish include climate changes and regime shifts. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. For more information see Sections 3.5.4 and 3.10.

- **Reasonably Foreseeable Future External Effects.** Potential effects of climate change and regime shifts on the BSAI and GOA forage fish stock can be either beneficial or adverse. Marine pollution has been identified as a potential adverse contribution, since acute and/or chronic pollution events could cause habitat degradation, and may cause changes in spawning or rearing success. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish habitat suitability. For more information on the effects of fishery gear on EFH, see Section 3.6.

- **Cumulative Effects.** A cumulative effect is possible for BSAI and GOA forage fish habitat suitability; however, this effect is unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

Direct/Indirect Effects of FMP 3.2 – Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. The incidental catch rates predicted for FMP 3.2 is not expected to affect biomass.

Catch/Fishing Mortality

A directed fishery on forage species is prohibited by Amendments 36 and 39 in the BSAI and GOA FMPs. However, forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (> 90 percent most years) of the forage fish bycatch is made up of smelt species (*Osmeridae*) from the pollock fishery. In the BSAI region, model projections for FMP 3.2 indicate incidental catch of forage fish would remain low at a level similar to the current catch (Table H.4-22 in Appendix H). Over the next five years the pollock catch in the GOA is projected to grow rapidly under FMP 3.2 (Table H.4-41 in Appendix H). The increased pollock catch under this FMP is projected to lead to greater incidental catches of forage fish.

Fishing mortality of BSAI and GOA forage fish is unknown at this time. As described above, forage fish bycatch and fishing mortality in the BSAI is predicted to remain relatively low under FMP 3.2. The predicted increase in forage fish bycatch in the GOA would intuitively lead to an increase in fishing mortality. However, since the fishing mortality is currently thought to be very low, there is no evidence that this increase will lead to an adverse affect on the population.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. It is unknown how the spatial or temporal concentration of fishing effort is expected to change under FMP 3.2.

Status Determination

The MSST of forage fish species is unknown at this time, but it is highly unlikely that management practices under FMP 3.2 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. However, it is assumed that the age and size composition of forage fish would not change under FMP 3.2. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest this would change under FMP 3.2.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the given data it would be extremely difficult to accurately assess the predator-prey impacts of FMP 3.2.

Summary of Effects of FMP 3.2 – Forage Fish

Information on forage fish species is very limited. Total biomass, spawning biomass and fishing mortality are not estimated in the model used for this analysis. Therefore, only qualitative assessment of the FMPs on these measures can be described.

A directed fishery for forage fish is prohibited by Amendments 36 and 39 in the BSAI and GOA FMPs. Therefore, the only direct effect of FMP 3.2 is incidental take of forage fish in other fisheries.

The model is able to estimate future bycatch of forage fish by averaging the 1997-2001 bycatch matrix. Model output for forage fish bycatch is closely linked to pollock catch. Smelts make up the vast majority of the forage fish bycatch in the BSAI and GOA. The bulk of the smelt bycatch comes from the pollock fishery.

Therefore, the projected level of incidental catch of forage fish is highly correlated with the pollock TAC set for the FMP.

Under FMP 3.2, the bycatch of forage fish in the BSAI remains at a low level similar to the current catch (Table H.4-22 in Appendix H). Under FMP 3.2, the GOA bycatch of forage species is projected to increase considerably in the next five years (Table H.4-41 in Appendix H). Although the total biomass of forage fish is unknown, the amount of incidental catch predicted for FMP 3.2 is thought to be a relatively small fraction of the biomass and unlikely to effect the abundance of the stock in the BSAI and GOA.

Indirect effects of FMP 3.2 include habitat disturbance and disproportionate removals of predators or prey. There is insufficient information to address the indirect effects of FMP 3.2.

Cumulative Effects Analysis of FMP 3.2 – Forage Fish

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 3.2.
- **Persistent Past Effects.** Persistent past effects have not been identified for fishing mortality in the BSAI and GOA forage fish stock.
- **Reasonably Foreseeable Future External Effects.** Potential effects on mortality are the same as those indicated under FMP 3.1.
- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.
- **Persistent Past Effects.** Persistent past effects have not been identified for the change in biomass in the BSAI and GOA forage fish stock.
- **Reasonably Foreseeable Future External Effects.** Potential effects on biomass are the same as those indicated under FMP 3.1.
- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 3.2, the effect of the spatial/temporal concentration of catch is unknown.
- **Persistent Past Effects.** Persistent past effects identified for the change in genetic structure and reproductive success of the BSAI and GOA forage fish are the same as those indicated under FMP 3.1.
- **Reasonably Foreseeable Future External Effects.** Potential effects on the reproductive success and genetic structure of forage fish are the same as those described under FMP 3.1.
- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect is unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.2, the change in prey availability for the BSAI and GOA forage fish is unknown.
- **Persistent Past Effects.** Persistent past effects identified for the change in prey availability are the same as those indicated under FMP 3.1.
- **Reasonably Foreseeable Future External Effects.** Potential effects on prey availability are the same as those indicated under FMP 3.1.
- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 3.2, the change in habitat suitability for the BSAI and GOA forage fish is unknown.
- **Persistent Past Effects.** Persistent past effects identified for the change in habitat suitability are the same as those indicated under FMP 3.1.
- **Reasonably Foreseeable Future External Effects.** Potential effects on habitat suitability are the same as those indicated under FMP 3.1.
- **Cumulative Effects.** A cumulative effect is possible for BSAI and GOA forage fish habitat suitability; however, this effect is unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

4.7.5 Non-Specified Species Alternative 3 Analysis

Grenadiers have been chosen to illustrate potential effects to non-specified species because they are currently the major catch in the non-specified FMP category. Non-specified species make up a large and diverse category, encompassing every species not listed in the current FMP as a target, prohibited, forage, or other species. Considering a single species group from this category such as grenadier, cannot possibly represent the diverse effects to all species in the category. However, because information is lacking for nearly all of these groups, and they are caught in small or unknown amounts (due to a lack of reporting requirements in this category), we discuss only potential effects to grenadier.

Formal stock assessments are not conducted for grenadier. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. Changes in bycatch of grenadiers were predicted based on modeled changes in target species catches and population trajectories (sablefish target fisheries have the most grenadier bycatch). While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact grenadier populations, or whether these impacts might be adverse, beneficial, or neutral.

Direct/Indirect Effects FMP 3.1 – Non-Specified Species

Direct and indirect effects for grenadier include mortality, changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking. For many non-target species, the differences in catch between the comparative baseline and FMP 3.1 are relatively small, such that diverse alternatives may have similar (though unknown) effects on each stock.

Under FMP 3.1, catch of grenadiers in both the BSAI and GOA is predicted to remain within or slightly above the currently observed range. In both areas, grenadier catch is predicted to increase slightly initially and then decrease following trends in the sablefish fishery.

Cumulative Effects Analysis PMP 3.2 - Non-Specified Species

A summary of the cumulative effects analysis associated with FMP 3.1 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis, see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 3.1. The current baseline condition is unknown, and catch information is lacking for all members of the non-specified category, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier, and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion of the non-target species bycatch in the GOA, and mortality is therefore considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** For grenadier and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on grenadier and other species with the non-specified complex, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier, and presumably all other species within the non-specified complex, are unknown under FMP 3.1. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of grenadier and other non-specified species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadier and all other members of the non-specified category will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadier and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex is unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on grenadier and other non-specified species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier, and other species within the non-specified complex, populations in BSAI and GOA are unknown under FMP 3.1. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to the genetic structure of the population if the genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality, and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For grenadier and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex is unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.1.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadier is unknown under FMP 3.1. The current baseline condition is unknown for all members of the non-specified complex, and species-specific catch information is lacking, since species identification does not occur in the fisheries. Formal stock assessments are not conducted, and biomass estimates in the BSAI and GOA for grenadier, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. The current non-management of grenadier could mask declines in individual grenadier species, and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline conditions have not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadier and all other members of the non-specified group depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadier, and all other species in the non-specified group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.1.

Direct/Indirect Effects FMP 3.2 – Non-Specified Species

Direct and indirect effects for grenadier include mortality, changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 3.2 are relatively small, such that diverse alternatives may have similar (unknown) effects on each stock.

Under FMP 3.2, catch of grenadier in both the BSAI and GOA is predicted to decrease relative to the currently observed catch. In the BSAI, grenadier catch is predicted to be cut to one sixth of currently observed levels. In the GOA, catch is predicted to decrease to approximately 8,000 mt per year. This projected decrease is due primarily to bycatch reduction incentives included in the rationalization programs under this FMP.

Cumulative Effects Analysis 3.1 - Non-Specified Species

A summary of the cumulative effects analysis associated with FMP 3.2 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis, see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 3.2. The current baseline condition is unknown, and catch information is lacking for all members of the non-specified category, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA and mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** For grenadier and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on grenadier and other species with the non-specified complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.2.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier and all other species within the non-specified complex are unknown under FMP 3.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier, and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of grenadier and other non-specified species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadier and all other members of the non-specified category will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadier and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex is unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on grenadier and other non-specified species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier and other species within the non-specified complex populations in BSAI and GOA are unknown under FMP 3.2. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to the genetic structure of the population if the genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For grenadier and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex is unknown and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are therefore, unknown for FMP 3.2.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadier is unknown under FMP 3.2. The current baseline condition is unknown for all members of the non-specified complex, and species-specific catch information is lacking, since species identification does not occur in the fisheries. Formal stock assessments are not conducted, and biomass estimates in the BSAI and GOA for grenadier, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. The current non-management of grenadier could mask declines in individual grenadier species and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadier and all other members of the non-specified group depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadier, and all other species in the non-specified group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for FMP 3.2.

4.7.6 Habitat Alternative 3 Analysis

This policy accelerates existing precautionary management measures through community or rights-based management, ecosystem-based management principles, and, where appropriate and practicable, increases habitat protection and imposes additional bycatch constraints. Under this approach, additional conservation and management measures would be taken as necessary to respond to social, economic or conservation needs, or if scientific evidence indicated that the fishery was adversely impacting the environment. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management.

Direct/Indirect Effects FMP 3.1 – Habitat

FMP 3.1 illustrates a management approach that accelerates precautionary management measures by increasing constraints where necessary, formalizing precautionary practices in the FMPs, and initiating scientific review of existing practices as a necessary precursor to the decision of how best to incorporate adequate precaution. There are no additional bottom trawl closures relative to the baseline, and there will be minor decreases in fishing effort. Figure 4.2-4 (bookend first appears in a previous section) illustrates the current suite of year-round closures in the BSAI and GOA management areas. Thus impacts to habitat under FMP 3.1 should be similar to FMP 1 and FMP 2.2.

Direct and indirect effects of the FMP on habitat are discussed through changes to living habitat through direct mortality of benthic organisms, changes to benthic community structure through benthic community diversity, and geographic diversity of impacts and protection. Due to their habitat type differences, the Bering Sea, Aleutian Islands, and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

In the GOA, the multi-species model results indicate that the catch of most living habitats will decline under FMP 3.1 (Table 4.5-48). In the BSAI, the bycatch levels are all within about + or - 20 percent of the baseline. We believe that the model projections for the GOA are unrealistically low relative to the baseline. The model framework artificially constrained specific fisheries, such as rockfish, that historically have had a high bycatch rate of living substrates (Jim Ianelli, AFSC, personal communication). Based on past performance it is doubtful that such constraints will severely curtail the rockfish fishery. Therefore, a more realistic prediction is that bycatch levels would be about the same as the baseline.

The habitat impacts model predicts the following effects for FMP 3.1 on biostructure relative to the baseline:

- **Bering Sea.** There is no predictable difference from the baseline where mean impacts are low when averaged over entire fishable EEZ. As with the baseline, impacts to biostructure ranged from 1.8 to 9.3 percent of the fishable EEZ, and from 8.2 to 41.9 percent of the fished area. A large expanse (8,000 square miles) of high fishing intensity potentially causes a 83 percent reduction in equilibrium biostructure level for Scenario 2 (i.e., 15 year recovery rate). Based on these results, there would be an insignificant change to mortality and damage to living habitat as a result of FMP 3.1. The rating is based on the insignificant change between FMP 3.1 projections and the comparative baseline.

- **Aleutian Islands.** There is no predictable difference from baseline. Therefore, the change resulting from FMP 3.1 on the baseline is insignificant. However, prevalence of long-lived species of coral in the bycatch is a particular concern in the Aleutian Islands under FMP 3.1. With a recovery rate for red tree coral possibly as low as $\rho = 0.005$ (200 years) and sensitivity $q_h = .27$, the habitat impact model indicates that fishing intensity as low as $f = .10$ (total area swept once every ten years) results in an equilibrium level reduction of 85 percent relative to the unfished level. About nine percent of the area is estimated to be fished at $f = 0.10$ or greater. This amounts to 3,590 square miles of area. Thus, continued bycatch and damage to living habitat at FMP 3.1 bycatch levels may have adverse consequences on habitat quality, and FMP 3.1 would not change this risk.

- **GOA.** There is no predictable difference from baseline where estimates of equilibrium impact on biostructure averaged over entire fishable EEZ, range 0.9 to 6.9 percent of the fishable area, and 3.8 percent to 29.0 percent of the fished areas. Only two percent of the fishable EEZ is impacted to a level potentially below 32 percent (Scenario 2) of unfished levels, but amounts to about 2,418 square miles of habitat in scattered concentrations. Therefore, for FMP 3.1, this change to mortality and damage to living habitat is insignificant.

Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection

- **Bering Sea.** Identical to the baseline and FMP 1, FMP 3.1 closures in the Bering Sea are mostly concentrated on sand substrate (Table 4.5-47). Only 27 percent of the geographical-habitat zones have ≥ 20 percent of their area closed to bottom trawling. Figure 4.1-10 shows that the amount of large contiguous areas of high fishing intensity, areas that are swept at least once each year with bottom trawls, exceeds 8,000 square miles (Table 4.1-26). Table 4.5-49 shows that of the Bering Sea fishable area, 19.3 percent is closed to bottom trawling under FMP 3.1. However, very little geographic diversity of fishing impacts occurs within the closed habitats, and nearly all of the closures are not year-round. Figure 4.5-4 shows areas closed to trawling only at various times of the year under this FMP, while Figure 4.5-5 depicts just those areas closed to fixed gear only.

  Application of the habitat impacts model indicated that, depending on the sensitivity and recovery parameters thought plausible, fishing of this intensity could reduce the amount of biostructure in the area by 13 to 75 percent of its unfished equilibrium level (Table 4.5-49). Such biostructure includes sponges, soft corals, tunicates, and anemones (Heifetz *et al.* 2002, Malecha *et al.* 2003). In these habitat areas, there are no existing closure areas that abut these intensely fished areas to provide a diverse level of impact. While existing closures tend to be large and cover all of the particular habitat, they provide little diversity in fishing impacts. The primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear, and they do not necessarily cross a wide range of habitat types. Some of the trawl closures are in effect year-round while others are seasonal (see Section 3.6). However, compared to the existing baseline, the predicted effects of FMP 3.1 on benthic community diversity is insignificant. Similarly, the predicted effects of FMP 3.1 on geographic diversity of impacts is predicted to be insignificant.

- **Aleutian Islands.** Identical to the baseline and FMP 1, FMP 3.1 closures in the Aleutian Islands are concentrated in shallow water where four percent of the area is closed to bottom trawling year round for all species. However, as shown on Table 4.5-49, about 43 percent of the fishable area in the Aleutians is closed to bottom trawling at one time or another during the year under this FMP. These closures are associated with sea lion rookeries. As in the baseline, there is very little diversity in protection. Less than one percent of the deep area is closed to bottom trawling. Figure 4.1-10 shows that none of the closure areas extend over any blocks of significant fishing effort. Figures 4.5-4 and 4.5-5 show the closure areas under FMP 3.1 broken down by gear type, bottom trawl and fixed gear, respectively. The Aleutian Islands bathymetry and habitat is distributed on a very fine scale, with fishing effort that is very patchy and in very small clusters. Based on these observations as compared to the baseline, the predicted effects of FMP 3.1 on benthic community diversity and geographic diversity of impacts are insignificant.

- **GOA.** Figure 4.5-6 shows that, as in the baseline, minimal geographic diversity of impact or protection results from the current suite of closed areas. Except for the southeast trawl closure which covers the entirety of several habitats, all other closures are inshore; none exist on the outer shelf or slope (see Figure 4.5-6). As shown on Table 4.5-49 and Figures 4.5-4 and 4.5-5, FMP 3.1 closes nearly 46 percent of the fishable area in the GOA to trawling at one time or another during the year. The inshore closure areas tend to be large relative to the size of bathymetric and habitat resolution scale, and thus tend to encompass much of a bathymetric feature. Based on these results, the predicted effects of FMP 3.1 on benthic community diversity and geographic diversity of impacts is insignificant.

Cumulative Effects on Bering Sea

Cumulative effects on habitat for FMP 3.1 are summarized on Table 4.5-50. The following discussion of the results presented on the table is broken down by geographic area.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Mortality of long lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing as described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution, all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts which include mortality due to smothering and/or reduced oxygen are expected to be more prevalent in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use are possible at several locations in the Bering Sea area including Port Moller, Port Heiden, Dillingham, St. Paul, and St. George. The impacts include mortality due to smothering and/or burying, and would affect nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Areas more likely to be impacted would be located nearer to shore. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Bering Sea benthic organisms. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effects for FMP 3.1 are rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue, and add to the adverse cumulative effects on benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing as described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution all have the potential to cause changes to benthic communities. Long-term (i.e., change to a weather pattern) wind induced waves and surges could also cause sufficient changes to the substrate, impacting that the benthic community. As discussed above, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with ENSO and La Nina events have been identified as having impacts on both the physical and biological systems in the North Pacific. These changes could have either beneficial or adverse effects on the benthic community (see Sections 3.6 and 3.10).

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Bering Sea. The additional external impacts described above will add to the lingering past mortality impacts, and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 3.1 are rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue, and add to the adverse cumulative effects to benthic living habitat.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected, since fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 illustrate the spatial measures that were in effect before 1980, or were later established by regulations following the publication of the Final Groundfish SEIS in November of 1980. As discussed in Section 3.6, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most of the restricted areas were implemented to spatially and temporally restrict the foreign fishery to prevent conflicts with domestic fisheries through bycatch of species important to U.S. fishermen, or grounds preemption and gear conflicts. Most domestic fishing efforts focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that back in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. This again was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980, almost nine percent of the fishable area in the Bering Sea was closed to trawling with 2.2 percent closed to all fishing. There were no longline only closures in the Bering Sea at that time.

- **Reasonably Foreseeable Future External Effects** include port expansion and the potential resultant changes to offal discharge and marine pollution episodes. As ports in the Bering Sea are expanded and new ports created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, the opening of new ports may allow vessels of all sizes to access new or relatively unfished areas. On the other hand, depending on distribution, fishing pressure in heavily fished areas may be eased as access to other areas becomes available. Closed areas proposed to continue under this FMP would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 3.1 would protect more benthic habitat from trawl gear in the future (19 percent) than was protected in 1980 (8.6 percent). However, the spatial distribution of the closed areas under FMP3.1 will not protect the full range of habitat types, or provide for a diversity of impacts within fished areas. Existing closures tend to be large and cover all of particular habitat. They provide little diversity in fishing impacts, since the primary focus of past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear (see internal effects discussion and baseline description in Section 3.6). The additional external impacts do not provide any protection, and could add to the lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 3.1 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain, since previously unfished areas would likely be fished, and impacts would occur in areas not previously impacted.

Cumulative Effects on Aleutian Islands

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral make impacts a particular concern in the Aleutians. Mortality of long lived species such as tree corals and other sessile epifauna, is likely to be persistent in these areas. The areas historically and recently closed to fishing as described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Dredging due to scallop fisheries and/or navigation can occur in localized areas (often in conjunction with port development), and can cause burial or smothering of benthic fauna. Damage to living substrates by longline and pot fisheries (see Section 3.6) has been documented, and is expected to continue in those heavily fished areas. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts which include mortality due to smothering and/or reduced oxygen are expected to be more prevalent in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use are possible at several locations in the Aleutian Islands including Atkutan, Adak, Unalaska, Cold Bay, Dutch Harbor, and King Cove. The impacts include mortality due to smothering, and/or burying, and would only affect nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Aleutian Islands benthic organisms. Long-lived species such as tree coral are more prevalent in the Aleutian Islands. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Even though the direct/indirect effects of FMP 3.1 are rated as insignificant, bycatch and damage to living habitat in the Aleutians will continue, and will add to the adverse cumulative consequences to benthic living habitat.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutians. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing as described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline, and pot fisheries, offal discharge, port expansion and use, and marine pollution, all have the potential to cause changes to benthic communities. Long-term (i.e., a change to a weather pattern) wind induced waves and surges could cause sufficient changes to the substrate, impacting the benthic community. As discussed above for mortality, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with ENSO and La Nina events have been identified as having impacts on both the physical and biological systems in the North Pacific (see Sections 3.6 and 3.10). These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Aleutians. The additional external impacts described above will add to the lingering past mortality impacts, and contribute to impacts that are already evident. Thus, even though direct/indirect effects of FMP 3.1 are rated insignificant, continued bycatch and damage to living habitat will add to the adverse effects on the benthic community.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. As discussed above for the Bering Sea, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing efforts focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries, in order to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980, about 31 percent of the fishable area in the Aleutians was closed to trawling, with about six percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time.

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and the potential resultant changes to offal discharge, and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted, or allowed to recover. As with the Bering Sea, ports in the Aleutians will be expanded and new ports created, and additional dock space for harboring the fishing fleet will be made available. While the fleet might not necessarily expand, the distribution of fishing effort is likely to change, and previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 3.1 would protect more benthic habitat from trawl gear in the future (43 percent) than was protected in 1980 (31 percent). However, the spatial distribution of the closed areas under the current FMPs may not protect the full range of habitat types.

Cumulative Effects on GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As described for the Bering Sea and Aleutian Islands, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Port expansion and increased use are possible at several locations in the GOA including Kodiak, Sand Point, Chignik, Port Lions, Ouzinkie, Valdez, and Seward. Impacts include mortality due to smothering and/or burying, and would likely only affect nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of GOA benthic organisms. The additional external impacts described above will add to the lingering past mortality impacts, and contribute to impacts that are already evident. Even though the direct/indirect effects of FMP 3.1 are rated as insignificant, continued bycatch and damage to living habitat in the GOA will add to the long-term and potentially irreversible adverse cumulative effects of fishing on the mortality of benthic organisms.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6, may be recovered or recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to GOA benthic communities. As discussed above, these changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the GOA. The additional external impacts described above will add to the lingering past impacts, and contribute to impacts that are already evident. Thus, even though the direct/indirect effects of FMP 3.1 are rated as insignificant, bycatch and damage to living habitat will continue in the GOA, and will add to the adverse cumulative effects of fishing.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects are judged to result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remain closed. During the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring, and there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. Figures 3.6-6 and 3.6-7, and Table 4.5-51 show that in 1980 about five percent of the fishable area in the GOA was closed to trawling, with about seven percent closed to all fishing. The largest closures in the GOA concerned longline fishing, where almost 61 percent of the fishable area was closed to longlining. In 1980, about 73 percent of the fishable area in the GOA was closed to some type of fishing throughout the year.

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and the potential resultant changes to offal discharge, and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted, or allowed to recover. As ports in the GOA are expanded and new ports created, additional dock space for harboring the fishing fleet is made available, and changes in the distribution of fishing effort would result. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 3.1 would protect more benthic habitat from trawl gear in the future (46 percent) than was protected in 1980 (16 percent). However, the spatial distribution of the closed areas under the FMP 3.1 may not protect the full range of habitat types. In 1980, more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under FMP 3.1 (<1 percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. The additional external impacts described above will add to the lingering impacts and contribute to impacts that are already evident.

Direct/Indirect Effects on FMP 3.2 – Habitat

One objective of FMP 3.2 is to implement new changes to existing precautionary measures on a more rapid time line. This FMP contains a composite of several different concepts for habitat protection and mitigation. Figure 4.2-5 (bookend) illustrates the suite of year-round closures in the BSAI and GOA management areas. In future years, this composite may not reflect what actually is done. Actions that are actually implemented in future years, may reflect only a part of this composite of strategies. These conceptual strategies are:

- Close specific areas of the GOA upper slope to bottom trawling that possess sensitive hard bottom habitats impacted by the rockfish fishery.

- Incorporate a band-approach where closures would be oriented perpendicular to depth contours from near shore to deep water, assuring protection of a diversity of habitat types across a range geographic areas.

- Develop a special conservation area in the Aleutian Islands to protect sensitive cold water coral communities.

- Rotate closures in the Bering Sea to mitigate for impacts.

In the following analysis, we examine qualitatively the relative merits of these conceptual approaches.

- **Slope Rockfish Closures.** These conceptual closures illustrate how the effects of fishing on habitat can be mitigated by reducing the impacts caused by a particular fishery. This strategy is currently being developed for the GOA slope rockfish fishery by the NPFMC EFH committee. The GOA closure scheme selected by the EFH committee was based on a preliminary run of the habitat impacts model. Further research may identify other fisheries and areas that would be better candidates for habitat mitigation. The exact location used in the analysis does not correspond to those areas being studied by the NPFMC and NOAA Fisheries in the EFH SEIS. Independent of the habitat impacts model, it is worth noting that GOA rockfish fisheries are responsible for a considerable portion of the bycatch of living substrates, especially coral and sponges (Table 4.1-8).

  The NPFMC and NOAA Fisheries should carefully consider the location of closures, so that unintended consequences do not occur. Displacement of effort to new areas with more sensitive habitat may be an unintended consequence of closures. If closures are placed primarily in areas with high fish densities, and effort shifts into areas of low densities, then increased effort and potentially more habitat impacts may occur overall. For this reason, the NRC (2002) suggests that for closures to be most effective, they should be combined with some effort controls. FMP 3.2 does illustrate a scenario of reduced TACs, and the use of fishery cooperatives combined with no-take reserves and MPAs. It is important to point out that closures alone, if they are strategically placed within historically fished areas, can provide benefits to habitat without necessarily requiring a reduction in TACs. The benefits to habitat can be enhanced by having areas selected for closure to be located within historically fished areas. This patchiness promotes habitat diversity (Duplisea *et al.* 2002).

- **Rotational Closures.** Rotational closures have been suggested as a strategy to protect seafloor habitat, while not permanently closing an area to fishing. Conceptually, rotational closures are not that much different from the concept of rotating crops. The theory is that by allowing some areas (fields) to go to seed and recover to a more natural state, benefits accrue to both habitat and food production objectives. However, rotational closures are not appropriate for highly structured seafloor habitats with long-lived species. Rotational closures need to be tied to recovery times of living habitats, and may be a viable alternative in sandy energetic habitats inhabited by short-lived animals. Specific knowledge of recovery times is required because if the rotation schedule is less than the recovery time, then all areas may be maintained in a disturbed state with little benefits to habitat or yield. For example, during a temporary trawl closure in the North Sea, fishing effort was displaced outside the closed area, and then returned when the area was re-opened several years later (Rijnsdorp *et al.* 2001). The net result was a more homogeneous distribution of fishing effort and habitat disturbance than in years prior to the closure. From a habitat perspective, it is preferable to keep fishing effort patchy (Duplisea *et al.* 2002) because repeated tows of the same area cause a diminishing mortality of benthic species, while some areas remain unfished. Thus, permanently closed areas are preferred over temporary, or rotating closures (Collie *et al.* in review).

- **Aleutian Island Special Management Area.** The Aleutian Islands potentially harbor the highest diversity and abundance of cold water corals and sponges in the world (Heifetz *et al.* 2002). A recent expedition to the Aleutian Islands explored coral and sponge habitat in the Aleutian Island near the Andreanof Islands and on Petrel Bank (NPFMC 2002b). Dive observations confirmed that coral and sponges are widely distributed in that region. Corals and sponges were found at 30 of 31 submersible dive sites. Probable anthropogenic disturbance to epifauna was observed at most dive sites, and may have been more evident in heavily fished areas. Coverage of corals ranged from approximately five percent on low-relief pebble substrate, to 100 percent coverage on high-relief bedrock outcrops. Unique coral habitat consisting of high density gardens of corals, sponges, and other sessile invertebrates was found at five sites between 150 and 350 m depth. These gardens were similar in structural complexity to tropical coral reefs, and shared several important characteristics with tropical reefs including complex vertical relief and high taxonomic diversity. The uniqueness and fragility of this habitat points to the need for the design of a special management regime that protects this habitat while still allowing fishing. Strategically placed closures in areas of sensitive habitat would protect this habitat as long as the displaced fishing effort does not occur to new areas with equally or more sensitive habitat. Unfortunately, there exists little information on the locations of these fragile habitats throughout the Aleutian Islands. Locating and mapping these areas is a priority for research. In the interim, one precautionary measure would be to restrict fishing to those areas that are known to have little or no sensitive habitat.

- **Band-Approach.** Incorporation of a band-approach, where closures are oriented perpendicular to depth contours from near shore to deep water, would assure protection of diversity of habitat types across a range of geographic areas. This concept has appeal in situations where little is known about benthic habitat types and locations. Ideally, these closures would be placed to ensure that a diversity of habitat types are protected. However, lacking good scientific information on distribution of habitat types, alternatives would be to randomly place the closures, or systematically place the closures at equal distances from one another. In theory, this strategy should promote habitat diversity and protect a wide range habitat types from the effects of fishing. Mitigation and diversity of impacts can occur if closures incorporate fished and unfished areas. One adverse aspect of random placement is that closures could have serious social and economic consequences. Determining where to apply this broad approach should include consultation with the fishing industry and nearby communities.

Direct and Indirect Effects FMP 3.2

Direct and indirect effects of the FMP on habitat are discussed through changes to living habitat through direct mortality of benthic organisms, changes to benthic community structure through benthic community diversity, and geographic diversity of impacts and protection. Due to their habitat type differences, the Bering Sea, Aleutian Islands, and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

In the GOA, the multi-species model results indicate that the bycatch of living habitat is projected to decline substantially under FMP 3.2. A decline in the bycatch of living substrates is realistic because FMP 3.2 has reduced TAC levels for some target species, especially rockfish. These reduced TACs should result in less fishing effort. Further effort controls would result from increased use of fishery and community-based cooperatives. While designed to address overcapacity and allocation issues, an indirect benefit of these programs appears to be reduced bycatch.

If the magnitude of such declines is actually realized, there could be beneficial impacts on living substrates, possibly resulting in increased abundance of some species of living substrates over baseline levels. Such abundance increases for short-lived biota with fast recovery rates may occur relatively quickly. For other species of living substrates, such as long-lived corals and perhaps some sponges that have been permanently eradicated from some areas, increases over baseline levels may not occur, or occur very slowly.

Conceptual deductions from the habitat impacts model yield the following inferences:

- **Bering Sea.** Based on the location of the FMP 3.2 closures relative to the distribution of fishing intensity shown in (Figure 4.7-1), the change relative to the baseline in total impact to biostructure would likely be insignificant relative to the baseline. However, there are some reductions in TAC which may result in some reduction in impacts. Most of the closure areas are located in sand habitat, with moderate amounts of closure in sand/mud habitat, and almost no closures in mud habitat. The closed areas are located in areas that have been lightly fished, compared to large areas of heavy fishing that are left open. Whether mean impact increases or decreases depends on relative density of target species and habitat in the open and closed areas, and the respective impact/recovery parameters (q, qh, and) in the open and closed areas. There is little information to indicate that habitat density and parameters would differ between the open and closed areas. One would expect target species density to be lower in areas of low fishing intensity and higher in the areas of high fishing intensity. If closed areas are of lower historical fishing density, benefits to habitat are likely minimal. If target species density is higher in the closed areas, benefits to habitat from the closure would increase.

- **Aleutian Islands.** A decrease in mean equilibrium impact could occur due to the specific closures depicted by the FMP 3.2 bookend. Closures where fishing occurs seem to bisect the cluster of historical fishing patterns, leaving the adjacent area open (Figure 4.7-1). Some reductions in TAC may result in less habitat impacts. Based on these results, there would be a significantly beneficial change to mortality and damage to living habitat as a result of FMP 3.2.

- **GOA.** The mean impact will increase in the GOA, as many of the closed areas are centered on high effort areas, which would be expected to have higher target fishery species densities (Figure 4.7-2). This results in an increased effort to catch fish in lower density open areas. This effort will result in enough of an increase in habitat impacts to negate impact reduction in the closed areas. It is not clear whether decreased TACs for some species will offset this increase in habitat impacts. Based on these results, under certain conditions, there could be significantly adverse changes to mortality and damage to living habitat as a result of FMP 3.2. The internal effect is rated as conditionally significant adverse.

Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection

- **Bering Sea.** Closures are fairly well distributed among geographical habitat types. Some improvement in geographic diversity would be achieved. While large expanses of high fishing intensity still remain open in this FMP, there is at least one closure area that covers a portion of high fishing intensity, as shown in Figure 4.7-1. This provides some improvement in the geographic diversity of impacts. An overall improvement to geographic diversity of impacts could be realized with smaller closure areas, with several covering a small fraction of the heavily fished areas. Some of the closures for this FMP are located in light fishing effort areas, and may provide some low level of contrast and diversity. Table 4.5-49 shows that of the Bering Sea fishable area, nearly 33 percent is closed to bottom contact at some point during the year under FMP 3.2. Figure 4.7-3 shows areas closed to trawling at various times of the year under this FMP, while Figure 4.7-4 depicts only those areas closed to fixed gear. Based on these results, the predicted effects of FMP 3.2 on benthic community diversity is conditionally significant beneficial. The predicted effects of FMP 3.2 bookend on geographic diversity of impacts is also significant beneficial.

- **Aleutian Islands.** Closures illustrated in FMP 3.2 bookend are well distributed among geographical habitat types. Improvement in geographic diversity of impacts would occur under this FMP scenario. As shown on Table 4.5-49, about 80 percent of the fishable area in the Aleutians is closed to bottom contact at some point during the year under this FMP. These closures are well distributed over a range of geographical-habitat zones. Figures 4.7-3 and 4.7-4 show the closure areas under FMP 3.2 by gear type, bottom trawl, and fixed gear. While the closure areas are especially large compared to the resolution of the bathymetry and fishing distribution and encompass different habitat types at a time, it may well be that a similar mix of habitat types occur adjacent to the closure areas. Figure 4.7-1 shows that several closed areas happen to bisect apparent historic clusters of fishing patterns, thus providing a contrast in impact for the habitat being fished. Based on these results, the predicted effects of FMP 3.2 on benthic community diversity is conditionally significant beneficial. The predicted effects of FMP 3.2 bookend on geographic diversity of impacts is significant beneficial.

- **GOA.** Closures illustrated by the FMP 3.2 bookend are well distributed among geographical habitat types. Slight improvement in geographic diversity of impact would result from this FMP. As shown in Table 4.5-49, and Figures 4.7-3 and 4.7-4, FMP 3.2 closes over 72 percent of the fishable area in the GOA to bottom contact at some point during the year. The closure areas are large in relation to the GOA spatial habitat or bathymetric resolution, and tend to encompass much of a bathymetric feature. Figure 4.7-2 shows that closures often encompass clusters of historically high fishing intensity, leaving little diversity or contrast of fishing intensity within a bathymetric feature or habitat type. An overall improvement to geographic diversity of impacts could have been realized, with smaller closure areas strategically placed to include only portions of entire habitat types or clusters of fishing intensity. For example, the closure areas on the upper slope should include some portion of areas where high fishing intensity has occurred, but do not need to be as large in size as illustrated in this FMP 3.2 scenario. Based on these results, the predicted effects of FMP 3.2 bookend on benthic community diversity and geographic diversity of impacts is found to be insignificant relative to the baseline.

Cumulative Effects FMP 3.2 on Bering Sea

A summary of cumulative effects for habitat in FMP 3.2 are summarized on Table 4.7-3. The following discussion of the results presented in the table is presented by geographic area.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. These effects include persistent mortality of long lived species such as tree corals and other sessile epifauna. See the cumulative effects discussion for FMP 3.1 for additional details.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat. See the FMP 3.1 cumulative effects discussion for the Bering Sea.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Bering Sea benthic organisms. There is little information to indicate that habitat density and parameters would differ between the open and closed areas, and the baseline condition is considered to be adversely impacted. Although some benefits accrue within proposed MPAs, impacts from fishing are not totally eliminated, and TAC/effort is likely to remain high. While there is an incremental expansion of no-take MPAs, the closures analyzed under this FMP are not refined, and may not be effective. It is unclear where future closures may be located, or whether they would be no-take reserves, or a form of gear-specific/species-specific MPA. Due to this uncertainty, along with the already impacted baseline, and with the addition of the external impacts on mortality, the cumulative effect of FMP 3.2 on mortality is conditionally significant adverse.

  However, if the closures proposed under FMP 3.2 were to be further defined based on additional information regarding important habitats in need of protection, and were properly designed and located to protect the sensitive habitats, future closures could provide successful mitigation of the effects of fishing. Overtime, valued habitat that has been adversely affected by fishing could recover. Under these conditions, cumulative effects may have more of a conditionally significant beneficial rating rather than conditionally significant adverse.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, these effects result in a conditionally significant beneficial change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Bering Sea. See the cumulative effects write-up for FMP 3.1 for additional information.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities as described for FMP 3.1. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Bering Sea. FMP 3.2 provides some improvement in the geographic diversity of impacts. However, some of the closures for this FMP are located where light levels of fishing occur, and may provide some low level of contrast and diversity. As described above for mortality, while benefits accrue due to the MPAs, the closed areas are not refined and may not be effective in protecting benthic community structure. For these reasons, along with the already impacted state of the benthic communities and the external adverse impacts, FMP 3.2 is rated as conditionally significant adverse.

  However, as described above for mortality, if the closures proposed under FMP 3.2 were to be further defined and designed to protect important habitats, mitigation of fishing-related impacts could occur, and cumulative effects may have more of a conditionally significant beneficial rating than a conditionally significant adverse.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects result in a significantly beneficial change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution has changed over time as areas have been closed and remained closed. Figures 3.6-6 and 3.6-7, and Table 4.5-51 show that in 1980, almost nine percent of the fishable area in the Bering Sea was closed to trawling, with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time. The cumulative effects section for FMP 3.1 provides additional discussion regarding these past effects.

- **Reasonably Foreseeable Future External Effects** include port expansion and the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes (see the discussion for FMP 3.1). Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in the distribution of fishing effort. The maps and statistics discussed above show that FMP 3.2 would protect more benthic habitat from trawl gear in the future (33 percent), than was protected in 1980 (8.6 percent). Closure areas under FMP 3.2 cover a portion of high fishing intensity, providing improvement in the geographic diversity of impacts. However, TAC is likely to remain high, and the locations of the proposed MPAs are not refined. The benefits provided by the closed areas are uncertain, because previously unfished areas would likely be fished, and impacts would occur in areas not previously impacted. The additional external effects, in combination with the past and predicted internal effects, are judged to be conditionally significant adverse. However, as described above for mortality and community diversity, better definition and focus of the closures could lead to a conditionally significant beneficial rating.

Cumulative Effects on Aleutian Islands

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long lived species of coral make impacts a particular concern in the Aleutians. Mortality of long lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see the FMP 3.1 cumulative effects discussion).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1 (cumulative effects in the Aleutians) dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Aleutian Islands benthic organisms. As described above for the Bering Sea, the baseline condition is already considered to be adversely effected. The proposed no-take MPAs will allow some benefits to accrue, but impacts will still occur, especially if the TAC remains high. The overall cumulative effect would be significantly adverse under certain conditions.

  However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, these effects result in a significantly beneficial change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutians. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see the FMP 3.1 cumulative effects discussion).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Aleutians. As described above for mortality of benthic organisms, the existing impacted baseline, combined with the uncertain benefits of the proposed MPAs, leads to a significantly adverse cumulative effects. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a cumulative effects rating of conditionally significant beneficial.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects result in a significantly beneficial change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected, because fishing effort and distribution has changed over time as areas have been closed and remained closed. Figures 3.6-6 and 3.6-7, and Table 4.5-51 show that in 1980, about 31 percent of the fishable area in the Aleutians was closed to trawling, with about six percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time (see the FMP 3.1 cumulative effects discussion).

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case (see FMP 3.1).

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 3.2 would protect more benthic habitat from trawl gear in the future (80 percent) than was protected in 1980 (31 percent). Closures illustrated in FMP 3.2 bookend are well distributed among geographical habitat types; improvement in geographic diversity of impacts would occur under this FMP scenario. Because TAC is likely to remain high, and the locations of the proposed MPAs are not refined. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished, and impacts would occur in areas not previously impacted. The additional external effects, in combination with the past and predicted internal effects, are judged to be conditionally significant adverse. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

Cumulative Effects on GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, these effects are considered conditionally significant adverse, since there would be much higher effort to catch fish in lower density open areas. It is not clear whether decreased TACs for some species will offset an increase in habitat impacts. Under certain conditions, there could be significantly adverse impacts on mortality of benthic organisms.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see the cumulative effects discussion for FMP 3.1 in the GOA).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of GOA benthic organisms. The external effects identified above have the potential to provide additional mortality to benthic organisms. However, as described for the Bering Sea, focusing and refinement of the closure areas could lead to a conditionally significant beneficial effect.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, these effects result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see the FMP 3.1 cumulative effects section for the GOA).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 3.1 in the GOA, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the GOA. As described above for both the Bering Sea and Aleutian Islands, while the FMP provides for additional closure area and no-take MPAs, impacts are not totally eliminated, and proposed MPAs might not be effective. The combination of internal and external impacts on benthic communities creates a conditionally significant adverse cumulative effect. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, these effects result in an insignificant change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected because fishing effort and distribution has changed over time as areas have been closed and remained closed. Figures 3.6-6 and 3.6-7, and Table 4.5-51 show that in 1980, about five percent of the fishable area in the GOA was closed to trawling, with about seven percent closed to all fishing. The largest closures in the GOA concerned longline fishing, where almost 61 percent of the fishable area was closed to longlining. In 1980, about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at some point during the year (see FMP 3.1 for additional discussion).

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion, and the potential resultant changes to distribution of fishing effort (see FMP 3.1 cumulative effects discussion for details). Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that FMP 3.2 would protect much more benthic habitat from trawl gear in the future (72 percent), than was protected in 1980 (16 percent). Closures illustrated by the FMP 3.2 bookend are well distributed among geographical habitat types. However, slight improvements in geographic diversity of impacts would result, and as described above for the Bering Sea and Aleutian Islands, the proposed MPAs might not be effective. Further refinement of the proposed MPAs may lead to a conditionally significant beneficial cumulative effects rating.

4.7.7 Seabirds Alternative 3 Analysis

4.7.7.1 Short-Tailed Albatross

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

<u>Incidental Take</u>

FMP 3.1 would adopt the new seabird protection measures for longline vessels that are based on the joint recommendations of NOAA Fisheries, USFWS, and the Washington Sea Grant Program and are currently undergoing agency and public review before being enacted (68 FR 6386). As described in Section 4.5.7.1, these new regulations are expected to substantially reduce the chances of taking short-tailed albatross on longlines. Since the measurable frequency of that mortality already approaches zero, and the population appears to be growing at a rate close to the theoretical maximum for the species, the reduced level of mortality under the new regulations is considered to be insignificant at the population level for the species. NOAA Fisheries and USFWS are currently researching the risk of short-tailed albatross incidental take due to collisions with trawl third wires. FMP 3.1 would incorporate any mitigation measures that arise from this research if it is considered necessary to protect the species. For these reasons, FMP 3.1 is considered to have insignificant effects on short-tailed albatross through incidental take in the fishery.

Seabird protection measures under FMP 3.2 would continue to be improved by scientifically based innovations in fishing techniques. The overall goal of the policy would be to reduce the incidental take of all seabird species, with special emphasis on ESA-listed species. The recent collaborative effort between NOAA Fisheries, USFWS, Washington Sea Grant Program, and the longline industry (Melvin *et al.* 2001) would likely be used as a model for the development of additional seabird protection measures. Since FMP 3.2 would seek to reduce take for all seabird species and some species are taken more often in trawls than on longlines, new mitigation measures aimed at reducing take in trawl gear or from collisions with third wires would be investigated. The potential reduction in the chances of taking short-tailed albatross in all fishing operations would certainly receive high priority in the research. It is likely that the overall chance of taking short-tailed albatross under FMP 3.2 would be much less than under the baseline conditions, which already approach zero. FMP 3.2 would therefore be considered to have an insignificant effect on short-tailed albatross through incidental take.

Changes in Food Availability

Short-tailed albatross forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 3.1 or FMP 3.2. Both FMPs are considered to have insignificant effects on short-tailed albatross through availability of food.

Benthic Habitat

Short-tailed albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 3.1 or FMP 3.2. Both FMPs are considered to have no effects on short-tailed albatross through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on short-tailed albatross are described in Section 3.7.4 (Table 3.7-12) and the predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for this species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.1 (Table 4.5-52) and are summarized below.

Mortality

- **Direct/Indirect Effects.** Under both FMP bookends, new seabird protection measures on the longline fleet (Section 3.7.1) and possibly the trawl fleet should substantially reduce the chances of taking short-tailed albatross incidentally in the groundfish fishery, although the risk would not be eliminated. Incidental take of short-tailed albatross is predicted to be a very rare event in the groundfish fishery and is considered insignificant at the population level.

- **Persistent Past Effects.** The most important persistent influence on the short-tailed albatross population is their near extinction due to commercial feather hunting. Conservation efforts have allowed the population to recover at or near to its biologically maximum rate. The total fishery-related mortality of short-tailed albatross is unknown, but it does not appear to be having an overriding effect on the population growth rate.

- **Reasonably Foreseeable Future External Effects.** The short-tailed albatross population may be substantially affected by several natural and human-caused mortality factors that may or may not occur in the future, including volcanic eruptions on their main breeding site, Torishima Island, and increased rates of incidental take in fisheries throughout their range. If the species experiences a substantial increase in mortality that threatens its recovery, it may lead to further efforts to protect the species from fishery interactions.

- **Cumulative Effects.** Since the population of short-tailed albatross is susceptible to several natural and human-caused mortality factors that may or may not occur in the future, including incidental take in the groundfish fisheries under FMP 3.1, the cumulative effect on short-tailed albatross is considered to be conditionally significant adverse at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under both FMP bookends. This effect is considered insignificant at the population level for short-tailed albatross.

- **Persistent Past Effects.** Short-tailed albatross primarily prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to natural fluctuations in primary productivity and oceanographic factors. Pollution from a variety of land and marine sources have potentially affected short-tailed albatross prey in the past, but specific toxicological effects are unknown.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on short-tailed albatross prey availability. Pollution is likely to affect short-tailed albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to short-tailed albatross, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of short-tailed albatross prey is considered to be insignificant at the population level.

Benthic Habitat

Since short-tailed albatross feed at the surface, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for short-tailed albatross.

4.7.7.2 Laysan Albatross and Black-Footed Albatross

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

The new seabird protection measures for longline vessels under FMP bookends 3.1 and FMP 3.2 would be expected to result in a substantial reduction of incidental take of Laysan and black-footed albatross relative to the baseline condition (Melvin *et al.* 2001). NOAA Fisheries is currently in the process of finalizing the new seabird deterrent regulations for the longline fleet. However, most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season. Incidental take data from the 2002 season should give some indication of the potential effectiveness of the new regulations in reducing take of albatross. Incidental take data are reported in the annual SAFE, Ecosystems Considerations Report. Data from the 2002 season will be available in the 2003 SAFE (see Comment Analysis Report [Appendix G] for updated statistics and analysis).

The incidental take of albatross in trawl gear and third wire collisions would receive attention under FMP 3.1 and even more attention under FMP 3.2. New trawl fleet regulations based on scientifically effective mitigation techniques would reduce incidental take of albatross to levels well below the baseline condition, which are already considered to be insignificant at the population level. Since the baseline level of incidental take for both albatross species is considered insignificant at their respective population levels (Section 4.5.7.2), the overall effect of FMP 3.1 and FMP 3.2 on the incidental take of these albatross species is considered insignificant.

Changes in Food Availability

Albatross forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 3.1 or FMP 3.2. Both FMP bookends are considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 3.1 or FMP 3.2. Both FMP bookends are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on these albatross species are described in Sections 3.7.2 and 3.7.3 (Tables 3.7-6 and 3.7-7), and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.5-53) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP3.2, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be installed. These measures are expected to reduce incidental take of both albatross species. Incidental take is considered insignificant at the population level for both species in this group.

- **Persistent Past Effects.** For black-footed and Laysan albatross, past mortality factors include large contributions from foreign longline fisheries and Hawaiian pelagic longline fisheries, a smaller contribution from the BSAI/GOA longline fisheries, and an unknown contribution from other longline fisheries (IPHC), trawl fisheries, and vessel collisions throughout their range. Both species have been experiencing population declines over the past decade. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown for both albatross species.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets and are expected to reduce take of albatross in those fisheries. It is expected that incidental take of black-footed and Laysan albatross in foreign longline fisheries will remain high and will continue to exceed the threshold for population level effects.

- **Cumulative Effects.** Since the populations of black-footed and Laysan albatross are undergoing measurable declines, and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries under FMP 3.1 and FMP 3.2, the cumulative effects on black-footed and Laysan albatross are considered to be significantly adverse at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under FMP 3.1 and FMP 3.2. This effect is considered insignificant at the population level for both albatross species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on albatross prey populations can not be assessed at this time.

- **Persistent Past Effects.** Albatross primarily prey on squid species and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Pollution from a variety of land and marine sources have potentially affected albatross prey in the past. However, very little is known about the specific toxicological effects on species important to albatross or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on albatross prey availability. Pollution is likely to affect albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to albatross, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of albatross prey is considered to be insignificant at the population level for all species.

Benthic Habitat

Since albatross feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.7.7.3 Shearwaters

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

The new seabird protection measures for longline vessels under FMP 3.1 and FMP 3.2 would not be expected to result in a reduction of incidental take of shearwaters, which would remain approximately at the baseline level (about 600 birds per year, Tables 3.7-2 and 3.7-3), since the new deterrence techniques are not effective for these species (Melvin *et al.* 2001). Additional research into weighted ground lines may prove effective for deterring diving birds and may lead to additional seabird protection measures in the future, especially under FMP 3.2. The incidental take of shearwaters in trawl gear and third wire collisions could receive attention under FMP 3.1 and even more attention under FMP 3.2. Potential future trawl fleet regulations based on scientifically effective mitigation techniques would likely be based on their capacity to avoid mortality of albatross but may prove effective for shearwaters as well. Since the baseline level of incidental take for these species is considered insignificant at their respective population levels (Section 4.5.7.3), the overall effect of FMP 3.1 and FMP 3.2 on the incidental take of shearwater species is considered insignificant.

Changes in Food Availability

Shearwaters forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 3.1 or FMP 3.2. Both FMP bookends are considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Shearwaters are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 3.1 or FMP 3.2. Both FMP bookends are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on these shearwater species are described in Section 3.7.6 (Tables 3.7-14), and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.5-54). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.3 (Table 4.5-54) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be installed, but are not expected to reduce incidental take of the shearwater species. Incidental take is considered insignificant at the population level for both shearwater species.

- **Persistent Past Effects.** For sooty and short-tailed shearwaters, mortality factors include large contributions from subsistence and commercial harvest of chicks on the nesting grounds, as well as climatic and oceanic fluctuations that cause periodic mass starvation, substantial contributions from foreign, Hawaiian, and BSAI/GOA groundfish longline and trawl fisheries, and a smaller contribution from vessel collisions throughout their range. It is difficult to assess the population trends in these abundant and widespread species, but there are some indications that both species may be declining. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown for these species.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets that are similar to those proposed for the Alaskan fisheries. These measures are not expected to reduce incidental take of shearwaters in those fisheries. It is expected that incidental take of shearwaters in foreign fisheries will likely continue as in the past, unless longline and trawl deterrence techniques are developed and applied that are effective for diving species.

- **Cumulative Effects.** Populations of shearwaters may be undergoing declines and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries. The cumulative effects on sooty and short-tailed shearwaters are considered to be conditionally significant adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid as bycatch under FMP 3.1 and FMP 3.2. This effect is considered insignificant at the population level for both shearwater species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on shearwater prey populations can not be assessed at this time.

- **Persistent Past Effects.** Short-tailed and sooty shearwaters are susceptible to periodic widespread food shortages that have caused massive die-offs in Alaskan waters. Natural fluctuations in primary productivity and oceanographic factors are considered to be the driving forces that determine the abundance of their main prey (euphausiids) rather than competitive interactions with other predators. Since shearwaters can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources have potentially affected shearwater prey in the past. However, very little is known about the specific toxicological effects on species important to these seabirds, or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on shearwater prey availability. Pollution is likely to affect shearwater prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to shearwaters, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of shearwater prey is considered to be insignificant at the population level for both species.

Benthic Habitat

Since shearwaters feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.7.7.4 Northern Fulmar

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

Northern fulmars constitute the majority of birds taken incidentally in all sectors of the groundfish fisheries (Section 4.5.7.3), and they would likely benefit the most from improved seabird protection measures in both the longline and trawl fleets. Because most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season, incidental take data from the 2002 season should give some indication of the potential effectiveness of the new regulations in reducing take of fulmars. Incidental take data are reported in the annual SAFE, Ecosystems Considerations Report. Data from the 2002 season will be available in the 2003 SAFE (NPFMC 2003b) (see Comment Analysis Report [Appendix G] for updated statistics and analysis). Since the baseline level of incidental take is already considered insignificant at the population level, the substantially reduced levels of take expected under FMP 3.1 and FMP 3.2 would be considered insignificant at the population level. These reductions in take would greatly reduce concerns about potential colony level effects, although the Biological Research Division (BRD) of the USGS would likely continue to investigate the issue. The overall effect of FMP 3.1 and FMP 3.2 on fulmars is therefore considered to be insignificant through incidental take.

Changes in Food Availability

Fulmars forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 3.1 and FMP 3.2. Both FMP bookends are considered to have insignificant effects on fulmars through availability of food.

Benthic Habitat

Fulmars are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 3.1 and FMP 3.2. Both FMP bookends are considered to have no effects on fulmars through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on northern fulmars are described in Section 3.7.5 (Table 3.7-13), and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-55 and summarized below.

Mortality

- **Direct/Indirect Effects.** Under these FMP bookends, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be installed, and additional measures for the trawl fleet would be investigated. These measures are expected to reduce incidental take of fulmars substantially below the baseline level of incidental take, which is considered insignificant at the population level.

- **Persistent Past Effects.** For northern fulmars, past mortality factors include large contributions from the BSAI/GOA groundfish fisheries and other net and longline fisheries in the North Pacific and Bering Sea. There is no indication of an area-wide population decline, but there is some concern that particular colonies may be experiencing declines related to the groundfish fisheries. Other potential mortality factors that have been identified include acute and chronic effects of pollution, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation) due to climatic and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Incidental take of fulmars is expected to continue in all offshore fisheries in the BSAI/GOA. The IPHC fisheries will be subject to new seabird avoidance measures, so incidental take from the halibut and sablefish fleet is expected to decline substantially. Future oil spills and other pollution incidents are likely but their effects on fulmars will depend on many factors that can not be predicted.

- **Cumulative Effects.** The population of northern fulmars appears to be stable and the primary human-caused mortality factors, including contributions from the groundfish fisheries under FMP 3.1 and FMP 3.2, are expected to decline in the future. The cumulative effects on fulmars are considered to be insignificant at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch under FMP 3.1 and FMP 3.2. This effect is considered insignificant at the population level for northern fulmars. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on fulmar prey populations can not be assessed at this time.

- **Persistent Past Effects.** Fulmars prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since fulmars can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources have potentially affected fulmar prey in the past. However, very little is known about the specific toxicological effects on species important to fulmars or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on fulmar prey availability. Pollution is likely to affect fulmar prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey to fulmars, can not be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of fulmar prey is considered to be insignificant at the population level.

Benthic Habitat

Since fulmars feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernible effect on their prey. Therefore, no cumulative effect is identified for these species.

4.7.7.5 Species of Management Concern (Red-Legged Kittiwakes, Marbled and Kittlitz's Murrelets)

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

The implementation of the new seabird avoidance measures under FMP 3.1 and FMP 3.2 would reduce the chances of taking surface-feeding species such as red-legged kittiwakes. This would likely have little effect on red-legged kittiwakes, since incidental take in the longline fisheries approaches zero under the baseline conditions. The effect of FMP 3.1 and FMP 3.2 on incidental take of red-legged kittiwakes is considered insignificant at the population level.

The incidental take of murrelets is expected to be similar to the baseline, which approaches zero. Given their nearshore preferences and less gregarious behavior, it is unlikely that murrelets would be taken regularly in any of the BSAI/GOA groundfish fisheries under FMP 3.1 or FMP 3.2. The effect of incidental take of murrelets is considered insignificant at the population level.

Changes in Food Availability

The ban on directed fisheries on forage fish would remain in place under FMP 3.1 and FMP 3.2. Given the wide variety of foods used by red-legged kittiwakes and the extensive areas over which they forage, it seems unlikely that they would be susceptible to localized depletion of prey during the non-breeding season. During the breeding season, kittiwakes are more limited in their options and are more susceptible to localized depletions of prey around their colonies. However, the species and size classes of forage fish and zooplankton that red-legged kittiwakes consume are taken only in negligible amounts by the groundfish fisheries and their abundance and distribution are not expected to be affected on an ecosystem level by the groundfish harvest under FMP 3.1 or FMP 3.2 (see Forage Fish and Ecosystem Sections 4.7.4 and 4.7.10). The groundfish fisheries have very little spatial overlap with murrelet foraging areas and, as described above for kittiwakes, are expected to have insignificant effects on the abundance and distribution of their prey species. The overall effect of FMP 3.1 and FMP 3.2 on the availability of food for these species is considered insignificant on the population level.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of groundfish fishery management. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles. However, benthic habitats in their nearshore foraging areas would not be affected directly by groundfish trawls under FMP 3.1 or FMP 3.2 as these take place further offshore. Both FMP bookends are considered to have insignificant effects on murrelet species through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on red-legged kittiwakes, marbled murrelets, and Kittlitz's murrelets are described in Sections 3.7.13 and 3.7.17 (Tables 3.7-22 and 3.7-26), and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.4 (Table 4.5-56) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be implemented. The incidental take of red-legged kittiwakes and both murrelets is expected to be very rare and insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging (red-legged kittiwakes), incidental take in coastal salmon gillnet and other net fisheries (murrelets), oil spills (murrelets), and logging of nest trees (marbled murrelets). Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed very little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. For red-legged kittiwakes, the introduction of nest predators or a large oil spill around the Pribilof Islands in nesting season could have significant effects on mortality. For the murrelet species, oil spills in nearshore habitats and incidental take in salmon and other net fisheries are likely to remain the largest factors in the future. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may contribute to future mortality. If the Kittlitz's murrelet population continues to decline and the species is listed under the ESA, new regulations may be placed on the various nearshore net fisheries to monitor and reduce incidental take of the species. These measures would also benefit marbled murrelets.

- **Cumulative Effects.** The three species in this group have all experienced substantial population declines in the recent past and are all susceptible to future human-caused mortality factors, including potentially small contributions from the groundfish fishery. The decline of red-legged kittiwakes on the Pribilofs may have been reversed recently, but it is not clear if their recovery will continue in the future. The cumulative effect for red-legged kittiwake is considered conditionally significant adverse at the population level. Both murrelet species continue to decline in their core areas and are considered to have significantly adverse cumulative effects at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all three species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All three species prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources, including the EVOS, have likely affected the prey of these species in the past. Since murrelets are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded murrelets from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is also likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** While the groundfish fisheries are considered to have an insignificant effect on prey availability on their own, the dynamic interaction of natural and human-caused events, including fisheries and pollution, on the availability of forage fish and invertebrate prey to seabirds is only beginning to be explored with directed research. Since this dynamic could conceivably be adverse or beneficial, depending on different circumstances, the cumulative effect on prey availability is considered to be unknown for these three species.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles, but they forage in shallow waters that are inshore of the groundfish fishery. Since the groundfish fishery would contribute minimally to potential effects on benthic habitats important to murrelets, insignificant cumulative effects are identified for the murrelet species.

4.7.7.6 Other Piscivorous Species (Most Alcids, Gulls, and Cormorants)

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

The new seabird protection measures for the longline fleet would be expected to result in a substantial overall reduction in take of surface-feeding species such as gulls. While this is a substantial management and fishery action and is considered an improvement relative to the baseline level of mortality, the baseline level of incidental take on longlines is already considered insignificant at the population level for gulls and alcids (Section 4.5.7.5). Incidental take in trawls would be expected to remain the same or be reduced, as a result of new scientifically based mitigation measures, relative to baseline conditions, which are considered insignificant on the population level for all piscivorous species. For these reasons, FMP 3.1 and FMP 3.2 are considered to have insignificant effects on piscivorous species through incidental take.

Changes in Food Availability

As described in Section 4.5.7.5, the potential effects of the groundfish fishery on piscivore prey availability are considered to be insignificant under the baseline conditions. The contribution of the fishery to the food supply of gulls in the form of fishery discards would be about the same as the baseline. Since the structure and intensity of the fishery would be very similar under FMP 3.1 and reduced under FMP 3.2, the overall effect of the fishery on the availability of food for piscivorous species is considered insignificant on the population level.

Benthic Habitat

Specific effects of trawling on seabird prey species in the BSAI/GOA (through habitat change rather than by direct take) are poorly known. However, none of the species in this group appear to have experienced consistent or widespread population declines, so there is no indication that the carrying capacity of the environment has been decreased through changes to benthic habitat (or any other mechanism). Overall trawl effort in the BSAI/GOA relative to the baseline conditions is predicted to be similar under FMP 3.1 and reduced under FMP 3.2. The effects on piscivorous seabirds through potential changes in benthic habitat are therefore considered insignificant at the population level.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on the species in this group, including most alcids, gulls, and cormorants, are described in the species accounts of Section 3.7 (Tables 3.7-16 and 3.7-20) and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-57 and summarized below.

Mortality

- **Direct/Indirect Effects.** Incidental take of surface-feeding piscivores (i.e. gulls) is expected to decrease due to new seabird protection measures for the longline fleet. Incidental take of diving species may also be reduced if new mitigation measures are developed and implemented for the trawl fleet. The incidental take all species in this group is expected to be insignificant at the population level under FMP 3.1 and FMP 3.2.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging, incidental take in a variety of foreign and U.S. coastal and pelagic fisheries, oil spills and other pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future, except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. Conservation concerns focus on preventing potential impacts around breeding colonies during the nesting season, since populations are concentrated in time and space. For some species, human impacts in nearshore habitats will likely have a much greater effect on their populations than offshore fisheries. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are considered insignificant at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All species in this group prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources have likely affected the prey of these species in the past. Since some of the alcids are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded them from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is likely to affect prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute to the dynamic interaction of natural and human-caused events that affect the availability of forage fish and invertebrate prey to seabirds. While this dynamic is only beginning to be explored with directed research, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under FMP 3.1 or FMP 3.2, the cumulative effect on prey availability is considered insignificant at the population level for these species.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, have the potential to modify benthic habitats and have indirect effects on the food web of diving piscivorous species. The overall effects on piscivorous seabirds through potential changes in benthic habitat are considered insignificant.

- **Persistent Past Effects.** Benthic habitats important to the diving species in this group have been affected by various foreign and U.S. fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated, so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to seabirds. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may have persistent effects in certain areas.

- **Reasonably Foreseeable Future External Effects.** All future fisheries in the BSAI/GOA that use bottom contact fishing gear are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will continue.

- **Cumulative Effects.** The groundfish fisheries contribute to the many human-caused and natural factors that alter benthic habitats important to the food web of piscivorous seabirds. While there has been limited research on specific effects of benthic habitat disturbance on seabirds, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under FMP 3.1 or FMP 3.2, the cumulative effect on benthic habitat is considered insignificant at the population level for these species.

4.7.7.7 Other Planktivorous Species (Storm-Petrels and Most Auklets)

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

Longline and trawl effort would be similar or less than baseline conditions, and new seabird avoidance measures would be expected to reduce incidental take from both longlines and trawls. The incidental take of storm-petrels and planktivorous auklets in the groundfish fisheries, through take in fishing gear and vessel strikes, is considered to be insignificant at the population level under the baseline conditions (Section 4.5.7.6). The reduced levels of take would be considered insignificant to their populations. The effects of FMP 3.1 and FMP 3.2 on incidental take of planktivorous species are considered to be insignificant at the population level.

Changes in Food Availability

As described in Section 4.5.7.6, the potential of the groundfish fishery to affect the abundance and distribution of planktonic prey through changes in predator/prey relationships is considered to be minor compared to the effects of primary productivity and oceanic fluctuations. The effect of the groundfish harvest on planktonic prey is considered insignificant to the populations of planktivorous species under the baseline conditions. Since the structure and intensity of the fishery would be similar or reduced relative to the baseline, the effect of FMP 3.1 and FMP 3.2 on prey availability for planktivores is considered insignificant on the population level.

Benthic Habitat

Storm-petrel and auklets are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of groundfish management. FMP 3.1 and FMP 3.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on the species in this group, including storm-petrels and most auklets, are described in Sections 3.7.7 and 3.7.18 (Tables 3.7-15 and 3.7-27), and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-58 and summarized below.

Mortality

- **Direct/Indirect Effects.** Incidental take of the species in this group is expected to decrease under FMP 3.1 and FMP 3.2 due to new seabird protection measures and is expected to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in foreign and U.S. coastal and pelagic fisheries, oil spills and other marine pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future, except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are considered insignificant at the population level.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch. Indirect effects on zooplankton and juvenile fish abundance through changes in the abundance of target fish predators is considered minor compared to seasonal changes in primary productivity and oceanographic factors. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazzards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** Factors that have affected the abundance and distribution of zooplankton and juvenile fish include bycatch in squid and forage fish fisheries, marine pollution, and the decimation of planktivorous whales by commercial whaling. These effects are considered minor compared to seasonal and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have minimal effects on prey availability for these species. Pollution is also likely to affect prey in the future, but specific predictions on the nature and scope of the effects, especially as it relates to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute in an indirect way to human influences on planktonic prey availability, which are considered minimal compared to natural fluctuations. These cumulative effects are considered insignificant at the population level for all species in this group.

Benthic Habitat

Since these planktivorous seabirds feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for these species.

4.7.7.8 Spectacled Eiders and Steller's Eiders

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Incidental Take

Under FMP 3.1 and FMP 3.2, NOAA Fisheries would cooperate with USFWS to develop scientifically-based fishing methods that reduce incidental take of all threatened or endangered species. As described in Section 4.5.7.7, incidental take of spectacled and Steller's eider already approaches zero under the baseline conditions, so it is unlikely that new protection measures would be implemented on their behalf. Because there is no predicted overlap between the groundfish fisheries and spectacled eiders, no effect on mortality has been identified under FMP 3.1. Although there is potential for expansion of the groundfish fisheries into spectacled eider critical habitat under FMP 3.2, there would likely be minimal temporal overlap of the fishery with the presence of eiders. Therefore, the risk of incidental take would be considered insignificant. Based on the very minimal overlap between the predicted fisheries and Steller's eider habitat, which only includes the Kuskokwim Shoals area, incidental take under FMP 3.1 and FMP 3.2 will likely remain at levels approaching zero and is therefore considered to have insignificant effects on the populations of Steller's eiders through incidental take.

Changes in Food Availability

Because there is no predicted overlap between the groundfish fisheries and spectacled eiders critical habitat, no effect has been identified for food availability of spectacled eiders under FMP 3.1. Although there is a potential for expansion of the fishery into spectacled eider critical habitat under FMP 3.2, bycatch of eider prey would be negligible and considered insignificant to spectacled eiders at the population level. Since there would be very little overlap between groundfish fisheries and critical habitat for Steller's eiders under FMP 3.1 or FMP 3.2, the effects of the groundfish fisheries on prey abundance and availability are considered insignificant at the population level.

Benthic Habitat

As discussed in Section 4.5.7.7, there is no overlap between the groundfish trawl fisheries and spectacled eider habitat. FMP 3.1 is not expected to change this situation and is considered to have no effects on spectacled eiders through benthic habitat changes.

For Steller's eiders, potential trawl effort in their critical habitat is limited to Kuskokwim Shoals. No changes in management under FMP 3.1 would lead to an increase in trawl use of this area. Therefore, potential effects are likely to remain similar to the baseline condition and are considered insignificant. The overall effect of FMP 3.1 on the benthic habitat of Steller's eider is considered to be insignificant at the population level.

Under FMP 3.2, two management programs designed to conserve fish populations may actually lead to increased fishing in some eider habitats. First, the establishment of Marine Protected Areas and no-fishing zones in many areas that were fished under the baseline conditions would force the groundfish fleet to look for new areas to fish. Second, complete rationalization of the fishery would tend to give fishermen more time and opportunity to explore for new fishing grounds. It is not known whether the fishery would have the economic incentive to start fishing more heavily in the Steller's eider critical habitat in Kuskokwim Bay or to expand northward to spectacled eider critical habitat north of St. Matthew Island. It is also not known whether disturbance of benthic habitat by fishing gear in these areas would have enough impact on benthic invertebrate populations to decrease eider foraging success. Although FMP 3.2 creates conditions under which these areas may be affected by benthic habitat disturbance, the level and type of disturbance needed to create population level effects on eiders is unknown. The effects of FMP 3.2 on the benthic habitat of spectacled and Steller's eider is considered unknown.

Cumulative Effects of FMP 3.1 and FMP 3.2

The past/present effects on spectacled and Steller's eiders are described in Sections 3.7.9 and 3.7.10 (Tables 3.7-17 and 3.7-18), and the predicted direct and indirect effects of the groundfish fishery are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-59 and summarized below.

<u>Mortality</u>

- **Direct/Indirect Effects.** Incidental take of eiders is expected to be similar to the baseline condition and is considered to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include sport hunting and subsistence harvest in Russia and Alaska, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution that causes physiological stress and reduces survival rates, lead shot poisoning on the nesting grounds, and collisions with vessels and other structures. Incidental take in the BSAI/GOA groundfish fisheries appears to have been very rare for Steller's eider. Both species have been afforded protection through the ESA.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. Conservation concerns focus on preventing potential impacts in critical habitat areas.

- **Cumulative Effects.** The groundfish fisheries do not contribute to direct mortality of spectacled eiders, so no cumulative effect is identified for that species. Decreased adult survival rates appear to have driven the past population decline of Steller's eiders. Known sources of direct human-caused mortality of Steller's eider, including very rare incidental take in the groundfish fisheries, do not appear to account for the past population decline in Alaska. However, several indirect factors may be contributing to decreased adult survival rates, including climate-induced changes in habitat, concentration of predators around nesting areas due to nearby human habitation, and pollution of nearshore waters from chronic and periodic sources of petroleum products (USFWS 2003a). Since the Alaska breeding population of Steller's eiders has declined dramatically in the past and has not recovered, and because several human-induced sources of mortality have been identified as potential contributing factors to this decline, including the potential for contributions to pollution and vessel collisions from the groundfish fisheries as managed under FMP 3.1 and FMP 3.2, the cumulative effects of mortality on Steller's eiders are considered significant adverse at the population level.

Changes in Food Availability

The abundance of marine invertebrate species important to the spectacled and Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. There is no predicted overlap between the groundfish fisheries and spectacled eider critical habitat under FMP 3.1; therefore, no cumulative effects have been identified for spectacled eiders through changes in food availability. Although many natural factors external to the fisheries may influence the abundance and distribution of eider prey, the minimal amount of spatial/temporal overlap with bottom-contact fisheries and the negligible bycatch of eider prey in these fisheries indicates that their contribution to changes in prey availability would be minimal. Therefore, insignificant cumulative effects on prey availability are identified for Steller's eiders under FMP 3.1 and FMP 3.2 and spectacled eiders under FMP 3.2.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, disrupt benthic habitats that support the prey of eiders. Under FMP 3.1, the groundfish fishery is not expected to occur in spectacled eider critical habitat or any other area that they typically use. A limited amount of bottom trawling is expected to overlap with Steller's eider critical habitat. The overall effects of FMP 3.1 on Steller's eiders through potential changes in benthic habitat are considered insignificant at the population level. There is a greater potential for the groundfish fishery to affect Steller's and spectacled eider habitats under FMP 3.2 than under FMP 3.1. However, the contribution of the fishery is considered unknown.

- **Persistent Past Effects.** Benthic habitats important to spectacled and Steller's eiders have been affected by various trawl and pot fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have begun to be investigated, so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to eiders. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may have persistent effects in certain areas. Climate change and ocean temperature fluctuations may also play a role in altering the benthic environment.

- **Reasonably Foreseeable Future External Effects.** All future fisheries that use bottom contact fishing gear in areas used by eiders are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will continue.

- **Cumulative Effects.** There is no predicted overlap between the groundfish fisheries and spectacled eider critical habitat under FMP 3.1 and a small potential for expansion into spectacled eider critical habitat under FMP 3.2. While the groundfish fisheries are predicted to have little spatial overlap with Steller's eider habitat under FMP 3.1 and FMP 3.2, the interaction of all human-caused and natural disturbances on benthic habitat important to Steller's eiders has not been examined with respect to their population declines in the past. The cumulative effects of benthic habitat disruptions and changes over the years as they relate to the food web important to eiders are therefore considered to be unknown.

4.7.8 Marine Mammals Alternative 3 Analysis

4.7.8.1 Western Distinct Population Segment of Steller Sea Lions

FMP 3.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

The analysis used to determine changes in the level of incidental takes described in Section 4.5.8 was applied to establish the significance of incidental take and entanglement of marine mammals expected to occur under FMP 3.1. With regard to incidental take, FMP 3.1 is not likely to result in significant changes to the population trajectory of the western distinct population segment (western population) of Steller sea lions. An average of 8.4 Steller sea lions from the western population was estimated to have been taken incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al.* 2001) (Table 4.5-60). The ratio of observed takes of Steller sea lions to observed groundfish catch (from 1995 to 1999) was multiplied by the new projected groundfish catch (all fisheries combined) to estimate incidental takes expected to occur over the next six years under this FMP management regime. The estimated annual incidental take level of Steller sea lions under FMP 3.1 in all areas combined is expected to be fewer than 10 based on expected catch in this FMP, or about one sea lion per 220,000 mt of groundfish harvested.

The MMPA requires NOAA Fisheries (NMFS Office of Protected Resources) to assess whether human-caused mortality threatens the stability or recovery of any species of marine mammal. The MMPA defines a measurement tool for this purpose, the PBR, that is a calculated value of the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. This calculation takes into consideration the most recent population estimates, historic population trends, status of the stock in relation to historic levels (i.e., whether it is depressed or not), and potential rates of recovery. According to the most recent stock assessment, PBR for the western population of Steller sea lions is 208 animals per year (Angliss and Lodge 2002). Mortality from incidental take and entanglement in marine debris is likely to continue under FMP 3.1 at levels that are small (less than 10%) relative to PBR and is therefore considered insignificant according to the criteria set for significance (Table 4.1-6).

Fisheries Harvest of Prey Species

Changes in the fishing mortality rate for Steller sea lion prey species were calculated using output from the multi-species management model which projected catch rates for the various FMPs. The estimated fishing mortality rates expected to occur under each FMP management regime were compared to the baseline fishing mortality rate in order to apply the significance criteria established in Table 4.1-6 for determining the effects on marine mammal populations. The baseline fishing mortality rates for the individual Bering Sea, Aleutian Islands and GOA groundfish fisheries, the fishing mortality rates projected to occur under each FMP, and the relative difference between the baseline and alternative fishing mortality rates are shown in Table 4.5-61.

Under FMP 3.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 30 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in the harvest of this key Steller sea lion prey species is considered to be significant. See the discussion regarding the unusually low fishing mortality rate in 2002 (which served as the comparative baseline) in Section 4.5.9.1. The harvest of EBS pollock under FMP 3.1 management regime meets the criteria of a significantly adverse impact to Steller sea lions.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 13 percent relative to the comparative baseline over the next five years under FMP 3.1. This change in F is insignificant at the population level for Steller sea lions under the 3.1 scenario. Fishing mortality rates are not calculated for the Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline conditions. There is no change in the projected catch of Aleutian Islands pollock between the baseline and FMP 3.1 and therefore effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level for this FMP.

Under FMP 3.1, the BSAI Pacific cod fishing mortality rate is expected to increase by 19 percent. This change is determined to be insignificant to Steller sea lions according to the criteria established in Table 4.1-6. Under FMP 3.1, the GOA Pacific cod fishing mortality rate is expected to increase by 19 percent which was determined to be insignificant to Steller sea lions. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to Steller sea lions with an expected increase in F of 60 percent relative to the baseline under FMP 3.1.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 3.1 is expected to result in insignificant population-level effects to Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The criterion used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations assumes that the FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interactions between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as "global controls." Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the western population of Steller sea lions. Spatial and temporal measures have not been added or repealed under FMP 3.1 and the spatial/temporal concentration of the fishery is not expected to change to a large degree relative to the baseline and is therefore rated insignificant.

Disturbance

FMP 3.1 retains the area closures contained under the baseline. The management regime under FMP 3.1 is not expected to result in increased disturbance to Steller sea lions relative to the baseline. The effects of disturbance are rated insignificant under FMP 3.1.

Cumulative Effects

The past/present effects on the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 3.1 are described above (Table 4.7-5). Representative direct effects used in this analysis include mortality and disturbance with major indirect effects of availability of prey and spatial/temporal concentration of the fisheries.

Mortality

- **Direct/Indirect Effects.** Effects of mortality from incidental take and entanglement in marine debris under FMP 3.1 are considered insignificant.

- **Persistent Past Effects.** Substantial mortality of Steller sea lions didn't occur in the fisheries until after the 1950s. The take of Steller sea lions was substantial after this time with over 20,000 animals believed to have been incidentally killed in the foreign and JV groundfish fisheries from 1966 to 1988, although data from this period are not complete (Perez and Loughlin 1991). In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 per year in the early 1990s to an average of 7.8 sea lions per year from 1996 to 2000. The number of Steller sea lions incidentally taken in state-managed, nearshore salmon gillnet fisheries and halibut longline fisheries was estimated at 14.5 sea lions per year in the PWS drift gillnet fisheries (Wynne *et al.* 1992). It is thought that shooting used to be a significant source of mortality prior listing the Steller sea lion as endangered under the ESA. Two cases of illegal shootings were prosecuted in the Kodiak area in 1998 and involved two Steller sea lions from the western stock (Angliss *et al.* 2001). The subsistence harvest of the western stock has decreased over the last ten years from 547 to 171 animals per year (1992 to1998) (Angliss and Lodge 2002). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). Predation by transient killer whales and sharks has always contributed to the natural mortality of Steller sea lions but the numbers of sea lions taken and the relative contribution of this factor to the recent population decline and lack of recovery is currently under investigation (Matkin *et al.* 2001, Matkin *et al.* 2003, Springer *et al.* 2003).

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillnet fisheries will continue in the foreseeable future but the numbers of Steller sea lions taken will likely be relatively low (<10 per year). Entanglement and intentional shootings would also be expected to continue at a level similar to the baseline condition. Pollution is not likely a factor for this population due to the isolation from human population centers. Predation will continue to contribute to natural mortality but climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** Mortality is based on the contribution of internal effects of the groundfish fishery and external mortality effects. These effects are considered significantly adverse since the overall human-caused mortality exceeds the PBR for this population and the species is listed as endangered under the ESA due to the severe historical decline. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and, under the baseline conditions, has been considered to not cause jeopardy under the ESA (NMFS 2001b).

Prey Availability

- **Direct/Indirect Effects.** The combined harvest of Steller sea lion prey species under FMP 3.1 is not expected to result in population-level effects, and is therefore considered insignificant.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in state waters, and partial overlap with other state-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s and one hypothesis is that the combined fisheries, perhaps in conjunction with climate and oceanographic fluctuations, greatly reduced the availability of forage fish to Steller sea lions. NMFS issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat but most of the focus was on the western population. A recent Steller sea lion BiOp and EIS (NMFS 2001b) explores this subject in great depth.

- **Reasonable Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a similar manner to the baseline condition. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects on availability of prey but the direction or magnitude of these changes are difficult to predict. Climate induced change has been suspected in the decline of the western population Steller sea lion.

- **Cumulative Effects.** The cumulative effect on prey availability for Steller sea lions is based on direct, indirect, and external effects on prey and is considered conditionally significant adverse. This rating is based on the adverse effects on prey availability in the past from foreign, JV, and domestic groundfish fisheries, the State-managed salmon and herring fisheries, and indications that prey availability has been a key factor in the decline of the western population over the last several decades. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine with natural fluctuations to affect prey availability such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** Spatial and temporal fishing measures under FMP 3.1 do not substantially deviate from the baseline and are considered insignificant.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of Steller Sea Lion Protection Measures, which remain in effect under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The only reasonably foreseeable future factors, external to the groundfish fisheries, that effect the spatial/temporal harvest of Steller sea lion prey would be the state-managed salmon and herring fisheries which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to continue to be managed in a similar manner to recent years. No new state or federal fisheries are anticipated at this time.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey is based on past and future effects of the groundfish fisheries and State-managed fisheries and is considered conditionally significant adverse. Although there are several hypotheses regarding the decline and lack of recovery of Steller sea lions, localized depletion of prey due to commercial fishing is a plausible mechanism for population level effects. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine to cause localized depletion of prey in key areas such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Disturbance

- **Direct/Indirect Effects.** FMP 3.1 retains the area closures set forth under the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under the FMP 3.1 management scenarios.

- **Persistent Past Effects.** Past effects of disturbance were identified from foreign, JV, and domestic groundfish fisheries in the BSAI and GOA and state-managed fisheries. Past disturbances was also identified from commercial harvest, intentional shooting and subsistence harvest. General vessel traffic and disturbance of prey fields from fishing gear have also regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects.** Future disturbance was identified for state-managed salmon and herring fisheries as well as general fishing and non-fishing vessel traffic in Steller sea lion foraging areas. Subsistence harvest was also identified as a continuing source of disturbance to Steller sea lions. Level of disturbance is expected to be similar to baseline conditions.

- **Cumulative Effects.** Disturbance to Steller sea lions is based on contributions from both internal and external effects. The cumulative effect was considered insignificant because it is similar to the baseline condition and population-level effects are unlikely.

Direct/Indirect Effects – FMP 3.2

Incidental Take/Entanglement in Marine Debris

Effects are expected to be insignificant as described under FMP 3.1 for the western population of Steller sea lions.

Fisheries Harvest of Prey Species

Changes in the fishing mortality rate for Steller sea lion prey species were calculated using output from the multi-species management model which projected catch rates for the various FMPs. The estimated fishing mortality rates expected to occur under each FMP management regime were compared to the baseline fishing mortality rate in order to apply the significance criteria established in Table 4.1-6 for determining the effects on marine mammal populations. The baseline fishing mortality rates for the individual BSAI and GOA groundfish fisheries, the fishing mortality rates projected to occur under each FMP, and the relative difference between the baseline and fishing mortality rates under each FMP are shown in Table 4.5-61.

Under FMP 3.2, the fishing mortality rate of EBS pollock is expected to increase by an average of 34 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key Steller sea lion prey species is considered to be significant. See the discussion regarding the unusually low fishing mortality rate in 2002 (which served as the comparative baseline) in Section 4.5.8.1. The harvest of EBS pollock under the FMP 3.2 management regime meets the criteria of a significantly adverse impact to Steller sea lions.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 29 percent relative to the comparative baseline over the next five years under FMP 3.2. This change in fishing mortality rate is rated as significantly beneficial under the FMP 3.2 scenario at the population level for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline conditions. There is no change in the projected catch of Aleutian Islands pollock between the baseline and FMP 3.2, therefore effects of Aleutian Island pollock harvests are deemed to be insignificant to Steller sea lions at the population level for this FMP.

Under FMP 3.2, the BSAI and GOA Pacific cod fishing mortality rates are expected to increase by 17 percent and six percent over the next five years. These respective changes are determined to be insignificant to Steller sea lions. Changes in Aleutian Islands Atka mackerel harvest are also expected to be insignificant to Steller sea lions under FMP 3.2, with a projected increase in fishing mortality rate of 14 percent relative to the baseline. The nearshore area closures under FMP 3.2 would require a significant spatial redistribution of Aleutian Islands Atka mackerel fishing effort. Under baseline conditions, approximately 43 percent of Aleutian Islands Atka mackerel were caught in areas that would be closed under FMP 3.2. Although the target species model projects a fishing mortality rate of 0.28, this rate may not be sustainable over five years in the limited area where the fishery would be displaced. According to the significance criteria in Table 4.1-6, harvest of Aleutian Islands Atka mackerel under FMP 3.2 would be insignificant to the western population of Steller sea lions under the worst case scenario and would be conditionally significant beneficial if the overall fishing mortality rate decreased due to the offshore displacement of the fishery.

Little difference is expected relative to the baseline and among the FMPs for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions.

The combined harvest of Steller sea lion prey species under FMP 3.2 is expected to decrease overall relative to the baseline and therefore result in insignificant population-level effects to Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The criterion used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations is that the FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. The spatial/temporal measures in FMP 1 (and retained throughout all of the FMPs) were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where Steller sea lions are known to occur. Under the baseline condition, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as "global controls." Additionally, groundfish fisheries have been dispersed in time and space under the baseline condition, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the western population of Steller sea lions in the wild. FMP 3.2 offers opportunities for additional temporal and spatial protection. Under FMP 3.2, a buffer out to15 nm from shore would offer increased protection areas determined to be important for Steller sea lions. These protective measures would be in addition to those that exist for Steller sea lion protection under the baseline condition and have the potential to provide beneficial effects to Steller sea lions. As these effects cannot be quantified, they are determined to be conditionally significant beneficial to Steller sea lions based on the assumption that they may result in improvements to the prey field to the extent that population-level effects could occur.

Disturbance

Effects of disturbance are considered insignificant as described under 3.1.

Cumulative Effects

The past/present effects on the western population Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 3.2 are described above. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative sense . This analysis seeks to provide an overall assessment of the species' population-level response to its environment as it is influenced by the groundfish fishery. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With regard to incidental take and entanglement, FMP 3.2 is not likely to result in significant changes to the population trajectory of the western population of Steller sea lions.

- **Persistent Past Effects.** Past effects of mortality are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects of mortality are the same as discussed under FMP 3.1.

- **Cumulative Effects.** Cumulative effects on mortality are based on the contribution of internal effect of the groundfish fishery and external mortality effects. This effect is considered significantly adverse since the overall human-caused mortality exceeds the PBR for this population, the species is listed as endangered under the ESA due to the severe decline of the species. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and has been considered to not cause jeopardy under the ESA (NMFS 2001b).

Prey Availability

- **Direct/Indirect Effects.** Under FMP 3.2, the combined harvest of Steller sea lion prey species is expected to result in insignificant population-level effects to Steller sea lions.

- **Persistent Past Effects.** Past effects are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects are the same as discussed under FMP 3.1.

- **Cumulative Effects.** The cumulative effect on prey availability for Steller sea lions is based on direct, indirect, and external effects on prey and is considered conditionally significant adverse. This rating is based on the adverse effects on prey availability in the past from foreign, JV, and domestic groundfish fisheries, the State-managed salmon and herring fisheries, and indications that prey availability has been a key factor in the decline of the western population over the last several decades. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine with natural fluctuations to affect prey availability such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Spatial/Temporal Effects of Harvest

- **Direct/Indirect Effects.** Effects under FMP 3.2 are determined to be conditionally significant beneficial to Steller sea lions based on the assumption that they may result in improvements to the prey field to the extent that population-level effects could occur.

- **Persistent Past Effects.** Past effects are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects are the same as discussed under FMP 3.1.

- **Cumulative Effects.** Effects of the spatial/temporal harvest of prey were identified as cumulative based on both internal past effects on the groundfish fishery and state-managed fisheries. These effects were considered conditionally significant beneficial based primarily on the internal effects of the FMP. Under FMP 3.2, Steller sea lion protection measures would be extended to a buffer out to15 nm from shore that would offer increased protection in areas determined to be important for Steller sea lions. This rating is conditional based on whether displacing fisheries offshore would result in actual improvements to the prey field to the extent that beneficial population-level effects occur.

Disturbance

- **Direct/Indirect Effects.** FMP 3.2 retains the area closures contained under the baseline and expands the closed buffer areas along the shoreline to 15 nm (outside of MPA or no take reserves). However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under FMP 3.2 management scenarios.

- **Persistent Past Effects.** Past effects of disturbance are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects of disturbance are the same as discussed under FMP 3.1.

- **Cumulative Effects.** Disturbance to Steller sea lions is based on contributions from both internal and external effects. Cumulative effects are considered insignificant because disturbance would decrease from the baseline condition and population-level effects are unlikely.

4.7.8.2 Eastern Distinct Population Segment of Steller Sea Lions

FMP 3.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 3.1 is not likely to result in significant changes to the population trajectory of the eastern distinct population segment (eastern population) of Steller sea lions. No Steller sea lions from the eastern population were taken incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al.* 2001) (Table 4.5-60). In this context, incidental take refers to animals which are deceased or have injuries that are expected to result in the death of the animal. Because no animals from the eastern population have been taken incidental to groundfish fisheries, changes in catch resulting from FMP 3.1 are not expected to result in an increase in the level of incidental takes.

Entanglement of Steller sea lions from the eastern population in derelict fishing gear or other materials seems to occur at frequencies that do not have significant effects on the population, and does not appear to represent a significant threat to the population. In conclusion, incidental take and entanglement in marine debris under

FMP 3.1 are expected to be similar to the baseline condition and are insignificant according to the significance criteria (Table 4.1-6).

Fisheries Harvest of Prey Species

BSAI groundfish fisheries are not likely to have large impacts on prey availability for the eastern population of Steller sea lions as there is little overlap between this population and fisheries that harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to have an effect on the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock and Pacific cod under FMP 3.1 are expected to decrease by 13 percent and increase by 19 percent, respectively, relative to the comparative baseline over the next five years. The fishing mortality rates under FMP 3.1 are therefore rated insignificant for GOA pollock and Pacific cod harvests.

Little difference is expected relative to the baseline and among the FMPs for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 3.1 is expected to be similar to the baseline condition and is expected to have insignificant effects on the eastern population of Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The criteria used to evaluate the spatial/temporal effects of the groundfish fisheries on marine mammal populations assumes that the FMP would be expected to result in either increased or decreased spatial/temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would occur. The spatial/temporal measures in the baseline (and retained throughout all of the FMPs) were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where Steller sea lions are known to occur. Under the baseline condition, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as "global controls." Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the eastern population of Steller sea lions in the wild. Spatial and temporal measures have not been added or repealed under FMP 3.1 so that the spatial/temporal concentration of the fishery is not expected to change significantly relative to the baseline and is therefore rated insignificant.

Disturbance

FMP 3.1 retains the area closures contained under the baseline. The management regime under FMP 3.1 is not expected to result in increased disturbance to Steller sea lions relative to the baseline and is therefore rated to have insignificant effects.

Cumulative Effects

The past/present effects on the eastern population of the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under FMP 3.1are described above. The effects considered in this analysis are listed in Table 4.5-63. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects including availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With regard to incidental take and entanglement, FMP 3.1 is not likely to result in significant changes to the population trajectory of the eastern population of Steller sea lions.

- **Persistent Past Effects.** It is thought that shooting used to be a significant source of mortality prior to listing the Steller sea lion as threatened on the ESA. NMFS Alaska Enforcement Division has successfully prosecuted two cases of illegal shooting involving four Steller sea lions from the eastern population (Angliss *et al.* 2001). It is not known to what extent illegal shooting continues in the eastern population but stranding of Steller sea lions with bullet holes still occurs. Predator control programs associated with mariculture facilities in British Columbia accounts for a mean of 44 animals killed per year from the eastern population (Angliss *et al.* 2001). The subsistence harvest from the eastern population of the Steller sea lion is very small and is subject to an average of only two Steller sea lions taken per year from southeast Alaska (1992-1997) (Angliss and Lodge 2002). Commercial harvest of Steller sea lions for hides and meat occurred prior to 1900 and likely depleted local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). The proportion of these from the eastern population are unknown. Intentional shooting of Steller sea lions, other than in subsistence hunts, became illegal after the species was listed as threatened under the ESA in 1990. It is thought that shooting used to be a significant source of mortality prior to that time. Steller sea lions are incidentally taken in low numbers by commercial fisheries other than groundfish fisheries, including some state-managed salmon drift and set gillet fisheries, the salmon troll fishery in southeast Alaska (mean of 1.25 and 0.2 respectively) (Angliss *et al.* 2001). Small numbers of Steller sea lions from the eastern population are also taken outside of southeast Alaska in groundfish fisheries (0.45 per year in Washington, Oregon and California) and set gillet fisheries in northern Washington (0.2 per year) (Angliss *et al.* 2001). The PBR for this population is 1,396 and current human-caused mortality is 45.5, substantially less than 10 percent of the PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillet and troll fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely relatively low (<10 per year). Groundfish fisheries in Washington, Oregon and California and salmon set gillnets fisheries will continue to take small numbers from this population. Entanglement and intentional shootings would also be expected to continue. Pollution is likely more of a factor for this population due to its proximity to population centers. Climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** Effects of mortality are based on the contribution of internal effects of the groundfish fishery and external mortality effects. This effect is considered insignificant since the overall human-caused mortality does not approach the PBR for this population. Although this population is listed as threatened under the ESA, it has been increasing over the last 20 years. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and has been determined to not cause jeopardy under the ESA (NMFS 2001).

Effects of Prey Availability

- **Direct/Indirect Effects.** The combined harvest of the eastern population of Steller sea lion prey species under FMP 3.1 is not expected to result in population-level effects and is considered insignificant.

- **Persistent Past Effects.** Past effects on key prey species of the eastern population of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in State waters, and partial overlap with other state-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries. NMFS issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat but most of the focus was on the western population. A recent Steller sea lion BiOp and EIS (NMFS 2001b) explores this subject in great depth.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a similar manner to the baseline condition. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects of availability of prey but the direction or magnitude of these changes is difficult to predict. Climate induced change has been suspected in the decline of the western population Steller sea lion, but effects of climate change or regime shifts on the eastern population of the Steller sea lion are largely unknown.

- **Cumulative Effects.** The cumulative effects of prey availability on the eastern population of the Steller sea lion are considered to be insignificant at the population level. The eastern population of Steller sea lions has been increasing steadily over the last 20 years so prey availability is not considered to be limiting the recovery of the population.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial and temporal fishing measures under FMP 3.1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries are determined to be insignificant to Steller sea lions.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of the baseline Steller sea lion protective measures.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon set and drift net gillet fisheries and salmon troll fisheries and herring fisheries are expected to continue in future years in a similar manner to the baseline conditions.

- **Cumulative Effects.** Cumulative effects for the spatial and temporal harvest of prey from both internal effects of the groundfish fishery and external effects such as state-managed fisheries are likely to remain similar to the baseline condition, under which the population has increased steadily, and is therefore considered insignificant for the eastern population of Steller sea lions.

<u>Disturbance</u>

- **Direct/Indirect Effects.** The effects of disturbance on Steller sea lions under the FMP 3.1 are expected to be similar to the baseline and population-level effects are unlikely. Therefore, cumulative effects are considered insignificant. Protection measures around rookeries and haulouts limit disturbance and will continue under FMP 3.1.

- **Persistent Past Effects.** Past disturbance was identified for foreign, JV, and federal domestic groundfish fisheries and state-managed salmon and herring fisheries. General vessel traffic has also contributed to the disturbance level for this population. Intentional shooting has likely been a disturbance factor in past years.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and vessel traffic will likely continue in the future at a level similar to the baseline condition. Disturbance from subsistence harvest is not a foreseeable effect for this population.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external sources is likely to remain similar to the baseline condition, under which the population has increased steadily, and is therefore considered insignificant.

Direct/Indirect Effects FMP 3.2

<u>Incidental Take/Entanglement in Marine Debris</u>

Effects are the same as described under FMP 3.1 and are considered insignificant.

<u>Fisheries Harvest of Prey Species</u>

BSAI groundfish fisheries are not likely to have large impacts on the prey availability of the eastern population of Steller sea lions as there is little overlap between this population and fisheries that harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to affect the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock under FMP 3.2 are expected to decrease 29 percent relative to the comparative baseline over the next five years. Average fishing mortality rates of GOA Pacific cod under FMP 3.2 are expected to increase by six percent relative to the comparative baseline over the next five years. The changes in the fishing mortality rate expected to occur under FMP 3.2 are insignificant for GOA Pacific cod harvests and significantly beneficial for GOA pollock.

Little difference is expected relative to the baseline and among the FMPs for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under FMP 3.2 is expected to result in insignificant population-level effects on Steller sea lions.

Spatial/Temporal Concentration of the Fishery

The spatial/temporal measures under the baseline conditions were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods which are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities, such as surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures yet where sea lions are known to occur. Under the baseline condition, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as "global controls." Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the eastern population of Steller sea lions in the wild. FMP 3.2 offers opportunities for additional temporal and spatial protections. Under FMP 3.2 all areas would have a 15 nm buffer from shore which would offer increased protection in areas determined to be important for Steller sea lions. These protective measures would be in addition to those that exist for Steller sea lion protection under the baseline conditions and have the potential to provide beneficial effects to Steller sea lions. However, since the eastern population of Steller sea lions has been increasing steadily over the past 20 years and food availability does not appear to be limiting their population recovery, it is unlikely that these additional protection measures would improve their access to prey to the extent that population-level effects would occur. While the spatial/temporal measures under FMP 3.2 could be considered beneficial, they are unlikely to result in substantial changes to the baseline condition and are therefore considered insignificant at the population-level for the eastern population of Steller sea lions.

Disturbance

Effects do not deviate from those described under the FMP 3.1 and are considered insignificant.

Cumulative Effects

For the eastern population of Steller sea lions, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under FMP3.2 are the same as discussed under FMP 3.1.

4.7.8.3 Northern Fur Seals

Direct/Indirect Effects FMP 3.1

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, incidental takes and entanglements of northern fur seals expected to occur incidental to groundfish fisheries under FMP 3.1 are not expected to result in population-level effects. Increased harvest rates under this management alternative are not large enough for expected take levels to change relative to the baseline (see section 4.5.8.3) and is therefore rated insignificant under FMP 3.1.

Fisheries Harvest of Prey Species

Under FMP 3.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 30 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, this change in the harvest of adult pollock, which is a key prey species of northern fur seals in the EBS, is rated significantly adverse. However, the actual effect of this increased harvest rate, in terms of biomass available, is likely insignificant due to the abnormally low fishing mortality under the comparative baseline (see the discussion regarding the unusually low fishing mortality rate of EBS pollock in 2002 in Section 4.5.8.1).

Catches of squid and small schooling fish (e.g., fish designated in the forage fish assemblage) in the groundfish fisheries of the BSAI and GOA are low, generally less than 1,000 mt per year. While precise biomass estimates for these groups do not exist, the exploitation rate on these groups in the groundfish fisheries is thought to be very low. For instance, squid biomass in the Bering Sea may be as large as 4 million mt, based on marine mammal food habits, daily ration, and abundance data (Sobolevsky 1996). Similarly, with respect to small schooling fishes, consumption of capelin in the GOA by arrowtooth flounder alone may be as large as 300,000 mt per year (Livingston 1994). Assuming that these crude projections of squid and capelin biomass at least approximate the order of magnitude of the true population levels, then the fisheries removals would amount to only a fraction of one percent of those populations. Fisheries for pollock and Pacific cod do not target fish younger than 3 years of age (Ianelli *et al.* 1999, Dorn *et al.* 1999, Thompson and Dorn 1999, Thompson and Zenger 1994, Fritz 1996). Catches of pollock smaller than 30 centimeters (cm) are small, and thought to be only 1 to 4 percent of the number of one- and two-year olds each year in the EBS and GOA (Fritz 1996).

Therefore, while fisheries do harvest prey of northern fur seals (i.e., pollock and Pacific cod), the harvest rates of those species in the size range consumed by fur seals tend to be low. Furthermore, the fraction of the northern fur seal diet composed of those species is a smaller fraction of the overall diet as compared, for instance, to Steller sea lions. The overall harvest of northern fur seal prey species is likely to be similar to the baseline condition and is therefore determined to be insignificant under FMP 3.1.

While the potential overlap with fisheries may be moderated by these factors, effects on northern fur seals may yet exist, the relevance of which is not reflected by estimates of biomass removals over large geographical areas. The potential for competitive overlap between northern fur seals and groundfish fisheries may be tempered by the spatial and temporal distribution of the harvest. These effects are analyzed under the "Spatial/Temporal" heading. Fisheries may also trigger trophic level effects which may affect the availability of northern fur seal prey and these effects are discussed in the ecosystem section.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 3.1 are determined to be insignificant to northern fur seals as they do not deviate from the spatial/temporal measures under the baseline conditions. However, effects to northern fur seals from spatial/temporal concentration of the fisheries under the strategy defined as the baseline for this environmental analysis were rated conditionally significant adverse in the Steller sea lion SEIS (NMFS 2001b). Therefore, while the spatial/temporal effects of FMP 3.1 are insignificant relative to the baseline, the baseline has been described as having potential adverse effects on northern fur seals.

Disturbance

Disturbance of northern fur seals under the FMP 3.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

Cumulative Effects

A summary of the past/present effects with regard to the northern fur seal are presented in Section 3.8.2 (Table 3.8-2). The predicted direct/indirect effects of the groundfish fishery under FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-64. Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey an spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With respect to mortality and entanglement in marine debris, the effects on the northern fur seal under FMP 3.1 are rated insignificant.

- **Persistent Past Effects.** Persisting effects of past mortality include commercial harvest of young males up to 1985, harvest of females between 1956 and 1968, incidental take in the JV and foreign fisheries, and annual subsistence harvest on the Pribilof Islands. Commercial harvest of fur seals peaked in 1961 with over 126,000 animals but was halted in 1985. The harvest of female fur seals on the Pribilof Islands, as many as 300,000 between 1956 and 1968, likely contributed to the decline of the population in the late 1970's and early 1980's (York and Kozloff 1987). This precipitous decline resulted in the depeleted status under the MMPA. Entanglements may have contributed significantly to declining trends of the population during the late 1970's (Fowler 1987). Since the cessation of commercial harvest in 1985, fur seal numbers have steadily declined (NMFS 1993, Angliss and Lodge 2002). The contribution of the earlier harvest of fur seals to the subsequent decline is uncertain. It has been nearly 20 years since commercial harvest was ended. Subsistence harvest has been one of the major contributors to fur seal mortality in recent years. From 1986 to 1996, the average annual subsistence take was 1,605 from St. Paul and St. George Islands. From 1995 to 2000 the average take dropped to 1,340 seals per year, which represents about 8 percent of the PBR for this species.

- **Reasonably Foreseeable Future External Effects.** These effects include incidental take from foreign fisheries outside the U.S. EEZ where fur seals are widely dispersed. State-managed fisheries take small numbers of fur seals, including the PWS drift gillet fishery, Alaska Peninsula and Aleutian Island salmon gillet fisheries, and the Bristol Bay salmon fisheries (Angliss *et al.* 2001). Subsistence will continue to be a major source of mortality in the future but is limited to the Pribilof Islands, but levels of take are expected to remain well below 10 percent of the PBR for this species. Short-term and long-term climate change is not considered a major mortality factor for this species.

- **Cumulative Effects.** Cumulative effects of mortality from internal and external factors are considered insignificant. The contribution of the groundfish fisheries is very small and approaches zero. The effect is insignificant because of the size of the fur seal population in relation to existing levels of take, which are well below the PBR of this species. Population-level effects are not anticipated.

<u>Availability of Prey</u>

- **Direct/Indirect Effects.** The effects of the groundfish fisheries on prey availability for northern fur seals under FMP 3.1are rated insignificant.

- **Persistent Past Effects.** Effects of groundfish harvest of prey species in the past have likely occurred from overlap of particular prey species and fish targeted by the foreign and JV fisheries in the BSAI, as well as the state and federal fisheries. Climate and oceanic fluctuations are also suspect in past changes to the abundance and distribution of prey.

- **Reasonably Foreseeable Future External Effects.** Effects on prey availability in the future may result from overlap in prey species with state-managed fisheries in nearshore areas and effects of climate change/regime shifts may also affect prey species abundance and distribution. Climate effects are largely unknown but could potentially have adverse effects on the availability of prey.

- **Cumulative Effects.** The cumulative effect of prey availability from both the internal contribution of the groundfish fisheries and external effects on prey such as other fisheries and possibly long-term climate change is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

<u>Spatial/Temporal Concentration of Harvest</u>

- **Direct/Indirect Effect.** The effects of the spatial/temporal concentration of the fisheries under FMP 3.1 are determined to be insignificant to northern fur seals as they do not deviate from the spatial/temporal measures under the baseline conditions.

- **Persistent Past Effects.** Effects of past fisheries harvest of prey are primarily from the foreign and JV fisheries and the state and federal domestic fisheries in the BSAI. There has been concern in regard to fishing effort being displaced offshore with the recent restrictions in the SSL Protection Measures, resulting in increased overlap with fur seal foraging area. The proportion of the total June-October pollock catch in fur seal foraging habitat increased from an average of 40 percent in 1995-1998 to 69 percent in 1999-2000 (NMFS 2001b). There is particular concern for the potential impact of this increased fishing pressure on lactating females from St. George Island where catch rates were consistently higher than in areas used by females from St. Paul. However, the competitive overlap is minimized by several factors including prey size and prey species of the fur seal.

- **Reasonably Foreseeable Future External Effects.** Effects of the spatial/temporal harvest of prey species exist primarily in the foreign and Federal domestic fisheries outside the EEZ, due to the extensive range of fur seals when they are away from their breeding rookeries. State-managed fisheries have very limited overlap with fur seal prey. Climate change was also identified as a potential factor in spatial/temporal effects on prey.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey based on the presence of internal and external factors is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established, and there is uncertainty regarding whether future fisheries harvests will contribute to the decreasing population trend, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

<u>Disturbance</u>

- **Direct/Indirect Effect.** Disturbance of northern fur seals under the FMP 3.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

- **Persistent Past Effects.** Past disturbance of fur seals has comes from commercial groundfish fisheries harvest by JV fisheries, foreign and federal domestic fisheries, and to a lesser extent the subsistence harvest of fur seals on the Pribilof Islands. It is unknown whether these past activities exert persistent effects in the present but the ongoing fisheries do continue to result in some level of disturbance to fur seals while they are in the BSAI region.

- **Reasonably Foreseeable Future External Effects.** Disturbance effects on fur seals were identified as state-managed fisheries, general vessel traffic, and subsistence activities on the Pribilof Islands.

- **Cumulative Effects.** The cumulative effects of disturbance from internal and external factors are considered insignificant because there is little to indicate adverse effects occurring on the population level.

Direct/Indirect Effects– FMP 3.2

For northern fur seals, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and disturbance are the same as discussed under FMP 3.1.

Spatial/Temporal Concentration of the Fishery

FMP 3.2 offers opportunities for additional temporal and spatial protections relative to baseline conditions and may be more precautionary from the standpoint of prey available to northern fur seals. Under FMP 3.2, all areas would be buffered out to 15 nm from shore which may offer increased protection to northern fur seal foraging areas. These protective measures would be in addition to those that exist for Steller sea lion protection under the baseline conditions and have the potential to provide beneficial effects to northern fur seals. Because these effects cannot be quantified they are determined to be conditionally significant beneficial to northern fur seals based on the assumption that they may result in improvements to the prey field to the extent that population-level effects could occur.

Cumulative Effects

For northern fur seals, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and disturbance under FMP3.2 are the same as discussed under FMP 3.1.

Spatial/Temporal Concentration of Harvest

- **Direct/Indirect Effects.** Effects of groundfish fisheries under FMP 3.2 on the spatial/temporal concentration of fisheries harvest are reduced compared to the baseline conditions; thus the effects of the spatial/temporal concentration of harvest under FMP 3.2 are determined to be conditionally significant beneficial to northern fur seals.

- **Persistent Past Effects.** Past effects of spatial/temporal concentration of fisheries harvest are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects are the same as discussed under FMP 3.1.

- **Cumulative Effects.** The cumulative effects of spatial/temporal harvest of prey, based on the presence of internal and external factors, are considered conditionally significant beneficial to northern fur seal populations. The significance rating is based on the reduction of spatial/temporal overlap with the groundfish fisheries and the increased protection with MPAs and shoreline buffers. The rating is conditional on whether the concentration of the fisheries was a factor in the past population decline and whether measures implemented under FMP 3.2 actually have beneficial population-level effects on northern fur seals.

4.7.8.4 Harbor Seals

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, takes and entanglements of harbor seals expected to occur incidental to groundfish fisheries under FMP 3.1 are not expected to result in population-level effects. Increased harvest rates under this management alternative may result in the increased take of 1 harbor seal relative to the baseline, for a total estimated average of fewer than 5 animals per year. This level of incidental take would not result in changes to the population trajectory for this species. Therefore, takes and entanglements of harbor seals incidental to groundfish fisheries are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Under FMP 3.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 30 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key harbor seal prey species is rated significant (see the discussion regarding the comparative baseline fishing mortality rate in Section 4.5.8.1.). The harvest of EBS pollock under the PA.1 management regime meets the criteria of a significantly adverse impact to harbor seals, but the actual effect in terms of biomass available is likely insignificant due to the unusually low fishing mortality under the baseline.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 13 percent under FMP 3.1 relative to the comparative baseline over the next 5 years and is considered insignificant. Under FMP 3.1, the BSAI Pacific cod fishing mortality rate is expected to increase by 19 percent, which is determined to be insignificant to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest under the 3.1 bookend are expected to be significantly adverse to harbor seals with a 60 percent increase in fishing mortality rate relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for harbor seals (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to harbor seals. The combined harvest of harbor seal prey species under FMP 3.1 is expected to be similar to the baseline and result in insignificant population-level effects overall.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under FMP 3.1 are determined to be insignificant to harbor seals as they do not deviate from the spatial/temporal measures under the baseline conditions.

Disturbance

Disturbance of harbor seals under FMP 3.1 is not expected to increase relative to the baseline and is therefore rated insignificant.

Cumulative Effects

A summary of the effects of the past/present with regards to the harbor seal is presented in Section 3.8.4 (Table 3.8-4). The predicted direct/indirect effects of the groundfish fishery under FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-65. Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Incidental takes and entanglements of harbor seals expected to occur in groundfish fisheries under FMP 3.1 are not expected to result in population-level effects, therefore they are considered insignificant.

- **Persistent Past Effect.** Residual effects on local populations of State predator control programs (1950s to 1972) and commercial hunts (1963 to 1972) may persist in some areas although there are no data on these factors. Foreign and JV groundfish fisheries in the 1960s and 1970s have likely contributed to some level of direct harbor seal mortality from entanglement in gear but based on the near shore distribution of harbor seals, there was likely minimal direct interaction and mortality is believed to have been very low. From 1990 to 1996, minimum estimates of harbor seals taken incidentally in groundfish gear in the Bering Sea were 4 per year and fewer than 1 per year in the GOA. In southeast Alaska, 4 harbors seals are estimated to be killed each year on longlines. Harvest of harbor seals for subsistence purposes is likely the highest cause of anthropogenic mortality for this species since the cessation of commercial harvests in the early 1970s. Between 1992 and 1998, the state-wide subsistence harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which were taken in southeast Alaska (Wolfe and Hutchinson-Scarbrough 1999). Harvest of Bering sea stock of harbor seals is approximately 161 animals, 42 percent of PBR for this species. For the GOA stock, the subsistence harvest is at approximately 91 percent of the PBR for this stock. For the southeast stock, subsistence harvest is at approximately 83 percent of PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take of harbor seals in state-managed fisheries such as salmon set and drift gillet fisheries would be expected to continue at its present low rate. Subsistence take is expected to continue to be the greatest source of human controlled mortality with a relatively high percentage of the PBR in both the GOA and southeast Alaska stock and a lower take in the BSAI region. Climate change is likely not a factor in the direct mortality of harbor seal although there would likely be indirect effects.

- **Cumulative Effects.** The combined effects of mortality resulting from internal effects and external sources are determined to be insignificant. The human-caused mortality for all harbor seals is below the PBR for each stock and, therefore, population-level effects are unlikely.

Availability of Prey

- **Direct/Indirect Effects.** The combined harvest of harbor seal prey species under FMP 3.1 is not expected to result in population-level effects and is considered insignificant.

- **Persistent Past Effects.** Availability of prey for harbor seals in the past has likely been affected by foreign and JV fisheries, federal domestic groundfish fisheries, and state-managed salmon and herring fisheries since the fish targeted by these fisheries are also prey for the harbor seal. Climate change/regime shift could possibly have been a factor in fluctuations in prey availability in the past.

- **Reasonably Foreseeable Future External Effects.** State-managed salmon and herring fisheries are identified as having potential adverse effects on harbor seal prey availability. Climate change/regime shift will continue to be a contributing factor although the effects can be beneficial or adverse, depending on the direction and magnitude of change.

- **Cumulative Effects.** The combination of internal effects of the groundfish fisheries and other external fisheries on prey availability were determined to be conditionally significant adverse. This rating is based on the fact that the population has declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on harbor seals through this mechanism are considered conditional.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The effects of the spatial/temporal concentration of the fisheries under FMP 3.1 are rated insignificant to harbor seals.

- **Persistent Past Effects.** Effects of groundfish harvest in the past have likely occurred from overlap between harbor seal prey species, types of fish targeted, and areas fished by the foreign and JV fisheries in the BSAI, as well as state and federal fisheries. Climate and oceanic fluctuations are not considered factors in past changes to the spatial/temporal harvest of harbor seal prey species.

- **Reasonably Foreseeable Future External Effects.** Future effects of spatial/temporal harvest on harbor seal populations may result from overlap between prey species and the state-managed fisheries in nearshore areas such as salmon and herring. Climate change/regime shifts may also affect prey species abundance and distribution. Since these fisheries generally occur in the nearshore areas in comparison to groundfish fisheries, overlap is more prevalent compared to the groundfish fisheries.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey from internal effects of the groundfish fisheries and external effects of other fisheries is considered to be conditionally significant adverse, based primarily on past effects and contributions from state-managed fisheries. This rating is based on the fact that the population has declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established, the potentially adverse cumulative effects on harbor seals through this mechanism are considered conditional.

Disturbance

- **Direct/Indirect Effect.** The effects of disturbance on harbor seals are considered to be insignificant at the population-level.

- **Persistent Past Effects.** Past disturbance of harbor seals may have resulted from groundfish fisheries including JV fisheries, foreign and federal domestic fisheries, and to a lesser extent the subsistence harvest of harbor seals. It is unknown whether these past effects persist but the ongoing fisheries activities and subsistence harvests continue to result in some level of disturbance to harbor seal populations.

- **Reasonablely Foreseeable Future External Effects.** State-managed fisheries, general vessel traffic, and subsistence activities would be expected to continue and may create some level of disturbance to harbor seals in the foreseeable future.

- **Cumulative Effects.** Cumulative effects of disturbance on harbor seal populations are expected to be similar to the baseline conditions and are considered insignificant.

Direct/Indirect Effects FMP 3.2

For harbor seals, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and disturbance are the same as discussed under FMP 3.1.

<u>Spatial/Temporal Concentration of the Fishery</u>

The FMP 3.2 bookend offers opportunities for additional temporal and spatial protections relative to baseline conditions and may be more precautionary from the standpoint of prey available to harbor seals. Under FMP 3.2 all areas would be buffered out to 15 nm from shore in areas not covered by MPAs or no-take preserves, which would offer increased protection to harbor seal foraging areas. These protective measures would be in addition to those that exist for Steller sea lion protection under the baseline conditions and have the potential to provide beneficial effects to harbor seals. Because these effects cannot be quantified they are determined to be conditionally significant beneficial to harbor seals based on whether they actually result in improvements to the prey field to the extent that beneficial population-level effects occur.

Cumulative Effects

For harbor seals, the analysis and conclusions regarding cumulative effects for mortality, prey availability, and disturbance under FMP3.2 are the same as discussed under FMP 3.1.

<u>Spatial/Temporal Concentration of the Fishery</u>

- **Direct/Indirect Effects.** FMP 3.2 offers opportunities for additional temporal and spatial protections relative to baseline conditions and may be more precautionary from the standpoint of prey availability to harbor seals. These effects are determined to be conditionally significant beneficial to harbor seal populations.

- **Persistent Past Effects.** Past effects of spatial/temporal concentration of fisheries are the same as discussed under FMP 3.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future effects of spatial/temporal concentration of fisheries are the same as discussed under FMP 3.1.

- **Cumulative Effects.** Overall, cumulative effects of spatial/temporal harvest of prey are determined to have potentially beneficial effects on the prey fields of harbor seals due to displacement of groundfish fisheries offshore (15 nm shoreline buffer). These effects are considered conditionally significant beneficial based on whether they actually result in improvements to prey fields to the extent that beneficial population-level effects occur.

4.7.8.5 Other Pinnipeds

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

Due to the low level of documented interactions between other pinnipeds and groundfish fisheries (see Section 4.5.8.5), takes and entanglements of other pinnipeds incidental to groundfish fisheries under FMP 3.1 are expected to be similar to the baseline condition, unlikely to cause population-level effects on any species, and considered insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The effects of fisheries harvests on ice seal prey species are insignificant under the baseline due to limited overlap (see Section 4.5.8.5). The effects of fisheries harvest under FMP 3.1 are expected to be similar to the baseline condition and are therefore determined to be insignificant to ice seals.

With regard to Pacific walrus, their diet is composed almost exclusively of benthic invertebrates (97 percent), particularly bivalve molluscs. Fish ingestion has been considered incidental to their normal feeding behavior (Fay and Stoker 1982). Groundfish removals under FMP 3.1 would have an insignificant effect on walrus prey availability.

The diet of northern elephant seals in the GOA is unknown; however, the species is known to be a deep diver. This behavior suggests that their foraging may be partitioned by depth from most groundfish fishing activities. The effects of groundfish harvests on prey species for northern elephant seals are therefore considered to be unknown under FMP 3.1.

Spatial/Temporal Concentration of the Fishery

Due to the limited potential for competitive overlap to occur, the spatial/temporal concentrations of the groundfish fisheries are expected to be inconsequential to pinnipeds in this category under FMP 3.1.

Disturbance

Disturbance of other pinnipeds under the FMP 3.1 management regime is not expected to change relative to the baseline, which is considered of negligible effect, and is therefore rated insignificant.

Cumulative Effects

A summary of the effects of the past/present with regards to other pinnipeds is presented in Section 3.8.3 and 3.8.5 through 3.8.9 (Table 3.8-3 and Tables 3.8-5 through 3.8-9). The predicted direct/indirect effects of the groundfish fishery under FMP 3.1 are described above. Cumulative effects are summarized in Table 4.5-66.

Mortality

- **Direct/Indirect Effects.** Population-level effects are not expected to result from incidental take and entanglement for any of the species in this group under the FMP 3.1 and are rated as insignificant.

- **Persistent Past Effects.** Past external effects on the populations of pinniped include low levels of incidental take in the foreign, JV, and domestic groundfish fisheries and low levels of take in the State-managed fisheries. Spotted seal incidental mortality in groundfish fisheries is one per year between 1995 and 1999 (Angliss and Lodge 2002). For bearded seal, the BSAI groundfish fisheries take an average of 0.6 per year. The Bristol Bay salmon drift gillet fishery from 1990-1993 indicated that 14 mortalities and 31 injuries of bearded seal. No mortalities of ringed seal have been observed in the last ten years in the BSAI groundfish (Angliss *et al.* 2001). For ribbon seal incidental take, the Bering Sea trawl fishery reported one taken in 1990, one in 1991, and one in 1997. An average of 86 elephant seals is taken each year in various gillet fisheries from California to Washington. Incidental take included one in the Bering Sea trawl fishery in 1990, two in the GOA trawl fishery in 1990, and three in the GOA longline fishery in 1990. One juvenile elephant seal, originally misidentified as a bearded seal, was taken in the Bering Sea trawl fishery in 1991 (Angliss *et al.* 2001). Of the 17 Pacific walrus that were caught each year in groundfish trawl fisheries in the EBS between 1990 and 1997, over 80 percent were already decomposed (Gorbics *et al.* 1998). Subsistence is the major human-cause external factor for morality. Annual subsistence harvest rates include 5,265 spotted seal, 6,788 bearded seal, 100 ribbon seal, 9,567 ringed seal, 1,000 walrus and zero elephant seal.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries will likely continue to take very small numbers of seals in this group. Subsistence take of these marine mammals will likely continue at a similar rate to the baseline conditions.

- **Cumulative Effects.** The combined effects of mortality within the other pinniped group resulting from internal effects of the groundfish fisheries and external effects, such as subsistence harvest, are considered insignificant. For spotted, ringed, bearded, and ribbon seals, PBRs cannot be calculated. Walrus take is below PBR and population level effects are unlikely. Elephant seal populations are expanding so overall mortality is considered insignificant. Contributions of the groundfish fisheries to overall mortality is very small.

Abundance of Prey

- **Direct/Indirect Effects.** Except for elephant seals, where the amount of prey overlap is unknown, there is very little overlap of species taken in the groundfish fisheries with prey of the pinnipeds in this group and the effects of fisheries harvest on prey species are determined to be insignificant under FMP 3.1.

- **Persistent Past Effects.** Past effects on spotted seal include foreign, JV, and domestic groundfish fisheries and State-managed fisheries for salmon and herring. For the other ice seals, elephant seals and walrus, no persistent past effects were identified.

- **Reasonably Foreseeable Future External Effects.** Future effects were identified for State-managed fisheries for the spotted seal. Climate change may be either a beneficial factor or adverse factor for the ice seals due to the potential effects on the extent of ice cover in the Bering Sea and effect on abundance and distribution of prey.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance of prey for pinnipeds is considered insignificant for all species. Spotted seals have some overlap of prey with the groundfish fisheries but the harvest of prey by the fisheries is not expected to have population level effects. The amount of groundfish fishery overlap with elephant seals is unknown but, since the elephant seal population is expanding, food does not appear to be limiting so cumulative effects on prey availability are considered insignificant. The amount of prey overlap with the other pinniped species is very limited and is considered insignificant for all species in this group.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** The effects from spatial/temporal concentrations of the fisheries are expected to be insignificant for pinnipeds in this category under FMP 3.1.

- **Persistent Past Effects.** Persistent past effects on spotted seals include foreign, JV, and domestic groundfish fisheries and state-managed fisheries. For other species, no past effects are identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries within the range of spotted seals would be expected to take place in the future in a manner similar to the baseline conditions. Future effects of spatial/temporal concentration of fisheries on ice seals and walrus would not be expected.

- **Cumulative Effects.** The spatial/temporal concentration of the groundfish fishery and all other fisheries is considered to have an insignificant cumulative effect on pinniped prey due to limited seasonal overlap. Population-level effects are unlikely for any of the species in this group.

Disturbance

- **Direct/Indirect Effects.** Similar levels of disturbance to the baseline are expected under FMP 3.1 and are considered insignificant.

- **Persistent Past Effects.** Past sources of disturbance for spotted seals have come from the foreign and JV fisheries, federal domestic groundfish fisheries in the BSAI, and state-managed fisheries for salmon. Overlap of fisheries is minimal for most species. The primary source of external disturbance to the "other pinniped" category would be related to subsistence harvest.

- **Reasonably Foreseeable Future Effects.** State-managed fisheries could be expected to continue at a level similar to the baseline condition. Disturbance from subsistence harvest activities in future years would be expected to be similar to baseline conditions as well.

- **Cumulative Effects.** Cumulative effects of disturbance were determined insignificant for all species based on very limited overlap with the fisheries and the lack of evidence that disturbance has a population-level effect on any of these species.

Direct/Indirect Effects – FMP 3.2

For species within the other pinniped group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under FMP 3.1.

Cumulative Effects

For species within the other pinniped group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under FMP3.2 are the same as discussed under FMP 3.1.

4.7.8.6 Transient Killer Whales

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

Increased harvest rates under this management alternative may result in the increased take of less than one killer whale relative to the baseline, for a total estimated average of fewer than 2 animals per year. It is not known what proportion of these whales were transients versus residents but it is likely that most takes have been resident killer whales since they feed on fish and would be more attracted to fishing activities. The expected level of take would not result in changes to the population trajectory of transient killer whales. Therefore, takes and entanglements of transient killer whales incidental to groundfish fisheries under FMP 3.1 are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The diet of transient killer whales consists of marine mammals. Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant under FMP 3.1.

Spatial/Temporal Concentration of the Fishery

The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant under FMP 3.1.

Disturbance

FMP 3.1 retains the area closures contained in the baseline. The management regime under FMP 3.1 is not expected to result in increased disturbance to killer whales relative to the baseline and is rated insignificant.

Cumulative Effects

The past/present effects on transient killer whales are described in Section 3.8.22 (Table 3.8-22) and the predicted direct/indirect effects of the groundfish fishery under FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-67. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects being availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With regard to incidental take and entanglement, FMP 3.1 is not likely to result in changes to the population trajectory of transient killer whales and is considered insignificant.

- **Persistent Past Effects.** Mortality has been documented in the JV fisheries, domestic groundfish fisheries, state-managed fisheries, and intentional shootings. Past incidental take in the groundfish fisheries is less than 2 animals per year, but its not known if these animals were transients or residents. In addition to mortalities caused by entanglement, killer whales are also susceptible to injury or mortality through vessel strikes. One killer whale was reported to be killed when it struck the propeller of a BSAI groundfish trawl vessel in 1998 (Angliss and Lodge 2002). The EVOS resulted in the loss of half of the individual killer whales from the AT1 pod in PWS (Matkin *et al.* 1999). This distinct group of whales is being evaluated for recognition as a separate stock and protection as a depleted stock under the MMPA. Contaminant levels in whales in this group were found to be many times higher than others killer whales (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Future mortality is expected from external factors such as state-managed fisheries, intentional shooting, and marine pollution, particularly persistent organic pollutants such as DDT and PCBs (Matkin *et al.* 2001).

- **Cumulative Effects.** Cumulative effects of mortality resulting from internal effects of the groundfish fisheries and external factors are determined to be insignificant. The exception to this finding is in the AT1 transient group in PWS. The cumulative effects of mortality on this group were determined to be significantly adverse due to the past external effects of the EVOS and their subsequent population decline.

Prey Availability

- **Direct/Indirect Effect.** Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant.

- **Persistent Past Effects.** Since marine mammals are the primary prey of transient killer whales, all of the factors that have been identified as affecting the abundance or distribution of cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include commercial and subsistence harvest, intentional shootings, incidental take in all fisheries, marine pollution, climate change, and regime shifts. In addition, there is the potential for past indirect effects of fisheries on the abundance of Steller sea lions, fur seals, and harbor seals, all of which are important prey species for transient killer whales. Declines in harbor seals in PWS after the EVOS could have affected the AT1 group of transient killer whales through their food supply (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey species important to transient killer whales, primarily marine mammals, would include state-managed fisheries to a small extent and subsistence harvests of the various marine mammals.

- **Cumulative Effects.** The cumulative effects on different marine mammal species are varied, with some populations declining substantially while others increase. Although some individual whales may specialize on particular prey species, the ability of these top predators to switch prey and forage over vast areas is believed to decrease the importance of any one species or stock of marine mammal prey. The overall availability of prey does not appear to be having population level effects on transient killer whales and therefore the cumulative effect is considered insignificant.

<u>Spatial/Temporal Concentration of the Fishery</u>

- **Direct/Indirect Effects.** The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant.

- **Persistent Past Effects.** All persistent past effects that have been identified for cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include the potential contribution of the spatial/temporal concentration of past fisheries to have caused localized depletion of prey for Steller sea lions, harbor seals, and northern fur seals with consequent population-level effects on those species.

- **Reasonably Foreseeable Future External Effects.** The future spatial/temporal concentration of external fisheries could have indirect effects on the abundance and distribution of marine mammals that are important prey for transient killer whales.

- **Cumulative Effects.** The cumulative effects of the spatial/temporal concentration of fisheries on different marine mammal species result in changes to the abundance and distribution of prey to transient killer whales. Since transient killer whales. are able to switch prey and forage over vast areas, the potential localized depletion of any one species or stock of marine mammal prey is unlikely to have population level effects on the killer whales. The cumulative effect of the spatial and temporal harvest of fish from all fisheries does not appear to be having population level effects on transient killer whales and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance to killer whales are expected to be similar to baseline conditions and are insignificant.

- **Persistent Past Effects.** Some levels of disturbance have likely occurred from foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Vessel traffic external to the fisheries has also contributed to overall disturbance of these animals. Effects of the level of disturbance on transient killer whales are largely unknown.

- **Reasonably Foreseeable Future External Effects.** External effects of state-managed fisheries and other vessel traffic on disturbance will likely occur in future years at a level similar to the baseline.

- **Cumulative Effects.** Cumulative effects of disturbance to transient killer whales are not likely to result in any population-level effects and are therefore considered insignificant.

Direct/Indirect Effects – FMP 3.2

For transient killer whales, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under FMP 3.1.

Cumulative Effects

For transient killer whales, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under FMP3.2 are the same as discussed under FMP 3.1.

4.7.8.7 Other Toothed Whales

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, FMP 3.1 is not likely to result in significant changes to the population trajectories of toothed whales. Incidental takes attributed to the fisheries and entanglement in fishing gear and marine debris occur at low levels thought to be insignificant to toothed whale populations (see section 4.5.8.7).

Fisheries Harvest of Prey Species

The effects of the groundfish fisheries on the toothed whales are largely constrained by differences between their prey items and the target species of the fisheries harvest (see Section 4.5.8.7). FMP 3.1 is not expected to increase the level of interactions above the baseline condition and is therefore determined to be insignificant at the population level.

Spatial/Temporal Concentration of the Fishery

As stated above, groundfish fisheries have little competitive overlap with toothed whales. The spatial and temporal concentration of the fisheries under FMP 3.1 are expected to be similar to the comparative baseline conditions, which are considered to have insignificant effects on endangered sperm whales and other toothed whales at the population level.

Disturbance

Disturbance of endangered sperm whales and other toothed whales under the FMP 3.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

Cumulative Effects

The past/present effects on the other toothed whale group are described in Sections 3.8.19 through 3.8.21 and 3.8.23 through 3.8.25 (Tables 3.8-19 through 3.8-25) and the predicted direct/indirect effects of the groundfish fishery under the FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-68. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Toothed whale mortality resulting from groundfish fishing activities is rare and is not expected to affect the population trajectories of any of these species. Therefore, it is considered insignificant at the population level.

- **Persistent Past Effects.** Persistent past effects on species within the other toothed whale group include incidental take and entanglement in foreign, JV, Federal domestic groundfish fisheries and State-managed fisheries, and subsistence hunting on beluga whales. The decline of the Cook Inlet beluga population is thought to have been the result of subsistence harvests, which ranged from 21 to 123 animals per year between 1993 and 1998. Only one beluga was harvested in 2001 under by hunters from Native Village of Tyonek and one beluga was harvest in 2002 by the Cook Inlet community hunters. Belugas are incidentally taken the State-managed salmon gillet fisheries in Bristol Bay and Cook Inlet. However, one beluga was reported to be taken from the eastern Bering stock in 1996 and 7 were reported taken in Bristol Bay in 2000. In the BSAI and GOA groundfish fisheries, no mortality or serious injuries to belugas have been observed. Harbor porpoise have not been taken in the observed groundfish fisheries over a ten year period between 1990 to 1998 (Angliss *et al.* 2001). Salmon gillet fisheries in southeast Alaska take approximately 3 individuals per year. Dall porpoise mean annual mortality was 6.0 for the Bering Sea groundfish trawl fishery, 1.2 for the GOA groundfish trawl fishery, and 1.6 for the Bering Sea groundfish longline fishery. The Alaska Peninsula/Aleutian Island salmon drift gillet fishery has a higher take of Dall's Porpoise with an estimated 28 porpoises in one year (1990). Thousands of Pacific white-sided dolphins were killed annually between 1978 and 1991 in the high seas driftnet fisheries, which no longer occurs (Angliss *et al.* 2001). One Pacific white-sided dolphin was taken in the BSAI trawl fishery and one in the BSAI longline fishery during the same time span (Angliss *et al.* 2001). State-managed salmon gillet fisheries take approximately 2 dolphins per year.

Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 with the highest counts occurring in 1968 when 16,357 sperm whales were harvested after which the population were severely depleted. Sperm whale interactions with longline fisheries operating in the GOA are known to occur and may be increasing in frequency. Sperm whale have been known to prey on sablefish caught on commercial longline gear in the GOA. Only three entanglements have been reported in the GOA longline fishery.

For killer whales, the combined mortality from the observed groundfish fisheries was 1.4 whales per year (Angliss *et al.* 2001). While it is most likely that whales interacting with fisheries are from resident pods (since they eat fish), no genetic testing has been done on whales incidentally taken in the groundfish fisheries to ascertain whether they were from resident or transient stocks.

For beaked whales (Baird's, Cuvier's, or Stejneger's), no incidental take or entanglement in BSAI and GOA groundfish trawl, longline, and pot fisheries has been documented (Hill and DeMaster 1999).

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and state-managed fisheries were identified as potential effect in the future since several of these species range outside of BSAI and GOA during the winter months. Subsistence take of some beluga whales would be expected to continue similar to the baseline conditions. Other species are not taken for subsistence purposes.

- **Cumulative Effects.** Cumulative effects of mortality resulting from internal and external factors are considered insignificant for all non-ESA listed species due to the low level of incidental take in the groundfish fisheries and limited external human-caused mortality.

  For the endangered sperm whale, the cumulative effect was also considered insignificant because the very low level of incidental take in the groundfish fisheries and very limited human-caused mortality from external sources is not expected to delay the recovery of sperm whale populations.

<u>Prey Availability</u>

- **Direct/Indirect Effects.** The groundfish fishery under FMP3.1 is not expected to increase the level of competitive interactions for toothed whale prey from the baseline condition and is therefore considered to have insignificant effects on toothed whale prey.

- **Persistent Past Effects.** Although this group preys on a wide variety of fish species, past effects on the availability of prey for this groups are identified for fisheries in general and include the foreign, JV, and federal domestic groundfish fisheries and the state-managed fisheries for salmon and herring. The diversity of diet in this whale group results in limited overlap for most species with the possible exception of sperm whales and resident killer whales.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries were identified an the external factor having a potential effect on prey for these species in the future. Climate and regime shift are also identified but the direction and magnitude of these effect are difficult to predict.

- **Cumulative Effects.** The ability of these whale species to forage over wide areas and on a variety of prey species moderates any potential impacts from fisheries competition. Cumulative effects on prey availability were identified for this group, including a very limited contribution from the groundfish fishery, but the degree of fishery harvest and bycatch of prey important to these whale species is not expected to have population-level effects on any species, including the endangered sperm whale, and is therefore considered insignificant.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** Spatial and temporal fishing measures under FMP 3.1 do not deviate from the baseline, which does not appear to be causing localized depletion of prey for any species of toothed whale, and are thus determined to be insignificant.

- **Persistent Past Effects.** The spatial/temporal concentration of foreign, JV, and domestic groundfish fisheries and the State-managed fisheries are believed to have had minimal effects on the abundance and distribution of toothed whale prey.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue in a manner similar to the baseline conditions. Effects of future fishing activities on toothed whale prey are expected to be minimal.

- **Cumulative Effects.** The ability of toothed whales to forage over wide areas and on a variety of prey species moderates any potential impacts from localized depletion of prey from the spatial/temporal concentration of fisheries. Cumulative effects on prey abundance and distribution, including a very limited contribution from the groundfish fishery, are not expected to have population-level effects on any species, including the endangered sperm whale, and are therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Effects of disturbance from the groundfish fishery under FMP 3.1 on toothed whale populations are determined to be insignificant at the population level..

- **Persistent Past Effects.** Past potential disturbance effects on species in this group were identified for foreign, JV, and federal domestic groundfish fisheries, however, there is little indication of an adverse population-level effect. General vessel traffic likely also contributes to disturbance for these species.

- **Reasonably Foreseeable Future External Effects.** Increases in the general marine vessel traffic and continued fishing activity in the state-managed fisheries were identified as potential sources of disturbance.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external factors is found to be insignificant for endangered sperm whales and other toothed whale species based on the lack of evidence that disturbance has a population-level effect for any of these species. For sperm whales, there is growing evidence that the whales are attracted to fishing vessels as reliable and easy sources of food.

Direct/Indirect Effects – FMP 3.2

For species within the other toothed whales group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under FMP 3.1

Cumulative Effects

For species within the other toothed whales group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under FMP 3.2 are the same as discussed under FMP 3.1.

4.7.8.8 Baleen Whales

Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

With respect to incidental take and entanglement in marine debris incidental to groundfish fisheries, FMP 3.1 is expected to be similar to the baseline condition and to have insignificant effects on the population trajectories of other baleen whales. See the discussion provided for incidental take of other baleen whales in Section 4.5.8.8.

Fisheries Harvest of Prey Species

The effects of groundfish fisheries under FMP 3.1 are considered insignificant to baleen whales in regards to harvest of prey species due to the lack of competitive overlap in species targeted by each (see Section 4.5.8.8).

Spatial/Temporal Concentration of the Fishery

Groundfish fisheries have little, if any, competitive overlap with baleen whale forage species; therefore changes to the spatial/temporal concentration of the fisheries is expected to result in effects that are insignificant at the population level.

Disturbance

Disturbance of baleen whales under the FMP 3.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

Cumulative Effects

The past/present effects on the other baleen whale group are described in Sections 3.8.11 to 3.8.18 (Tables 3.8-11 through 3.8-18) and the predicted direct/indirect effects of the groundfish fishery under the FMP 3.1 are described above. The effects considered in this analysis are listed in Table 4.5-69. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effect.** The low level of take and entanglement of baleen whales projected to occur under FMP 3.1 is considered insignificant at the population level..

- **Persistent Past Effects.** Commercial whaling from last century has had a lingering effect on almost all of the baleen whales in this group with the possible exception of the minke whale. These include blue whales, fin whales, sei whales humpback whales, gray whales and right whales. A full discussion of the effects of commercial whaling is presented in Section 3.8.9. Subsistence harvest of whales has also affected several of the baleen whales in the past. Gray whales are harvested both in Alaska and in Russia and have a 5-year quota of 620 whales. The 1968-1993 average take for Russian and Alaska Natives combined was 159 whales per year. Bowhead whales are harvested under the International Whaling Commission which allows up to 67 strikes per year although actual strikes have been less than the quota since 1978. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Fin whales were reported in this region year-round, most often in the summer and autumn (POP 1997). Humpback whales are present year-round in Alaska waters but are most frequently reported during the summer and autumn. In 1997, a dead humpback was found entangled in netting and trailing orange buoys near the Bering Strait. It is often difficult to determine if the entanglement occurred with active or derelict gear, or to identify the fishery the derelict gear originated from. Two mortalities (in October 1998 and February 1999) were reported by observers in the BS pollock trawl fishery operating near Unimak Pass. The extent of interactions between bowhead whales and the groundfish fishery is not known. Bowhead whales are present in the Bering Sea during winter and early spring but are usually associated with ice-covered regions. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Of 236 bowhead whales examined from the Alaskan subsistence harvest (from 1976 to 1992), three had visible ship-strike injuries from unknown sources and six had ropes attached or scars from fishing gear (primarily pot gear), one found dead was entangled in ropes similar to those used with fishing gear in the Bering Sea (Philo *et al.* 1992). Since 1992, additional bowhead whales have been observed entangled in pot gear or with scars from ropes. The extent of interactions between gray whales and the groundfish fishery is not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Since 1997, five entanglements (mostly in pot gear) and one ship strike mortality have been reported in Alaska waters. Since 1989, no incidental takes of right whales are known to have occurred in the north Pacific. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. Because the right whale population is believed to be very small, any mortality incidental to commercial fisheries would be considered to be significant. Yet, based on the lack of reported mortalities of right whales, the estimated annual mortality rate incidental to commercial fisheries is zero whales per year from this stock.

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and state-managed fisheries are expected to continue to take small numbers of baleen whales in the coming years. Entanglement in fishing gear will also continue to affect baleen whales throughout their ranges. Subsistence harvest for gray whales and bowhead will continue to be the largest source of human-caused mortality.

- **Cumulative Effects.** Cumulative effects of mortality resulting from internal effects of the fishery and contributions from external factors are considered conditionally significant adverse for fin, humpback, and northern right whales due to past effects on their population, potential for interactions with fisheries, and their endangered status. Right whales are very rare so even one human-caused mortality could be considered significant. Given the overlap of their preferred habitat with the BSAI fisheries, the chances of future adverse interactions with fishing gear are more than negligible. The adverse rating for these three species is conditional on whether future take or entanglement substantially affects their rates of recovery. Cumulative effects are found to be insignificant for the endangered blue, bowhead, and sei whales. These species rarely interact with the fisheries so population-level effects are not anticipated. Mortality is also considered insignificant for non-ESA-listed minke and gray whales. Population-level effects are not expected for either of these species.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 3.1 are determined to be insignificant to baleen whale species in regards to harvest of prey species and the lack of competitive overlap in species targeted by each.

- **Persistent Past Effects.** Persistent past effects on availability of prey were not identified due to the lack of competitive overlap in prey species targeted.

- **Reasonably Foreseeable Future External Effects.** Future external effects were identified from state-managed fisheries such as herring, which are preyed on by humpback whales and fin whales. Other species would not be expected to be affected through prey availability.

- **Cumulative Effects.** Cumulative effects of prey availability on baleen whale species are not anticipated on a population level for any of the species in this group primarily due to the limited overlap of prey species with fisheries. The effects are considered insignificant for all species.

Temporal and Spatial Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial and temporal concentration of fishery harvests under FMP 3.1 do not deviate substantially from the baseline; thus the effects are determined to be insignificant.

- **Persistent Past Effects.** Persistent past effects of temporal and spatial concentrations of the fisheries were not identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries would be expected to continue and would contribute to some degree of effect on some species within the baleen whales group.

- **Cumulative Effects.** Cumulative effects on the spatial and temporal concentration of harvest of baleen whale prey resulting from internal effects of the fishery and contributions from external factors are considered insignificant for endangered and non-ESA listed species in this group due to the limited overlap of prey species within the fisheries.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance similar to those that occurred to other baleen whales under baseline conditions are expected under FMP 3.1 and are considered insignificant.

- **Persistent Past Effects.** Some level of disturbance has likely occurred from foreign and JV fisheries, domestic groundfish fisheries, and state -managed fisheries along with general vessel traffic. For some species, such as the gray whale and bowhead whale, subsistence activities have contributed to disturbance of these animals.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and general vessel traffic from recreational boating, whale watching, and commercial vessels would be expected to continue in future years in addition to subsistence activities.

- **Cumulative Effects.** Cumulative effects of disturbance resulting from internal and external sources are determined to be similar to the baseline condition and not likely to result in a population-level effect for any of the species in this group. Therefore, the cumulative effect is considered to be insignificant for both endangered and non ESA-listed baleen whales.

Direct/Indirect Effects – FMP 3.2

For species within the baleen whales group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under FMP 3.1

Cumulative Effects

For species within the baleen whales group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under FMP 3.2 are the same as discussed under FMP 3.1.

4.7.8.9 Sea Otters

Direct/Indirect Effects – FMP 3.1

Incidental Take/Entanglement in Marine Debris

Sea otter interactions with fishing gear, either passive or active, are infrequent. Laist (1997) reported that sea otter entanglement in marine debris is rare. Likewise, incidental takes in fishing gear occur at a rate too low to cause population level effects. While the PBRs for the three sea otter stocks in Alaska were 871 (southeast), 2,095 (southcentral), and 5,699 (southwest), mortalities incidental to commercial fishing were 0, fewer than 1, and fewer than 2 per year, respectively (Angliss and Lodge 2002).

In southwest Alaska, the North Pacific Groundfish Observer Program reported eight kills in the Aleutian Islands sablefish pot fishery in 1992. No other sea otter kills were reported by NOAA observers in the region from 1990 to 1996. In the 2000 "List of Fisheries" sea otters were added to the BSAI groundfish trawl as a "species recorded as taken in this fishery." The USFWS is currently pursuing information regarding the extent of that possible interaction. The total fishery mortality and serious injury for the Alaska sea otter are considered to be insignificant (i.e., will not affect population trajectories). The level of incidental catch and entanglement for sea otters under FMP 3.1 is likely to be similar to the baseline condition and the effects are considered insignificant at the population level.

Fisheries Harvest of Prey Species

The effects of FMP 3.1 on sea otters are limited by differences between their prey and the fisheries harvest targets. Sea otters consume a wide variety of prey species, including annelid worms, crabs, shrimp, mollusks (e.g., chitons, limpets, snails, clams, mussels, and octopus), sea urchins, and tunicates. Occasionally, groundfish (e.g., sablefish, rock greenling, and Atka mackerel) may also be consumed but invertebrates are considered the predominant elements of their diet (Kenyon 1969, USFWS 1994). Given the minor importance of groundfish in their diet, fisheries removals under FMP 3.1 are expected to be similar to the baseline condition and the effects on prey availability to otters are considered insignificant at the population level.

Spatial/Temporal Concentration of the Fishery

The grounds for suggesting competition for forage between sea otters and commercial fisheries are weak despite the species broad geographical distribution in the GOA and the Aleutian Islands. Sea otters inhabit waters of the open coast, as well as bays and the inside passages of southeastern Alaska. Since their primary prey items are found on the bottom in the littoral zone, to depths of 50 m, the majority of otters feed within 1 km of the shore (Kenyon 1969). In areas where shallow waters extend far offshore (e.g., Unimak Island), sea otters have been reported as far as 16 km offshore. They are often seen resting and diving for food in and near kelp beds (Kenyon 1969). Because of this habitat preference for shallow areas, they do not overlap spatially with groundfish fisheries. Since the spatial and temporal concentration of the fisheries under FMP 3.1 is expected to be similar to the baseline, which does not appear to affect the localized abundance of sea otter prey, FMP 3.1 is considered to be insignificant for this effect on sea otters.

Disturbance

As noted for many of the other marine mammals, the effects of disturbance caused by vessel traffic, fishing operations, or sound production on sea otters in the GOA and BSAI are expected to be insignificant. Sea otters exhibit considerable tolerance for vessel traffic and in some cases are attracted to small boats passing by (Richardson *et al.* 1995). Sea otters may be more tolerant of underwater sound relative to other species, owing to the greater amount of time they spend at the surface. Levels of disturbance under FMP 3.1 are expected to be similar to the baseline level and are therefore considered insignificant for sea otters.

Cumulative Effects

The past/present effects on the sea otter are described in Section 3.8.10 (Table 3.8-10). Representative direct effects used in this analysis include mortality and disturbance. Major indirect effects are availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The effects of incidental take and entanglement on sea otters under FMP 3.1 are considered insignificant.

- **Persistent Past Effects.** Commercial exploitation for pelts had a huge impact on sea otters dating from the mid-1700s to the late 1800s, causing them to become nearly extinct (Bancroft 1959, Lensink 1962). Protective measures instituted in 1911 have allowed remnant groups to increase and reoccupy much of the historic sea otter range in Alaska (Kenyon 1969, Estes 1980). Residual effects from this early harvest likely persist in several areas. Alaska Natives have hunted sea otters for pelts and meat throughout history. Current harvest levels represent 9 percent of PBR for the southwestern stock, 15 percent of PBR for the southcentral stock, and 35 percent of PBR for southeast stock. (USFWS 2002a, 2002b and 2002c). In 1992, fisheries observers reported 8 sea otters taken incidentally by the Aleutian Island Black Cod Pot Fishery. During that year, only a third of the fisheries were observed, yielding an estimate of 24 otters killed in cod pot gear. No other sea otter takes were reported from observed fisheries in the range of the southwest stock from 1993 through 2000. In 1997, one sea otter was reported to have been taken in the BSAI groundfish trawl fishery (USFWS 2002a, 2002b and 2002c). Oil spills, such as the EVOS, can result in substantial mortality of sea otters. Sea otter numbers have declined dramatically from the Alaska Peninsula to the Bering Sea and this stock is being considered for listing under the ESA.

- **Reasonably Foreseeable Future External Effects.** Low levels of incidental take in commercial and subsistence fisheries, subsistence hunting, and periodic mortalities from oil spills are likely to continue in the future. Population level effects from killer whale predation may continue in the southwest Alaska stock, depending on the recovery of alternate prey and behavior of transient killer whales.

- **Cumulative Effects.** The cumulative effects of mortality from all sources are different for different stocks of sea otters. The sea otter populations of southeast and southcentral Alaska appear to be stable or increasing and are not expected to have additional mortality pressures in the future. Cumulative effects for these stocks are therefore considered insignificant. The rapid decline of the southwest Alaska stock does not appear to be the result of food shortages, disease, or toxic contamination and is likely the result of increased predation by transient killer whales following the collapse of their preferred sea lion prey population in the 1980s (Estes *et al.* 1998). Since the mechanisms of the population decline are still under investigation, the cumulative effects on the southwest stock are considered to be conditionally significant adverse from mortality.

Prey Availability

- **Direct/Indirect Effects.** The effects of the FMP 3.1 on sea otters are limited by differences between their prey and the fisheries harvest targets. As such, the effects of harvesting key prey species in groundfish fisheries are determined to be insignificant for sea otters.

- **Persistent Past Effects.** The groundfish fisheries have had little effect on the availability of prey in the past for sea otters due to the limited overlap in their prey species and the fish targeted by the groundfish fisheries. There is some minor overlap between state-managed crab fisheries and sea otter prey.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries that take crab from shallow waters were identified as having future external effects on sea otters. The overlap primarily occurs in inshore areas or offshore areas with relatively shallow water.

- **Cumulative Effects.** Cumulative effects on prey availability resulting from internal effects of the groundfish fisheries and external factors, such as the crab fisheries, are determined to be insignificant due to the very limited overlap of these fisheries and the sea otter forage species. Population-level effects are not anticipated.

Spatial/Temporal Concentration of the Fisheries

- **Direct/Indirect Effects.** Despite the species broad geographical distribution in the GOA and the Aleutian Islands, they do not generally overlap spatially with groundfish fisheries. Therefore, the effects of the spatial/temporal concentrations of the fisheries are insignificant for sea otters.

- **Persistent Past Effect.** The limited spatial overlap of groundfish fisheries and other fisheries in the past have limited their interaction with sea otter prey. Past effects of spatial/temporal concentration have likely been in very specific areas and associated with State-managed crab fisheries.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries are likely to continue into the future at a level similar to the baseline conditions.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey in the internal and external fisheries is considered to be insignificant due their limited spatial overlap with sea otter habitat. These fisheries are unlikely to have population-level effects.

Disturbance

- **Direct/Indirect Effects.** Baseline levels of disturbance caused by vessel traffic, fishing operations, or sound production on sea otters in the GOA and BSAI are considered to be insignificant. Levels of disturbance under FMP 3.1 are expected to be similar to the baseline; therefore, the effects of disturbance on sea otters are considered insignificant.

- **Persistent Past Effects.** Past disturbance levels are primarily related to vessel traffic from fisheries and other vessels and disturbance associated with subsistence harvest of sea otters

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue at a similar level to the baseline conditions. Vessel traffic within sea otter habitat in future years would also be expected to be similar to the baseline.

- **Cumulative Effects.** Cumulative effects of disturbance on sea otters are considered insignificant and are unlikely to result in any population-level effects. Contribution of the groundfish fishery to the overall cumulative effect is minor.

Direct/Indirect Effects – FMP 3.2

For sea otters, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under FMP 3.1

Cumulative Effects

For sea otters, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under FMP 3.2 are the same as discussed under FMP 3.1.

4.7.9 Socioeconomic Alternative 3 Analysis

This alternative would seek to accelerate the existing precautionary management measures through community or rights-based management, ecosystem-based management principles and, where appropriate and practicable, increase habitat protection and impose additional bycatch constraints. This section contains both quantitative and qualitative assessments of select economic and social effects of FMP 3.1 and FMP 3.2.

In general, the quantitative economic outcomes of this management policy appear nearly identical to those projected under Alternative 1. No significant differences between the management policies are projected, at least in the variables for which changes are captured by the projection model. Most of the differences between the policies occur in variables such as product prices, harvesting and processing capacity and average costs that have not been quantified in the analysis.

4.7.9.1 Harvesting and Processing Sectors

The model and analytical framework used in the analysis of the effects of FMP 3.1 on the harvesting and processing sectors are described in Section 4.1.7.

Table 4.7-6 summarizes projected impacts of FMP 3.1 on harvesting and processing sectors. The numbers in the table reflect the 5-year average of outcomes projected for 2003 to 2007. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, harvests of this species are estimated to increase by 36 percent, from 218 thousand mt to 297 thousand mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment and groundfish payments to labor.

4.7.9.1.1 Catcher Vessels

Direct/Indirect Effects of FMP 3.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period in Table 4.7-6 to 2001 catcher vessel conditions reveals that under FMP 3.1 there would be few significant changes in overall retained harvests of groundfish relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, retained catches of this species are expected to increase by about 55 percent. In addition, an increase in the TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant increase in the retained harvests of these species. Retained harvests of pollock and flatfish are not expected to change significantly. This leads to direct/indirect effects ratings of insignificant and significantly beneficial (A-R-S-O) under FMP 3.1.

Ex-Vessel Value

The total ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline but not significantly, leading to a direct/indirect effect rating of insignificant under FMP 3.1. Increased Pacific cod harvests by the smaller trawl catcher vessels and pot catcher vessels account for much of the increase in groundfish ex-vessel value. Longline vessels are expected to benefit from the increased catches of sablefish and rockfish. These increases in catch are expected to occur despite the reduction in PSC limits for halibut, herring, crab, and salmon in the GOA and BSAI. Catcher vessel fisheries which currently close seasonally because they reach seasonal PSC limits include the Pacific cod fisheries in the GOA and BSAI, and the GOA flatfish fisheries.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to increase under FMP 3.1, but not significantly.

Impacts on Excess Capacity

A conditionally significant decrease in excess capacity in the harvesting sectors is expected under this FMP relative to the comparative baseline, which leads to a direct/indirect effect rating of conditionally significant beneficial under FMP 3.1. The significance of the decrease is conditional because it is uncertain to what extent FMP 3.1 would extend rights-based management to additional groundfish fisheries. One of the primary reasons for expanding the use of rights-based management is to prevent the build-up of excess harvesting and processing capacity or reduce excess capacity that already exists (NMFS 2001a). Excess capacity both contributes to and is the result of the race for fish, with its associated potential adverse impacts on profitability, product quality, and safety. Rights-based systems, whether they allocate shares of the catch to individuals or groups, are incentive adjusting methods, in that they attempt to control capacity by creating economic incentives for owners of vessels to decrease their use of labor and capital rather than by directly regulating the level of fishing effort.

The implementation of additional individual or group-based (e.g., community or cooperative) quota systems that end the race for fish and allow transfer of quota shares would be expected to lead to some consolidation of quota to fewer vessels. The degree of consolidation will vary depending on the level of excess capacity, economies of scale and scope in harvesting, and rules that restrict transfer and accumulation of quota shares (NMFS 2001a). Similar consolidation could occur with expanded use of cooperatives or community quota programs. Some excess capacity (in the sense of an ability of vessels and processors to catch and harvest a TAC in less time than a maximum season length would allow) can be expected to persist regardless of what type of additional rights-based measures are put in place. This is generally the case for a number of reasons: it is often not economically efficient to operate at maximum possible production levels; there are typically certain times of the year when it is more efficient and profitable to harvest and process fish; and alternative uses for fishing and processing capital are limited (NMFS 2001a).

Average Costs

A conditionally significant decrease in average costs is expected under this FMP relative to the comparative baseline, which leads to a direct/indirect effect rating of conditionally significant beneficial under FMP 3.1. The significance of the decrease in average costs is conditional because it is uncertain to what extent FMP 3.1 would extend rights-based management to additional groundfish fisheries. Increased rationalization of the fisheries would be expected to reduce the costs of harvesting. Individual vessels will have the opportunity to select the least cost combination of fishing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective harvesting operations. Fixed costs will be reduced by consolidating harvesting operations and retiring or selling off vessels. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting rights and on the level of excess capacity prior to implementation of remedial measures.

The measures under FMP 3.1 include potential increases in time and area closures to protect the Steller sea lion. These time and area closures could result in increased operating costs and/or reduced harvest levels, and higher costs could offset some of the savings made through rationalization. In addition, a proposal to implement major changes in the time and area provisions of the existing Steller sea lion protection measures might require additional consultation under Section 7 of the ESA. These consultations could result in measures that further restrict fishing operations. Alternatively, improving the data on the interaction of Steller sea lions and fisheries may allow for relaxation of some of Steller sea lion protection measures and result in beneficial economic benefits for fishery participants.

Fishing Vessel Safety

A conditionally significant increase in fishing vessel safety is expected under this FMP relative to the comparative baseline, which leads to a direct/indirect effect rating of conditionally significant beneficial under FMP 3.1. The significance of the increase in fishing vessel safety is conditional because it is uncertain to what extent FMP 3.1 would extend rights-based management to additional groundfish fisheries. Rights-based systems of any kind are expected to improve safety by reducing the pressure to fish under dangerous conditions (NMFS 2001a). The race for fish creates incentives to fish farther from shore or in areas and seasons with more hazardous weather conditions and requires crew members to work for long stretches with little rest or sleep. Rights-based systems should slow down the fishing and reduce the financial penalty incurred by opting to stop fishing under unsafe conditions. The most important benefit of improved safety will be a decrease in fishery related injuries and loss of life. Other benefits include savings from not having to replace lost vessels and gear. Finally, significant improvements in safety, if they occur, should result in decreased insurance costs for industry (NMFS 2001a).

At the same time, it is important to recognize that rationalized fisheries do not necessarily guarantee improvements in safety for fishermen. Under an IFQ program, for example, market opportunities or biological conditions (e.g., spawning aggregations) may still encourage fishermen to fish at times or in places that are unsafe.

Cumulative Effects of FMP 3.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety.

<u>Groundfish Landings By Species Group</u>

- **Direct/Indirect Effects.** An insignificant change in retained harvest of groundfish relative to the comparative baseline is projected under FMP 3.1 with the exception of Pacific cod, sablefish and rockfish which are likely to increase significantly. This leads to direct/indirect effects ratings of insignificant/significantly beneficial under FMP 3.1.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects.** Given the current downward trends in the commercial salmon and crab fisheries, catcher vessels that rely on a mix of groundfish, salmon and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under FMP 3.1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (54 percent), as well as for sablefish and rockfish. Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under FMP 3.1. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is not expected to increase significantly under FMP 3.1.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in ex-vessel value (11 percent) that are predicted for FMP 3.1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from FMP 3.1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Changes in ex-vessel value relative to the baseline under FMP 3.1 are insignificant.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (10 percent) under FMP 3.1, may mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (11 percent) under FMP 3.1. Therefore, cumulative effects on employment and payments to labor are expected to be insignificantly beneficial under FMP 3.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Changes in excess capacity are likely to be conditionally significant beneficial under FMP 3.1.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Under FMP 3.1, the extent to which rights-based management would be implemented in groundfish fisheries is uncertain. Should rights-based management extend to many of the groundfish fisheries, excess capacity would be reduced in that particular fishery. Excess capacity currently exists in other fisheries to a certain extent as well and may continue to exist unless management measures are taken to reduce it. Assuming that rights-based management is implemented to additional groundfish fisheries, a conditionally significant beneficial cumulative effect is likely for excess capacity under this FMP. (For details see the Overcapacity Paper in Appendix F-8).

Average Costs

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects are expected to occur for average costs under FMP 3.1.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Area closures also affect average costs through increases or decreases in transit time to fishing areas. Increases in closure areas, increase costs whereas decreases in closures usually decrease costs. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with average costs in the groundfish fishery, cumulative effects may result. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. The extent to which rights-based management and community cooperatives would be implemented is uncertain. Should these programs be implemented average costs would be reduced. Overall, conditionally significant beneficial cumulative effects are projected for average costs under FMP 3.1.

<u>Fishing Vessel Safety</u>

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects are predicted under FMP 3.1.

- **Persistent Past Effects.** The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Under FMP 3.1, vessel safety could improve due to the end of the race for fish and less pressure to fish under dangerous conditions. Closures implemented through other fisheries may affect vessel safety in the groundfish fisheries though these closures are not expected to result in a significant cumulative effect on vessel safety. Thus, a conditionally significant beneficial cumulative effect is projected for FMP 3.1 as a result of rights-based management that could be implemented.

Direct/Indirect Effects of FMP 3.2

Table 4.7-6 summarizes projected impacts of FMP 3.2 on harvesting and processing sectors. The numbers in the table reflect the 5-year average of outcomes projected for 2003 to 2007. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, harvests of this species are estimated to increase by 30 percent, from 218 thousand mt to 284 thousand mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment and groundfish payments to labor. Bycatch of non-target species and PSC is expected to decrease with incentives includes in rationalization programs.

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 catcher vessel conditions reveals that under FMP 3.2 there would be a number of significant changes in overall retained harvests of groundfish relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, retained catches of this species are expected to increase by about 48 percent, leading to a significantly beneficial effect under this FMP. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the retained harvests of these species, leading to a significantly adverse effect under this FMP. Retained harvests of pollock and flatfish are not expected to change significantly.

Reducing PSC limits for herring, crab, halibut and salmon in the BSAI could impact the temporal nature of many fisheries. Fisheries which currently close seasonally because they exceed seasonal PSC limits could have even shorter seasons and possibly harvest less of the TAC if PSC limits are reduced. However, other measures implemented under FMP 3.2 such as bycatch reduction incentive programs and increased rationalization may lead to a reduction in prohibited species bycatch rates and thereby lessen the constraints of PSC limits on groundfish fisheries, regardless of whether or not the limits are reduced.

Ex-Vessel Value

The ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by the smaller trawl catcher vessels and pot catcher vessels account for much of the increase in groundfish ex-vessel value. Longline vessels are expected to experience a significant reduction in ex-vessel value due to the decrease in catches of rockfish and sablefish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to decrease under FMP 3.2, but not significantly. Longline vessels account for most of the decrease in employment and payments to labor.

Impacts on Excess Capacity

The comprehensive rationalization program that would be implemented under FMP 3.2 is expected to result in a significant decrease in excess capacity in the harvesting and processing sectors relative to the comparative baseline, leading to a significantly beneficial rating for the direct/indirect effect under FMP 3.2. One of the primary reasons for expanding the use of rights-based management is to prevent the build-up of excess harvesting and processing capacity or reduce excess capacity that already exists (NMFS 2001a). Excess capacity both contributes to and is the result of the race for fish, with its associated potential adverse impacts on profitability, product quality, and safety. Rights-based systems, whether they allocate shares of the catch to individuals or groups, are incentive adjusting methods, in that they attempt to control capacity by creating economic incentives for owners of vessels to decrease their use of labor and capital rather than by directly regulating the level of fishing effort.

The implementation of additional IFQ programs that end the race for fish and allow transfer of quota shares would be expected to lead to some consolidation of quota to fewer vessels. The degree of consolidation will vary depending on the level of excess capacity, economies of scale and scope in harvesting, and rules that restrict transfer and accumulation of quota shares (NMFS 2001a). Similar consolidation could occur with expanded use of cooperatives or community quota programs. Some excess capacity (in the sense of an ability of vessels and processors to catch and harvest the TAC in less time than a maximum season length would allow) can be expected to persist regardless of what type of additional rights-based measures are put in place. This is generally the case for a number of reasons: it is often not economically efficient to operate at maximum possible production levels; there are typically certain times of the year when it is more efficient and profitable to harvest and process fish; and alternative uses for fishing and processing capital are limited (NMFS 2001a).

Average Costs

Either a significant increase or decrease in average costs could occur under FMP 3.2 relative to the comparative baseline, leading to direct/indirect effects ratings of significantly adverse and significantly beneficial. Increased spatial/temporal closures as well as restrictions on bottom trawling for pollock are likely to increase average costs, whereas the comprehensive rationalization program is likely to reduce costs. It is uncertain if the cost decreases would compensate for the cost increases.

The increase in buffer zones around Steller sea lion rookeries and haulouts under FMP 3.2 would likely result in vessels spending more time fishing farther from port, thereby increasing operating costs. In addition, a proposal to implement major changes in the time and area provisions of the existing Steller sea lion protection measures might require additional consultation under Section 7 of the ESA. These consultations could result in measures that further restrict fishing operations. Alternatively, improving the data on the interaction of Steller sea lions and fisheries may allow for relaxation of some of Steller sea lion protection measures and result in beneficial economic benefits for fishery participants.

Under FMP 3.2, spatial displacement of fishing effort due to the extensive closure areas to protect habitat could also lead to increased operating costs for vessels. The spatial displacement of fishing effort would be large for some bottom trawl fisheries. Operating costs would be expected to increase as vessels must travel further to fish, and gross revenue may decline as vessels may be required to fish in less productive areas.

It is reasonable to assume that, subject to regulatory constraints, harvesters target catch with the gear that maximizes its value either by increasing the value (quality) of the fish or by decreasing the harvesting cost or both. To the extent that the historical fishing gear was used because it has the lowest cost per unit of catch, the prohibition on bottom trawling for pollock in the GOA would result in increased cost per unit of catch for those fishing vessels that switch to pelagic trawling. Moreover, these vessels would have to purchase new gear and learn to use it. For vessels that use bottom trawl gear exclusively, the conversion necessary to fish with pelagic trawl gear would be substantial in some cases. In addition to new trawl gear, the conversion could include a more powerful engine, new gear handling equipment on deck, and new electronics.

Increased rationalization is expected to reduce the costs of harvesting. Individual vessels will have the opportunity to select the least cost combination of fishing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective harvesting operations. Fixed costs will be reduced by consolidating harvesting operations and retiring or selling off vessels. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting rights and on the level of excess capacity prior to implementation of remedial measures.

Fishing Vessel Safety

Either a significant improvement or reduction in fishing vessel safety could occur under FMP 3.2 relative to the comparative baseline, leading to direct/indirect effects ratings of significantly beneficial/significantly adverse under FMP 3.2. The net effect of the various measures on fishing vessel safety is uncertain. The comprehensive rationalization program is expected to promote vessel safety by eliminating the race for fish. On the other hand, increased spatial/temporal closures will limit the areas and seasons available to fish, and are likely to force vessels to operate farther from shore and in less than optimal weather conditions.

The implementation of rights-based systems under this FMP is expected to improve safety by reducing the pressure to fish under dangerous conditions (NMFS 2001a). The race for fish creates incentives to fish in areas and seasons with more hazardous weather and sea conditions and requires crew members to work for long stretches with little rest or sleep. Rights-based systems should slow down the fishing and reduce the financial penalty incurred by opting to stop fishing under unsafe conditions. The most important benefit of improved safety will be a decrease in fishery related injuries and loss of life. Other benefits include savings from not having to replace lost vessels and gear. Finally, significant improvements in safety, if they occur, should result in decreased insurance costs for the industry (NMFS 2001a). At the same time, it is important to recognize that rationalized fisheries do not necessarily guarantee improvements in safety for fishermen. Under an IFQ program, for example, market opportunities may still encourage fishermen to fish at times or in places that are unsafe.

On the other hand, the additional area closures to protect habitat that are implemented under FMP 3.2 may result in vessels fishing farther from a port. This would decrease fishing vessel safety. Smaller catcher vessels based out of the Alaska Peninsula, Aleutian Islands, and Kodiak communities may be especially exposed to additional risks. These effects could be mitigated somewhat if individual fishing quotas were set aside for smaller vessels to fish in certain nearshore areas.

Cumulative Effects of FMP 3.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.7-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9. Table 3.9-125 and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Insignificant cumulative effects are predicted under FMP 3.2 for most species except for Pacific cod which is expected to increase significantly. Sablefish and rockfish are expected to decrease significantly, leading to a significantly adverse direct/indirect effects rating.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects.** Although there are currently reductions in the commercial salmon and crab fisheries, the predicted increases in retained harvest of Pacific cod (48 percent) may help mitigate that effect. Reductions in harvest of the A-R-S-O complex (42 percent) are projected to be significant but could be mitigated by the large increases in Pacific cod. Changes in other economic development activities and other sources of municipal and state revenue are also expected to be mitigated by the increase in retained Pacific cod harvests. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these effects are not expected to be significant. Overall, cumulative effects are projected to be insignificant under FMP 3.2.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is not expected to increase significantly under FMP 3.2. Longline vessels are expected to experience a significant reduction in ex-vessel value due to the decrease in catches of rockfish and sablefish.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** While marginal changes in ex-vessel value in other fisheries may occur in the future, these changes are not expected to result in significant cumulative effects on groundfish ex-vessel value. Other economic development activities and other sources of municipal and state revenue are not expected to have a significant cumulative effect on ex-vessel value under FMP 3.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Changes in employment and payments to labor relative to the baseline under FMP 3.2 are insignificant.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Given the current reductions in the salmon and crab fisheries, and the fact that many fishermen often participate in multiple fisheries, fewer fishermen may be able to support their participation in the groundfish fisheries as a result of these reductions. However, the opposite result may occur where more harvesters are competing for groundfish employment as a result of reductions in other fisheries. Though these changes may occur, they are not expected to result in significant cumulative effects on groundfish employment under FMP 3.2. Payments to labor in other fisheries are not expected to contribute to significant cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on payments to labor are insignificant.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Changes in excess capacity are likely to be significantly beneficial under FMP 3.2.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Under FMP 3.2, the comprehensive rationalization program and expansion of the IFQ program would significantly reduce excess capacity. Although excess capacity would still remain in other fisheries such as salmon and crab, the program implemented under FMP 3.2 would have such a strong effect that the benefits would far outweigh the effects of overcapacity in other fisheries. (For details see the Overcapacity Paper in Appendix F-8). Significantly beneficial cumulative effects on excess capacity are likely.

Average Costs

- **Direct/Indirect Effects.** Significantly beneficial and significantly adverse effects are expected to occur for average costs under FMP 3.2.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. As described in Section 4.7.9.1 above, area closures also affect average costs through increases or decreases in transit time to fishing areas. Additional closures included in FMP 3.2 would increase average costs by causing fishermen to travel farther to harvest fish. On the other hand, comprehensive rationalization is likely to significantly reduce average costs. Therefore, cost savings depend on the constraints put on the transfer and consolidation of harvesting rights and the level of excess capacity that might still remain in other fisheries. Significantly adverse or beneficial cumulative effects could result under FMP 3.2.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Significantly adverse or significantly beneficial effects are predicted for fishing vessel safety under FMP 3.2.

- **Persistent Past Effects.** The persistent past effects that contributed to increased demand for groundfish species include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Under FMP 3.2, vessel safety could improve due to the end of the race for fish and rationalization. However, additional closures implemented through FMP 3.2 plus any closures implemented through other fisheries may adversely affect vessel safety causing vessels to travel farther and in potentially dangerous weather conditions. Thus, significantly beneficial or adverse cumulative effects are possible under this FMP, depending on these variables.

4.7.9.1.2 Catcher Processors

Direct/Indirect Effects of FMP 3.1

Groundfish Landings By Species Group

Comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 catcher processor conditions reveals that under FMP 3.1 there would be few significant changes in overall groundfish catches relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 30 percent. Catches of pollock, flatfish, and A-R-S-O species are not expected to change significantly. This leads to direct/indirect effects ratings of insignificant and significantly beneficial for groundfish landings by species groups under FMP 3.1.

Groundfish Gross Product Value

The overall wholesale product value of groundfish outputs of catcher processors is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by head-and-gut trawl catcher processors, pot catcher processors, and longline catcher processors account for much of the increase in product value. The harvest of Pacific cod by surimi trawl catcher processors and fillet trawl catcher processors is limited by AFA sideboard measures that restrict the participation of AFA-eligible vessels in other groundfish fisheries to some level of historic participation. This leads to a direct/indirect effect rating of insignificant for groundfish gross product value under FMP 3.1.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under FMP 3.1, but not significantly.

Product Quality and Product Utilization Rate

A conditionally significant increase in product quality and product utilization rates is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the increase in product quality and utilization is conditional because it is uncertain to what extent FMP 3.1 would extend rights-based management to additional groundfish fisheries. The race for fish creates incentives to maximize profits per unit of fishing time rather than per unit of fish. Consequently, it may induce wasteful practices or reduce the incentives to increase recovery rates if those increases are costly either in out-of-pocket costs or opportunity costs of time. Even when increased or full utilization is profitable in terms of the value and costs of product, there may be an implicit cost due to storage space limitations that will force more frequent unloading.

For the most part, rights-based systems should give individuals and groups the incentive to get the maximum value out of each unit of catch. Consequently, product quality and utilization rates are expected to increase under this FMP, should rights-based management be extended to additional fisheries. Some increases in value can be expected as a result of the improved quality that can be achieved by more careful harvesting and handling practices (In a race for fish these time-consuming practices may be neglected because the opportunity costs are too high.) For example, vessels may choose to make shorter tows to reduce the crushing of fish in the codend or may spend more time searching for larger, more valuable fish. The value of production will also increase because processors have the time and incentive to make products of higher value and to retain fish they had previously discarded . For example, in rationalized fisheries, head-and-gut trawl catcher processors may be more likely to retain male rock sole and small yellowfin sole because retention of those fish would no longer put vessels at a competitive disadvantage compared to vessels that discard.

Excess Capacity

As with catcher vessels, a conditionally significant decrease in excess capacity in the harvesting and processing sectors is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in excess capacity depends on the extent to which FMP 3.1 extends rights-based management to additional groundfish fisheries.

Average Costs

As with catcher vessels, a conditionally significant decrease in average costs is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in average costs depends on the extent to which FMP 3.1 extends rights-based management to additional groundfish fisheries.

Fishing Vessel Safety

As with catcher vessels, a conditionally significant increase in fishing vessel safety is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The increase in fishing vessel safety depends on the extent to which FMP 3.1 extends rights-based management to additional groundfish fisheries.

Cumulative Effects of FMP 3.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, insignificant effects are expected for retained harvests of groundfish species, except for Pacific cod, which is expected to result in significant increases (30 percent).

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue, and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Given the current downward trends in the commercial salmon and crab fisheries, catcher vessels that rely on a mix of groundfish, salmon and crab may experience a reduction in harvest levels. However, this cumulative effect will likely not result in significant changes in groundfish landings under FMP 3.1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (30 percent). Overall, reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under FMP 3.1. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is not expected to have significant changes from the baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (8 percent) that are predicted for FMP 3.1 may mitigate some of the current declines in other fisheries. For these reasons, insignificant cumulative effects on gross product value are expected to result from FMP 3.1.

<u>Employment and Payments to Labor</u>

- **Direct/Indirect Effects.** Insignificant changes in employment and payments to labor are predicted for catcher processors under FMP 3.1.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (8 percent) under FMP 3.1 is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (8 percent) under FMP 3.1 thereby mitigating some of the reductions in other fisheries. Fisheries are not expected to contribute to cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under FMP 3.1.

<u>Product Quality and Product Utilization Rate</u>

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects in product quality and product utilization rates are expected under FMP 3.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed under the Section 4.5.9.1.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, any continuation of this harvest strategy in fisheries may hinder some of these improvements. Overall, increases in product quality and utilization are likely in the long-term, given the trend towards improved fishing and preservation techniques. Thus, conditionally significant beneficial cumulative effects are projected under FMP 3.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects in excess capacity are expected under FMP 3.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under FMP 3.1, conditionally significant cumulative effects are expected for excess capacity.

Average Costs

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects in average costs are expected under FMP 3.1 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Area closures also affect average costs through increases or decreases in transit time to fishing areas. Increases in closure areas increase costs, whereas decreases in closures usually decrease costs. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with average costs in the groundfish fishery, cumulative effects may result. Should costs in other fisheries increase or decrease, catcher processors that are dependent on multiple fisheries are often sensitive to these changes. Assuming rights-based management extends to other groundfish fisheries under FMP 3.1, average costs would be reduced. As FMP 3.1 closures do not increase significantly from the baseline condition, cumulative effects on average costs in the groundfish fisheries are expected to be conditionally significant beneficial.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Conditionally significantly beneficial effects for fishing vessel safety are expected under FMP 3.1.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, distance to fishing areas, and sea conditions relative to vessel size. Additional closures that may result from other fisheries management measures may increase the risk to fishermen, however, these effects are not expected to be significant under FMP 3.1. The extent to which rights-based management is implemented under FMP 3.1 will affect vessel safety. As there are no predicted increases in area closures under FMP 3.1, and assuming rights-based management is extended to other groundfish fisheries, cumulative effects on vessel safety are conditionally significant beneficial compared to the baseline condition.

Direct/Indirect Effects of FMP 3.2

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 catcher processor conditions reveals that under FMP 3.2 there would be few significant changes in overall groundfish catches relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 24 percent. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the retained harvests of these species. Retained harvests of pollock and flatfish are not expected to change significantly. Bycatch of non-target species and PSC is expected to decrease with incentives included in rationalization programs. This leads to a range of effects ratings of insignificant to significantly beneficial to significantly adverse for groundfish landings by species groups under FMP 3.2.

Groundfish Gross Product Value

The overall wholesale product value of groundfish outputs of catcher processors is expected to increase relative to the comparative baseline but not significantly. Increased Pacific cod harvests by head-and-gut trawl catcher processors, pot catcher processors and longline catcher processors account for much of the increase in product value. The harvest of Pacific cod by surimi trawl catcher processors and fillet trawl catcher processors is limited by AFA sideboard measures that restrict the participation of AFA-eligible vessels in other groundfish fisheries to some level of historic participation.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under FMP 3.1, but not significantly.

Product Quality and Product Utilization Rate

Either a significant improvement or reduction in product quality and utilization rates could occur under FMP 3.2 relative to the comparative baseline, leading to direct/indirect effects ratings of significantly beneficial and significantly adverse. The net effect of the various measures on fishing vessel product quality and utilization is uncertain.

The implementation of a comprehensive rights-based management program will tend to improve product quality and utilization rates. The race for fish creates incentives to maximize profits per unit of fishing time rather than per unit of fish. Consequently, it may induce wasteful practices or reduce the incentives to increase recovery rates if those increases are costly either in out-of-pocket costs or opportunity costs of time. Even when increased or full utilization is profitable in terms of the value and costs of product, there may be an implicit cost due to storage space limitations that will force more frequent unloading. For the most part, rights-based systems should give individuals and groups the incentive to get the maximum value out of each unit of catch. Some increases in value can be expected as a result of the improved quality that can be achieved by more careful harvesting and handling practices (In a race for fish these time-consuming practices may be neglected because the opportunity costs are too high.) For example, vessels may choose to make shorter tows to reduce the crushing of fish in the codend or may spend more time searching for larger, more valuable fish. The value of production will also increase because processors have the time and incentive to make products of higher value, where previously they had focused on products that could be produced quickly or with lower quality fish. For instance, we might expect to see more fillet production in place of round or headed and gutted product.

On the other hand, the additional area closures that are implemented under FMP 3.2 may contribute to lower product quality. However, this effect is not likely to offset the gains from rationalization. It is reasonable to assume that, subject to regulatory constraints, harvesters target catch in areas that maximizes its value either by increasing the quality of the fish or by decreasing the harvesting cost or both. Consequently, a measure that prohibits vessels from using historical fishing grounds may result in a decline in product quality (e.g., fish may be smaller or a less uniform size).

Excess Capacity

As with catcher vessels, the comprehensive rationalization program that would be implemented under FMP 3.2 is expected to result in a significant decrease in excess capacity in the harvesting and processing sectors relative to the comparative baseline, leading to a significantly beneficial direct/indirect effect rating. Because the number of catcher processors that are not AFA-eligible outnumber the vessels that are AFA-eligible, the reduction in excess capacity resulting from rationalization should be significant.

Average Costs

The net effect of the FMP is unknown with regard to average costs. As with catcher vessels, the various measures under FMP 3.2 are likely to both significantly increase and decrease costs relative to the comparative baseline, leading to significantly beneficial and significantly adverse direct/indirect effects ratings. Increased spatial/temporal closures as well as restrictions on bottom trawling for pollock are likely to increase average costs, whereas the comprehensive rationalization program is likely to reduce costs. Unlike catcher vessels, catcher processors are not linked to inshore processing facilities and therefore are more likely to be able to adapt to area closures.

Fishing Vessel Safety

As with catcher vessels, either a significant improvement or reduction in fishing vessel safety could occur under FMP 3.2 relative to the comparative baseline, leading to significantly beneficial and significantly adverse direct/indirect effects ratings. The net effect of the various measures on fishing vessel safety is uncertain. The comprehensive rationalization program is expected to promote vessel safety by eliminating the race for fish. On the other hand, increased spatial/temporal closures will limit the areas and seasons available to fish, and are likely to force vessels to operate farther from shore and in less than optimal weather conditions.

Cumulative Effects of FMP 3.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.7-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, insignificant changes in groundfish harvests are expected under FMP 3.2, however increases in Pacific cod and decreases in rockfish and sablefish are predicted for this FMP.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** As stated under FMP 3.1, the current downward trends in the commercial salmon and crab fisheries are adversely affecting catcher processors that rely on a mix of fisheries harvests. However, this cumulative effect may not result in significant changes in groundfish landings under FMP 3.2. An increase in TAC for Pacific cod in the BSAI and GOA is expected (24 percent). Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under FMP 3.2. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these effects are not expected to result in significant changes under this FMP. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is not expected to result in significant changes from the baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described under FMP 3.1, insignificant cumulative effects on ex-vessel value are expected to result from FMP 3.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Insignificant changes in employment and payments to labor are predicted for catcher processors under FMP 3.2.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Total employment and payments to labor are expected to increase under FMP 3.2. As with catcher vessels, reductions in the salmon and crab fisheries, and the reliance many fishermen have on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (7 percent) under FMP 3.2, may mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (7 percent) under FMP 3.2. Catcher processors that participate in the halibut fishery may be less sensitive to reductions in salmon and crab. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under FMP 3.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** A significantly beneficial or adverse effect on product quality and product utilization rates are possible under FMP 3.2, however it is difficult to predict.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed under Section 4.5.9.1.

- **Cumulative Effects.** Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, the additional closures under this FMP may make it more difficult to preserve the quality achieved through better handling. The increase in rights-based management implemented under FMP 3.2 will provide incentives for catcher processors to get the maximum value per unit of fish but they may have to travel farther to catch them. Overall, significantly beneficial or adverse cumulative effects are possible for product quality and utilization under FMP 3.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** A significantly beneficial effect in excess capacity is expected under FMP 3.2 relative to the baseline. Excess capacity is predicted to decrease significantly.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** As with FMP 3.1, comprehensive rationalization in the groundfish fishery will help reduce excess capacity. Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as well as being expanded in the groundfish fisheries under FMP 3.2, significantly beneficial cumulative effects are expected for excess capacity.

Average Costs

- **Direct/Indirect Effects.** Various measures under FMP 3.2 are likely to both increase and decrease average costs. The net effect of FMP 3.2 on average costs is unknown. More details on these effects are located in the direct/indirect section above.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described in more detail under FMP 3.1, average costs in the groundfish fisheries are often associated or shared with other fisheries and include both fixed costs and variable costs. Area closures also affect average costs through increases or decreases in transit time to fishing areas. Since catcher processors are more adaptable to area closures because they are not tied to inshore processors, the effects of these on average costs are not significant. The effects of comprehensive rationalization under this FMP are likely to reduce costs, although this assumes that fish taxes do not indirectly increase average costs. Significantly beneficial or adverse cumulative effects are possible under FMP 3.2.

Fishing Vessel Safety

- **Direct/Indirect Effects.** Significantly beneficial and adverse effects for fishing vessel safety are possible under FMP 3.2. The net effect of this FMP on vessel safety is uncertain. Details on the direct/indirect effects are located at the beginning of this section.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Vessel safety is primarily a function of the race for fish, distance to fishing areas, and sea conditions relative to vessel size. Additional closures that may result from other fisheries management measures may increase the risk to fishermen. Although the end to the race for fish will have significant benefits for vessel safety under this FMP, the increase in closures may diminish this effect. Therefore, significantly beneficial or adverse cumulative effects are possible under FMP 3.2.

4.7.9.1.3 Inshore Processors and Motherships

Direct/Indirect Effects of FMP 3.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 inshore processor and mothership conditions reveals that under FMP 3.1 there would be few significant changes in overall groundfish catches relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 50 percent.

In addition, an increase in the TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant increase in the harvests of these species. Harvests of pollock and flatfish are not expected to change significantly. This leads to direct/indirect effects ratings of insignificant and significantly beneficial for groundfish landings by species group under FMP 3.1.

Groundfish Gross Product Value

The wholesale product value of groundfish processed by inshore processors and motherships is expected to increase relative to the comparative baseline, but not significantly. Increased deliveries of Pacific cod to Bering Sea pollock shore plants, Alaska Peninsula and Aleutian Islands shore plants, Kodiak shore plants, and floating inshore processors account for much of the increase in groundfish product value. Southeast Alaska shore plants and southcentral Alaska shore plants are expected to benefit from the increased catches of sablefish and rockfish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore processors and motherships are expected to increase under FMP 3.1, but not significantly.

Product Quality and Product Utilization Rate

As with catcher processors, a conditionally significant increase in product quality and product utilization rates is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the increase in product quality and utilization is conditional because it is uncertain to what extent FMP 3.1 would extend rights-based management to additional groundfish fisheries. With additional fisheries operating under rights-based management rather than the race for fish, inshore processors will likely be able to slow their overall throughput and focus on obtaining the highest value per fish rather than the most fish per unit of time.

Excess Capacity

A conditionally significant decrease in excess capacity in the harvesting and processing sectors is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in excess capacity depends on the extent to which FMP 3.1 extends rights-based management to additional groundfish fisheries. In contrast to the harvesting sector, however, rights-based management measures can increase the excess capacity of inshore processors in the short run. For example, when the IFQ program was established for the sablefish and halibut longline fisheries additional fresh-market processors and buyers entered the fisheries. In addition, existing processors that had increased capacity to cope with the fish gluts that occurred under race for fish found that they had more capacity than was necessary under the slower-paced IFQ fisheries. In contrast, in the BSAI pollock fishery, managed under the American Fisheries Act, processing capacity increases were specifically limited by restricting entry into the pollock fishery and sideboard restrictions imposed on AFA catcher vessels. In the long-run, however, excess processing capacity is expected to significantly diminish in rationalized fisheries.

Average Costs

As with catcher vessels, a conditionally significant decrease in average costs is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in average costs depends on the extent to which FMP 3.1 extends rights-based management to additional groundfish fisheries.

Increased rationalization is expected to reduce the costs of processing. Individual processing facilities will have the opportunity to select the least cost combination of processing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective processing operations. Fixed costs will be reduced by consolidating processing operations and retiring or selling off processing equipment. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting and processing rights and on the level of excess capacity prior to implementation of remedial measures.

Cumulative Effects of FMP 3.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.7-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Overall, retained harvests of groundfish species are expected to be insignificant, except for Pacific cod. With a projected 50% increase in Pacific cod, landings are expected to have significant effects.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue, and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Inshore plants and motherships that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. Those that also process halibut may be less sensitive to these reductions in other fisheries. The combination of increases in halibut, reductions in salmon and crab, and relatively stable projections for groundfish (except for significant increases in Pacific cod), insignificant cumulative effects may result under FMP 3.1. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these changes are not expected to result in insignificant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase from the baseline, but not significantly.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (10 percent) that are predicted for FMP 3.1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from FMP 3.1.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Employment and payments to labor are expected to increase under FMP 3.1, but not significantly.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Processors that rely on salmon and crab may continue to experience reductions in employment and payments to labor. Groundfish projections under FMP 3.1 are not significant (10 percent) but may mitigate some of the reductions due to salmon and crab. Processors may also experience increases if they process halibut and groundfish due to recent increases in the halibut fishery. Under FMP 3.1, the combination of reductions and increases in these multiple fisheries are likely to result in insignificant cumulative effects on employment and payments to labor.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** A conditionally significant increase in product quality and utilization rate is expected under FMP 3.1 relative to the baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As with catcher processors, advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, any continuation of this harvest strategy in fisheries may hinder some of these improvements. Overall, increases in product quality and utilization are likely in the long-term, given the trend towards improved fishing and preservation techniques. Thus, conditionally significant beneficial cumulative effects are projected under FMP 3.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** A conditionally significant beneficial effect in excess capacity is expected under FMP 3.1 relative to the baseline. Capacity is expected to decrease.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Should rights-based management extend to additional groundfish fisheries, excess capacity would be further reduced. However, rights-based management is optional under FMP 3.1, therefore a conditionally significant beneficial cumulative effect is expected to occur for excess capacity under this FMP, particularly if other fisheries do not change their licensing programs.

Average Costs

- **Direct/Indirect Effects.** A conditionally significant beneficial effect in average costs are expected under FMP 3.1 relative to the comparative baseline. Average costs are expected to decrease.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described under catcher vessels and catcher processors, average costs in the groundfish fisheries are often associated or shared with other fisheries and include both fixed and variable costs. Should costs or closure areas in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. As FMP 3.1 closures change significantly from the baseline condition, rights-based management may occur, and a conditionally significant beneficial cumulative effect on average costs in the groundfish fisheries is expected.

Direct/Indirect Effects of FMP 3.2

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 inshore processor and mothership conditions reveals that under FMP 3.2 there would be a number of significant changes in overall harvests of groundfish relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 43 percent. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the harvests of these species. Harvests of pollock and flatfish are not expected to change significantly. Bycatch of non-target species and PSC is expected to decrease with incentives included in rationalization programs. This leads to direct/indirect effects ratings of insignificant, significantly adverse, and significantly beneficial for groundfish landings by species group under FMP 3.2.

Groundfish Gross Product Value

The overall wholesale product value of groundfish processed by inshore processors and motherships is expected to increase relative to the comparative baseline, but not significantly. Increased deliveries of Pacific cod to Bering Sea pollock shore plants, Alaska Peninsula and Aleutian Islands shore plants, Kodiak shore plants, and floating inshore processors account for much of the increase in groundfish product value. Decreased deliveries of rockfish and sablefish will have a significantly adverse impact on the product value of southeast Alaska shore plants and southcentral Alaska shore plants. The product value of Alaska Peninsula and Aleutian Islands shore plants and Kodiak shore plants will also be adversely affected by this decrease, but less so.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore processors and motherships are expected to increase under FMP 3.2, but not significantly.

Product Quality and Product Utilization Rate

As with catcher processors, either a significant improvement or reduction in product quality and utilization rates could occur under FMP 3.2 relative to the comparative baseline, leading to direct/indirect effects ratings of significantly beneficial and significantly adverse. The net effect of the various measures on product quality and utilization is uncertain. The implementation of a comprehensive rights-based management program will tend to improve product quality and utilization rates. However, a large portion of the product currently produced by inshore processors and motherships is already produced in rationalized fisheries (e.g., sablefish longline fishery and BSAI pollock fishery). Furthermore, the additional area closures that are implemented under FMP 3.2 may cause product quality to decrease. Pacific cod and Alaska pollock are fragile fish whose quality deteriorates rapidly longer times from harvest to processing. As such, any factors that will increase the length of time to processing will, in general, lower the quality of the product produced. To the extent that FMP 3.2 results in catcher vessels traveling farther distances from (inshore) processors, and thereby lengthening the time between harvest and processing, the quality of surimi, fillets, and roe will be adversely affected.

Excess Capacity

As with catcher vessels and catcher processors, the comprehensive rationalization program that would be implemented under FMP 3.2 is expected to result in a significant decrease in excess capacity in the processing sectors relative to the comparative baseline in the long-term, leading to a significantly beneficial direct/indirect effect rating. In the short run, however, a comprehensive rationalization may create excess capacity that would continue during the transition from the race for fish to rights-based management.

Average Costs

As with catcher vessels and catcher processors, the net effect of FMP 3.2 on average costs relative to the baseline is uncertain. The spatial/temporal closures are likely to contribute to higher average costs for processors. On the other hand, a comprehensive rationalization program is expected to contribute to lower average costs. This leads to direct/indirect effects ratings of significantly beneficial and significantly adverse.

This FMP includes measures that result in considerable spatial/temporal displacement of fishing effort. The result could be reduced harvest levels and increases in average costs. On the other hand, increased rationalization is expected to reduce the costs of processing. Individual processing facilities will have the opportunity to select the least cost combination of processing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective processing operations. Fixed costs will be reduced by consolidating processing operations and retiring or selling off processing equipment. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting and processing rights and on the level of excess capacity prior to implementation of remedial measures.

Cumulative Effects of FMP 3.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.7-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects.** Projected increases in Pacific cod are expected under FMP 3.2, however, sablefish and rockfish are projected to have a significant decrease. Pollock and flatfish harvests are not expected to change significantly.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, other sources of municipal and state revenue, and are described in detail in Section 4.5.9.1.

- **Cumulative Effects.** Current downward trends in the commercial salmon and crab fisheries may put pressure on processors who do not rely on mixed harvests. Those processors that rely also on groundfish and halibut catch may experience some increases in landings under FMP 3.2. The significant increases in Pacific cod and the current increasing trends in halibut may counteract the reductions in other fisheries. Insignificant cumulative effects on groundfish landings are expected to result under FMP 3.2. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations or diversity as explained in more detail in Section 4.5.10, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects.** The gross product value is expected to increase from the baseline but not significantly. Decreased deliveries of rockfish and sablefish will have a significantly adverse impact on the product value of southeast Alaska shore plants and southcentral Alaska shore plants. The product value of, Alaska Peninsula and Aleutian Islands shore plants and Kodiak shore plants will also be adversely affected by this decrease, but less so.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described with catcher processors, changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contributions to education programs have been decreasing. Marginal increases in gross product value (5 percent) that are predicted for FMP 3.2 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from FMP 3.2.

Employment and Payments to Labor

- **Direct/Indirect Effects.** Insignificant effects are predicted for catcher processors under FMP 3.2.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of the groundfish and halibut fisheries. The increase, although slight, in groundfish employment (7 percent) under FMP 3.2, is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (7 percent) under FMP 3.2 thereby mitigating some of the reductions in other fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under FMP 3.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects.** Either a significant improvement or reduction in product quality and utilization rates could occur under FMP 3.2 relative to the comparative baseline.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Technological advances have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, the increase in area closures may counteract any improvements in product quality achieved by better handling. Overall, increases in product quality and utilization are likely in the long-term given the trend towards improved fishing and preservation techniques. Thus, significantly beneficial or adverse cumulative effects are possible under FMP 3.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Significantly beneficial changes in excess capacity are possible under FMP 3.2 relative to the baseline over the long-term. The net effect of these measures on capacity are unknown. Details on these effects are presented at the beginning of this section under direct/indirect effects.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** Although excess capacity still remains in other fisheries as well as the groundfish fishery, comprehensive rationalization and an end to the race for fish help mitigate this effect (Overcapacity Paper Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under FMP 3.2, the cumulative effects on excess capacity are likely to be significantly beneficial compared the baseline.

Average Costs

- **Direct/Indirect Effects.** Both significantly beneficial and adverse effects are possible under this FMP. Spatial temporal closures are likely to increase costs, however comprehensive rationalization would decrease costs.

- **Persistent Past Effects.** For details on persistent past effects, see the beginning of Section 4.5.9.1, Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1.

- **Cumulative Effects.** As described for catcher vessels and catcher processors, average costs in the groundfish fisheries are often associated or shared with other fisheries and include fixed and variable costs. Increases in closure areas increase costs, whereas decreases in closures usually decrease costs. The cumulative effect on average costs under FMP 3.2 is uncertain because increased spatial/temporal closures will increase costs, however the comprehensive rationalization of the fishery will greatly reduce costs. Details on these effects are located in the direct/ indirect discussion of inshore plants and motherships above. Significantly beneficial or adverse cumulative effects are possible under FMP 3.2.

4.7.9.2 Regional Socioeconomic Effects

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described below. The past/present effects on regions that participate in the groundfish fishery are described in Section

3.9 (and summarized in Table 3.9-126) and below; these regions (illustrated in Figures 3.9-9 through 3.9-13) include the Aleutian Islands/Alaska Peninsula (comprised of the Aleutians East Borough and the Aleutians West Census Area, which includes the communities of Unalaska, Nikolski, Atka, Adak and the Pribilof Islands), Kodiak Island (Kodiak Island Borough, which includes the City of Kodiak) southcentral Alaska (the Kenai Peninsula Borough, Matanuska-Susitna Borough, Municipality of Anchorage, and the Valdez-Cordova Census Area, which includes the PWS region), southeast Alaska (all of the southeastern part of the state, from Yakutat Borough to Dixon Entrance), Washington inland waters (all counties bordering Puget Sound and the Strait of Juan de Fuca), and Oregon coast (Lincoln, Tillamook, and Clatsop counties, the three northernmost Oregon coastal counties). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case.

Due to the linkages of potential effects on regions that participate in the groundfish fishery to changes in harvest and processing levels under each of the policy alternatives and illustrative bookends, the direct and indirect effects of each alternative are based on an economic model that distributes potential effects to each of the participating regions. The indicators used to assess potential regional effects include the following:

- In-region processing and related effects.
- Regionally owned at-sea processors.
- Extra-regional deliveries of regionally owned catcher vessels.
- In-region deliveries of regionally owned catcher vessels.
- Total direct, indirect, and induced labor income and FTEs.

As discussed earlier, these indicators also reflect changes in other important regional characteristics such as secondary economic activity associated with the support of fishing, state and municipal revenue generated by fishing, and indirectly population, to the extent that it is related to employment opportunities. For more information on the economic model used to assess direct and indirect regional effects, see the analysis for FMP 1 and Section 4.1.7 of this document.

Direct/Indirect Effects of FMP 3.1

FMP 3.1 represents a more precautionary approach to fisheries management that extends management measures currently being employed or evaluated. This includes further rationalization of the groundfish fishery and additional measures related to bycatch, protection of prohibited species, and habitat protection. Under FMP 3.1, in general there is a net overall increase in fishery socioeconomic indicator values over baseline conditions for all regions. For example, total value of processing sales increases over baseline conditions, while total processing and harvesting related income and employment increase for all regions combined. None of these changes, however, rise to the level of significance. Overall, the pattern of change is driven by the same factors seen under FMP 1 (but the caveat of inaccurate distribution indicator values associated the A-R-S-O species group between the southcentral and southeast Alaska regions applies). However, one of the major changes from previous alternatives is the intent to rationalize the groundfish fishery. The potential effects of rationalization, particularly indirect and induced effects, are not completely captured in the model. These include 1) potential consolidation of the harvesting and processing sectors, where total employment is reduced but lasts for longer periods with higher pay, 2) transition of fishing support sectors from a peak-demand/race for fish to a lower level of year-round demand, with similar employment effects, 3) consideration of additional closure areas to protect habitat, which may have disproportionate effects on smaller fixed gear vessels, and 4) the possibility of regional protection measures, such as landing or co-op requirements, that cannot be assessed at this time.

In general, the community level effects of rationalization, in and of itself, are anticipated to result primarily from a redistribution of participation, effort, and activity between and within regions rather than from changes at the overall fishery level. Potential adverse impacts to specific local communities resulting from rationalization programs are largely associated with the nature and magnitude of consolidation of harvesting and processing capacity or effort following the implementation of rationalization measures (although other impacts are associated with changes in temporal distribution of effort). These impacts could be profound in some communities, especially for those communities that are remote or marginal in their participation relative to the overall fishery or its established centers. It is likely that future rationalization programs would incorporate some type of regional or community protection measures to provide for the sustained participation of fishing communities, such as those currently being contemplated in the ongoing analysis and evaluation of potential rationalization approaches for the Bering Sea and Aleutian Islands crab fisheries. To a large extent, impacts to communities would be determined by the efficacy of the community protection measures, if any, included in any particular rationalization program. The discussion of these types of impacts in this section is largely qualitative rather than quantitative as particular rationalization approaches and accompanying regional or community protection measures will depend on program specifics that have not been developed. The potential effects of rationalization on communities are further described in the overcapacity qualitative analysis in Appendix F of this PSEIS.

The following subsections provide a region-by-region summary of change under FMP 3.1 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 3.1, total in-region groundfish processing value would increase (with increases occurring in BSAI values), as would in-region processing associated labor income and FTE jobs, but none of these increases would be considered significant. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would increase in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease, but by a less than significant amount. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would decrease; for in-region deliveries, catcher vessel payments to labor and FTEs would also decrease, but all of these changes are less than significant (and for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small). With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. (Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes.) The total regional direct, indirect, and induced labor income and FTE employment would increase under this FMP (from a base of $226 million in labor income and 4,796 FTEs), but this increase would not be significant. Under FMP 3.1, the more closely defined sector impacts may be considered less than significant on a local sector as well as a regional (and most likely a multiple community) basis. However, this FMP may result in a number of other types of impacts that could be significant under certain conditions.

Under this FMP, some structural changes in the fishery and support sector enterprises will accrue to this and other regions as a result of the rights-based and community-based management, but in the absence of program specifications, it is not possible to identify those changes in a straightforward manner. In general, with a decline in the race for fish, consolidation is likely to occur within processing and harvesting sectors and across communities. However, rights based programs may build in caps and/or community or regional protection measures to act as a governor on consolidation, and the impacts to particular communities or regions will depend on the nature and efficacy of those caps or restrictions. All things being equal, the number of processing and harvesting entities will decline, as will overall employment. If consolidation results in the loss of some local groundfish processing markets, small vessels in those local markets would be disproportionately vulnerable to adverse impacts, as they are inherently less able to be flexible in their activities over wide geographic areas than are larger vessels. (Small vessel owners would presumably be assured of equity in the initial allocation of harvest quota itself, and of the ability to sustain their participation in the fishery, as MSA Section 303(d)(5)c) mandates that any new IFQ program must consider the allocation of a portion of the annual harvest in the fishery for small vessel owners.) Support sector businesses (and some coastal communities that have large support sectors) that derive benefits from seasonal peaks (and the economic inefficiencies) of current race-for-fish fisheries will experience adverse impacts, at least in the short-term during a transition to a lower if more stable level of employment (and, in general, higher labor income per remaining position). For example, the relatively well developed support service sector in Unalaska/Dutch Harbor derives marked benefits from the current economic inefficiency within the fishery. It is relatively expensive to provide services in the community, but under conditions where it is important to minimize down time during a fishing season, services that cost more but are available in a more timely manner than other potential options are often deemed well worth the trade-off. Under a rationalized fishery, cost considerations become relatively more important, giving service purchasers more options (to the possible detriment of providers in comparatively remote locations). These types of impacts will be seen in other regions as well (especially Kodiak), but will perhaps be most apparent or severe in this region due to a relative lack of diversification in the local economies of the relevant fishing communities. The economic modeling that generated the regional impact numbers accounted for the structural changes in the fishery, but does not account for potential community protection measures. As a result, impacts may be considered conditionally significant, and dependent upon the specific yet-to-be-designed protection measures.

Kodiak Island. Total in-region groundfish processing value would increase (with higher values for GOA; BSAI values are not a significant portion of the regional total) as would associated labor income and FTE jobs, but none of these increases would be large enough to be significant. Regionally owned at-sea processing value would increase (with the majority of the increase attributable to changes in BSAI values), as would associated labor income and FTEs, but these changes would not be significant. (In this region, under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total. Labor income and FTEs distribution between these processing sectors follow a similar pattern.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase, as would catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries, but these increases would not be significant. For in-region deliveries, catcher vessel payments to labor would increase and FTEs would decrease but these changes would be less than significant (and over a smaller base than seen for extra-regional deliveries). On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would increase, as would FTE employment under this FMP (from a base of $66 million in labor income and

1,600 FTEs), but none of these changes would be considered significant. For the Kodiak Island region, FMP 3.1 would not result in significant impacts on a local sector basis, or on a regional or community basis. As noted under the Alaska Peninsula and Aleutian Islands region discussion, however, there could be some adverse impacts to Kodiak Island region support services based on changes associated with the rationalization of the fishery, but Kodiak could also be the beneficiary of service business displaced from more remote locations, so the net impact is unknown.

Southcentral Alaska. Total in-region groundfish processing value would increase by 36 percent (all attributable to GOA increases). Associated labor income and FTE jobs would also increase by 36 percent. Regionally owned at-sea processing value would increase by 28 percent (with relatively large increases in BSAI values and smaller increases in GOA values), and associated labor income and FTEs both increasing by 28 percent. (In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would increase, but by an insignificant amount, while in-region deliveries would increase by 42 percent. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would increase by about 42 and 41 percent, respectively. Similarly, for in-region deliveries, catcher vessel payments to labor and FTEs would increase by about 42 and 41 percent, respectively. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase by about 28 percent and FTE employment would increase by a slightly less than significant amount (from a base of $23 million in labor income and 567 FTEs). For the southcentral Alaska region, FMP 3.1 would have significantly beneficial impacts on a local sector basis, but it is important to recognize that some of these changes may be overstated (and some understated for the southeast Alaska region). Impacts to the region as a whole and participating communities may be less significant than would otherwise appear to be the case, given the diversified nature of the local economies and the relative lack of dependence on groundfish related activities.

Southeast Alaska. Total in-region groundfish processing value would decrease by a negligible amount (all attributable to GOA decreases), as would associated labor income and FTE jobs (but both have relatively low base values). Regionally owned at-sea processing value would increase by 25 percent (with increases in both BSAI and GOA values), and associated labor income and FTEs both would increase by 25 percent. (In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would increase by a slightly less than significant amount, and in-region deliveries would decrease by a negligible amount. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would increase by about 20 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would remain about the same. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease as would FTE employment (from a base of $34 million in labor income and 879 FTEs), but these changes would be less than significant. The impacts from FMP 3.1 are likely to be significantly beneficial for some local sectors, but impacts on a regional basis for southeast Alaska are less than significant, and are likely to be so for the involved communities, given the local economic diversity and relatively light dependence on the groundfish fishery.

Washington inland waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase (with increases in both BSAI and GOA values, although GOA values are comparatively very small), and associated labor income and FTEs would both increase, but these changes would be less than significant. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase as would catcher vessel payments to labor and FTE jobs associated with extra regional deliveries, and those associated with in-region deliveries, however, none of these changes would rise to the level of significance. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase as would FTE jobs (from a base of $557 million in labor income and 10,316 FTEs), but these changes would not be significant. FMP 3.1 would have consistently beneficial benefits in the Washington inland waters region, but these gains would not rise to the level of significance on a local sector, regional, or community basis.

Oregon coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase, as would associated labor income and FTE jobs, but these increases would not be significant. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this FMP. The total regional direct, indirect, and induced labor income would increase, as would FTE employment (from a base of $15 million in labor income and 318 FTEs), but these changes would not be significant. FMP 3.1 would have consistently beneficial impacts for the Oregon coast region, but these would not rise to a level of significance for local sectors, the region, or individual communities.

Cumulative Effects of FMP 3.1

See Table 4.7-6 for a summary of the cumulative effects on regional socioeconomics under FMPs 3.1 and FMP 3.2.

<u>In-Region Processing and Related Effects</u>

- **Direct/Indirect Effects.** For FMP 3.1, direct/indirect effects are considered insignificant for all regions except the southcentral Alaska region, which is significantly beneficial due to projected increase in labor income and FTE employment.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1, cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are generally insignificant, although for different reasons in different regions. The influence of external factors is adverse for many of the in-region processors based in Alaska and their associated regions. Trends in multi-species fisheries and other sources of municipal and state revenue, primarily due to the continued crab closures, downturn in salmon and reductions in state and municipal revenue, result in adverse effects on in-region processing and municipal revenue. These adverse external effects are somewhat offset by increases in Alaska in-region processing, resulting in a finding of insignificant cumulative effect except in portions of the Alaska Peninsula/Aleutian Islands region, where external effects likely result in conditionally significant adverse cumulative effects. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant, and there are no reasonably foreseeable events that would have a significant contribution, resulting in a finding of insignificant cumulative effect. Rationalization will likely result in the need to coordinate delivery and processing schedules in processors participating in multi-species fisheries, but the effects can not be determined.

<u>Regionally Owned At-Sea Processors</u>

- **Direct/Indirect Effects.** Under FMP 3.1, direct/indirect effects are considered significantly beneficial for the southcentral and southeast Alaska regions. Direct/indirect effects are generally insignificant for the remaining regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. For more detail, see the analysis for In-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1, cumulative effects on regionally owned at-sea processing and on related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. While direct/indirect effects are beneficial for southcentral and southeast Alaska regions, reasonably foreseeable external effects will not contribute much to cumulative effects, particularly given the size and diversity of the regional economies. Direct/indirect effects are insignificant in the Alaska Peninsula/Aleutian Islands and Kodiak Island, where most of the

Alaska at sea processor fleet is based. As indicated previously, with a more diversified economy and population base, cumulative effects in Kodiak will be adverse due to external factors, but cumulatively insignificant, as are effects for the Alaska Peninsula/Aleutian Islands.

Extra-Regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 3.1, direct and indirect effects are insignificant for all regions.

- **Persistent Past Effects** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1, extra-regional deliveries increase and direct/indirect effects are insignificant for the six regions. Given the size and diversity of regional economies, in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. Extra-regional deliveries decrease to the Alaska Peninsula/Aleutian Islands; adverse external effects related to other fisheries and revenue sharing results in a conditionally significant adverse cumulative effect for some communities within this region.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 3.1, direct/indirect effects are insignificant with slight increases or decreases for all regions except southcentral Alaska, where the increase is significantly beneficial.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1, the direct/indirect effects range from beneficial to mostly insignificant. Given the size and diversity of regional economies in Washington inland waters, the Oregon coast regions, Alaska Peninsula/Aleutian Islands, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. Significantly beneficial cumulative effects are expected for southcentral Alaska.

Total Direct, Indirect, and Induced Labor Income and FTE's

- **Direct/Indirect Effects.** Under FMP 3.1, direct/indirect effects on labor income and employment are significantly beneficial for the southcentral Alaska region; and insignificant for the rest of the regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.1 direct/indirect effects on labor income and employment are insignificant for all regions, except southcentral Alaska, which is significantly beneficial. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Adverse trends in other fisheries (particularly salmon) and reductions on municipal revenue, decrease regional labor income and employment benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects are generally insignificant in all regions, except for portions of the Alaska Peninsula/Aleutian Islands and southeast Alaska regions, where effects are conditionally significant adverse.

Direct/Indirect Effects of FMP 3.2

Under FMP 3.2, in general the pattern of gains and losses in socioeconomic indicator values across regions is more mixed than seen in the previous FMPs. While total value of processing sales increases over baseline conditions (by a less than significant amount), and while total processing and harvesting related income and employment increase for all regions combined (again, by a less than significant amount), there are a variety of increases and decreases behind these totals. A more conservative TAC for sablefish and rockfish has a disproportionate adverse impact on the southcentral and southeast Alaska regions, but also has an adverse impact on the Kodiak region. The western GOA area also experiences a relative decline of Pacific cod related values. On the highest level of aggregation, the Alaska Peninsula and Aleutian Islands, Washington inland waters, and Oregon coast regions experience a net beneficial impact under FMP 3.2, whereas the Kodiak, southcentral, and southeast Alaska regions experience a net adverse impact in socioeconomic terms.

Regional and community impacts associated with the rationalization component of FMP 3.2, in and of itself, would be similar to those described under FMP 3.1. Under this FMP, however, there are many additional local area closures and it is to be expected (but is not apparent in the data) the smaller catcher vessels with less effective range (and therefore less inherent geographic flexibility) would feel disproportionate impacts in all regions. The rationalization that occurs under this FMP would likely serve to ameliorate the adverse impacts of area closures for most of the fleet, but inherent limitations associated with size would render these offsetting benefits less viable for the small vessels of the fleet. For all vessels, the beneficial impacts of rationalization are, of course, conditional on being able to find fish outside of the closed areas. These pragmatic challenges may "tip" adverse impacts from borderline to significant for some communities, depending the composition of the local fleet, particularly in the southcentral and southeast regions. The following subsections provide a region-by-region summary of change under FMP 3.2 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 3.2, total in-region groundfish processing value would increase (with increases in the BSAI portion somewhat offset by decreases in the much smaller GOA portion of the total), as would in region processing associated labor income and FTE jobs, but these increases would be less than significant. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would increase in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional deliveries by regionally owned catcher vessels would decrease by a less than significant amount, while in-region deliveries by regionally owned catcher vessels would decrease by 22 percent. Catcher vessel payments to labor would decrease (but not significantly) and FTE jobs associated with extra-regional deliveries would decrease by about 23 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 22 and 23 percent, respectively, but for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. (Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes.) The total regional direct, indirect, and induced labor income would increase as would FTE employment (from a base of $226 million in labor income and 4,796 FTEs), but these changes would be less than significant. In terms of quantitative output, the impacts of FMP 3.2 on the Alaska Peninsula and Aleutian Islands region are a mixture of adverse and beneficial when examined on a local sector basis, but are in and of themselves likely to illustrate significant impacts on the regional level (and community level quantitative data is largely unavailable due to confidentiality restrictions). There are, however, two other types of regional or community impacts likely under this FMP that are not apparent in the quantitative data.

In general, as noted under FMP 3.1, with a decline in the race for fish, consolidation is likely to occur within processing and harvesting sectors and across communities. However, rights based programs can include caps and/or community or regional protection measures to act as a governor on consolidation, and the impacts to particular communities or regions will depend on the efficacy of those caps or restrictions. Also in general terms, the number of processing and harvesting entities will decline, as will overall employment. Support sector businesses (and some coastal communities that have large support sectors) that derive benefits from seasonal peaks (and the economic inefficiencies) of current race-for-fish fisheries will experience adverse impacts, at least in the short-term during a transition to a lower if more stable level of employment (and, in general, higher labor income per remaining position). These types of impacts will be seen in other regions as well (especially Kodiak), but will perhaps be most apparent in this region due to a relative lack of diversification in the local economies of the relevant fishing communities. The economic modeling that generated the regional impact numbers accounted for the structural changes in the fishery, but does not account for potential community protection measures. As a result, impacts may be considered conditionally significant, and dependent upon the specific yet-to-be-designed protection measures.

Another type of impact that is not captured by the economic output model is also likely to be important for some communities in the Alaska Peninsula and Aleutian Islands region. Under FMP 3.2, more areas are set aside for MPAs and the impact of these on communities, especially communities with relatively small vessel fleets with limited range and flexibility to move between major fisheries, may be relatively large. However, the ultimate determinant of the level of impact of this type of management approach will be the efficacy of the counterbalancing alternative features designed to respect traditional fishing grounds and maintain open area access for coastal communities. It is not possible to assess this balance in advance of having either the MPA areas or the community protection measures specified. As a result, impacts of this nature are likely to be conditionally significant. Clearly, however, the small vessel fleets within this region are particularly vulnerable, and it is important to recognize that the fleets of some regional communities already face adverse circumstances under existing conditions resulting from the cumulative effects of Steller sea lion protection measure closures, a precipitous decline in economic returns from the salmon fishery, and Area M salmon intercept avoidance based restrictions, among others. Further, communities within this region that have both (1) support service sectors that may experience decline as a result of rationalization and (2) small vessel fleets may experience a range of interactive impacts that are not apparent from quantitative modeling outputs.

Kodiak Island. Total in-region groundfish processing value would decrease (with higher values for GOA; BSAI values are not a significant portion of the regional total), as would associated labor income and FTE jobs, but none of these changes would be significant. Regionally owned at-sea processing value would increase (with the vast majority of the increase attributable to changes in BSAI values), and associated labor income and FTEs also increase, but none of these changes would rise to the level of significance. (In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total; labor income and FTEs distribution between these processing sectors follow a similar pattern.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase as would catcher vessel payments to labor associated with extra-regional deliveries, but none of these changes would all be less than significant, and FTE jobs would remain about the same. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by a less than significant amount (and over a smaller base than seen for extra-regional deliveries). On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would decrease as would FTE employment (from a base of $66 million in labor income and 1,600 FTEs), but all of these changes would be less than significant. For the Kodiak Island region, FMP 3.2 will have less than significant impacts on a local sector basis, as well as on a regional and community of Kodiak basis. As was the case for the Alaska Peninsula and Aleutian Islands region, however, there may be conditionally significant impacts accrue to (1) the support service sector as a result of the rationalization features of this FMP and (2) the smaller vessels in the fleet due to the inherent lack of flexibility in dealing with extensive MPA set asides (and, perhaps, the inability to take advantage of the potentially ameliorating nature or features of rationalization).

Southcentral Alaska. Total in-region groundfish processing value would decrease (all attributable to GOA decreases), as would associated labor income and FTE jobs, but these decreases would not be considered significant. Regionally owned at-sea processing value would decrease (with decreases in BSAI values and GOA values), as would associated labor income and FTEs, but these changes would be less than significant. (In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional deliveries by regionally owned catcher vessels would decrease and in-region deliveries increase, but not significantly. Catcher vessel payments to labor would decrease a less than significant amount and FTE jobs associated with extra regional deliveries would decrease by about 21 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would increase, but not significantly. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease as would FTE employment (from a base of $23 million in labor income and 567 FTEs), but none of these changes would appear significant. For southcentral Alaska, FMP 3.2 would not result in significant impacts at a local sector or at the regional level. However, there may be conditionally significant impacts to some community small vessel fleets, but that cannot be ascertained prior to the development of specific features of the rationalization and MPA management approaches.

Southeast Alaska. Total in-region groundfish processing value would decrease by 33 percent (all attributable to GOA decreases). Associated labor income and FTE jobs would also decrease by 33 percent (but both are relatively low values). Regionally owned at-sea processing value would increase (with increases in both BSAI values and GOA values), along with associated labor income and FTEs, but none of these changes are significant. (In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease by 24 and 34 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would both decrease by about 24 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 34 and 33 percent, respectively. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease by about 33 percent and FTE employment would also decrease by about 21 percent (from a base of $34 million in labor income and 879 FTEs). For the southeast Alaska region, FMP 3.2 would have significant impacts on some local sectors, but a caveat on these data is that impacts to the southcentral Alaska region may be somewhat overstated in a beneficial direction and the impacts to southeast Alaska may be somewhat overstated in an adverse direction. Overall, impacts on the regional level, or even on the involved community level are unlikely to be significant, given the overall diversity of community economies in this region, and the relative lack of dependency specifically on groundfish. On the other hand, there could be conditionally significant impacts that accrue to the local small vessel fleet as a result of specific rationalization and MPA features that are unknown at this time, as noted in earlier regional sections.

Washington inland waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase (with increases in both BSAI and GOA values, although GOA values are comparatively very small), as would associated labor income and FTEs, but these increases would be less than significant. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by less than significant amounts. Catcher vessel payments to labor associated with extra regional deliveries would increase and FTE jobs would decrease, but these changes would not be significant. For in-region deliveries, catcher vessel payments to labor and FTEs would increase, but not significantly. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase, as would FTE employment (from a base of $557 million in labor income and 10,316 FTEs), but these changes would be less than significant. In general, the impacts of FMP 3.2 would not be significant for the Washington inland waters region. Impacts to local sectors are likely to be less than significant, as are impacts to communities, given the size and nature of local economies, and the relative lack of groundfish dependency on the community or regional level. The concerns regarding small vessel fleets and MPAs under this FMP do not apply to the Washington inland waters region in the same way that they do to the Alaska regions, nor do concerns regarding unintended consequences of rationalization on support sector businesses. Washington inlands waters region support sector enterprises are likely to be the beneficiaries of increased efficiency within the fishery and a reallocation or redistribution of support functions away from remote locations closer to the grounds.

Oregon coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase, as would associated labor income and FTE jobs, but these increases would not be significant. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this FMP. The total regional direct, indirect, and induced labor income would increase as would FTE employment (from a base of $15 million in labor income and 318 FTEs), but these changes would be considered less than significant. Under FMP 3.2, Oregon coast local sectors would experience beneficial but less than significant impacts, and regional and community impacts would also be considered beneficial but less than significant. This region would not experience adverse impacts to the small vessel fleet from MPAs and rationalization as may be seen in the Alaska regions, nor is it likely to lose or gain significantly via changes in the support sector businesses that may accompany further rationalization of the fishery.

Cumulative Effects of FMP 3.2

See Table 4.7-6 for a summary of the cumulative effects on regional socioeconomics under FMPs 3.1 and FMP 3.2.

In-Region Processing and Related Effects

- **Direct/Indirect Effects.** For FMP 3.2, direct/indirect effects are considered insignificant for all regions except the southeast Alaska region, which is significantly adverse. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, in terms of direct/indirect impact, the Alaska Peninsula/Aleutian Islands, Washington inland waters, and Oregon coast regions experience a net beneficial impact under FMP 3.2, whereas the Kodiak Island, southcentral, and southeast Alaska regions experience a net adverse impact in socioeconomic terms. Within these latter three Alaska regions, decreases in processing values are exacerbated by the adverse external effects in other fisheries, economic development and state and municipal revenue. Southcentral Alaska has a relatively diversified economy and cumulative effects will be insignificant; cumulative effects for Kodiak Island, southeast Alaska, and portions of Alaska Peninsula/Aleutian Islands are likely to be conditionally significant adverse. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant, and there are no reasonably foreseeable events that would have a significant contribution.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** For FMP 3.2, direct/indirect effects are insignificant for all regions. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, direct/indirect effects are insignificant for all six regions. Cumulative effects are also insignificant for FMP 3.2, for the same reasons discussed under FMP 3.1.

Extra-Regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 3.2, direct and indirect effects are insignificant for all regions, except southeast Alaska where they are significantly adverse. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, cumulative effects are insignificant for all regions, except for southeast Alaska, where they are significantly adverse. Given the size and diversity of regional economies, in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. In southeast Alaska and the Alaska Peninsula/Aleutian Islands, adverse external effects are likely to result in conditionally significant adverse cumulative effects.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects.** Under FMP 3.2, direct/indirect effects are insignificant for the Kodiak Island, southcentral Alaska, Washington inland waters, and Oregon coast regions. Effects are significantly adverse for the Alaska Peninsula/Aleutian Islands and southeast Alaska regions. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, direct/indirect effects of in-region deliveries range from mostly insignificant to significantly adverse. Given the size and diversity of regional economies in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. In the Alaska Peninsula/Aleutian Islands and southeast Alaska regions, significantly adverse direct/indirect effects combine with adverse external effects in other fisheries and revenue sharing to result in a conditionally significant adverse cumulative effect.

Total Direct, Indirect, and Induced Labor Income and FTE's

- **Direct/Indirect Effects.** Under FMP 3.2, direct/indirect effects on labor income and employment are insignificant for all regions except southeast Alaska, which is significantly adverse. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects.** Under FMP 3.2, employment decreases in all Alaska regions, but is insignificant except in southeast Alaska where effects are significantly adverse. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Adverse trends in other fisheries (particularly salmon) and reductions on municipal revenue, decrease regional labor income and employment benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Islands, and southeast Alaska regions. Cumulative effects are generally insignificant in all regions, except for portions of the Alaska Peninsula/Aleutian Islands and southeast Alaska regions, where effects are conditionally significant adverse.

4.7.9.3 Community Development Quota Program

The predicted direct and indirect effects of the groundfish fishery under FMPs 3.1 and FMP 3.2 are described below. The past/present effects on CDQ are described in Section 3.9 (and summarized in Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case (Table 4.7-6). The representative indicator used in this analysis is allocation of catch to CDQ groups. It should be noted that allocation reflects potential revenue to CDQ groups, and indirectly the potential funds that are available for approved economic development activities in CDQ communities.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Under FMP 3.1 and FMP 3.2, the CDQ program would continue to operate as it does under baseline conditions. Under FMP 3.1, no adverse changes to the CDQ program or region in comparison to baseline conditions are foreseen.

Cumulative Effects of FMP 3.1 and FMP 3.2

For a summary of the direct/indirect and cumulative ratings see Table 4.7-6.

CDQ Allocations

- **Direct/Indirect Effects.** The direct/indirect effects of FMP 3.1 and FMP 3.2 on the CDQ program are insignificant.

- **Persistent Past Effects.** The past/present effects on the CDQ program for groundfish fisheries include establishment of the CDQ program; FMP amendments that further added or defined the CDQ in 1992,1995,1996, and 1998; establishment of multi-species CDQ programs, and persistent limitations on economic development and associated employment activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and other sources of municipal and state revenue all have the potential to affect the CDQ program adversely or beneficially. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMPs 3.1 and FMP 3.2, a cumulative effect is identified for the CDQ program, and the effect is judged to be insignificant. With guaranteed CDQ shares through the CDQ program continuing to operate, no significantly adverse cumulative impacts to the CDQ program are expected.

4.7.9.4 Subsistence

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described below. The past/present effects on subsistence are described in Section 3.9 (and summarized in Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, sport and personal use, and long-term climate change and regime shift.

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

Potential impacts to subsistence fall into four main categories: subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon in western Alaska and bycatch in the groundfish fisheries, and indirect impacts on other subsistence activities, including loss of income that would be otherwise directed toward subsistence pursuits, and the loss of access to commercial fishing vessels and gear that would be otherwise be available for joint production opportunities. Under FMP 3.1 and FMP 3.2, no changes in the commercial fishery are anticipated that would result in impacts to baseline subsistence groundfish fishing conditions. There is also no indication that this FMP would have an adverse impact on Steller sea lion subsistence activities or take over baseline conditions. Salmon bycatch would likely be decreased under this FMP due to a moderate reduction in PSC limits, and bycatch reduction incentives with rationalization under FMP 3.2. However, available information does not suggest that such reductions, while presumably beneficial for salmon subsistence resource use, would result in significant increases in salmon returns to salmon subsistence fishery areas. Catcher vessel activity and labor income are anticipated to increase under this FMP, therefore there would be no indirect impacts to subsistence through a decline in income or joint production opportunities.

Cumulative Effects of FMP 3.1 and FMP 3.2

The predicted direct and indirect effects of the groundfish fishery under the FMP 3.1 and FMP 3.2 are described above. The past/present effects on subsistence are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. Representative indicators used in this analysis are the same as those used in the direct/indirect analysis and include subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon, and indirect impacts on other subsistence activities such as income and joint production opportunities.

Subsistence Use of Groundfish

- **Direct/Indirect Effects.** Under this FMP, no changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline subsistence groundfish fishing conditions.

- **Persistent Past Effects.** Foreign, JV, domestic, and state-managed fisheries have decreased populations of some species of groundfish used for subsistence. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries and long-term climate change have the potential to adversely contribute to subsistence use of the groundfish fisheries. Economic development and sport and personal use are not likely to adversely contribute to subsistence use of the groundfish fisheries. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, a cumulative effect is identified for subsistence use of groundfish, but is judged to be insignificant. The external impacts of other fisheries, other economic development activities, and sport and personal use of subsistence use of groundfish are not likely to contribute to significantly adverse cumulative effects to the groundfish fisheries. However, other state-managed fisheries could have adverse impacts to the subsistence use of groundfish due to the direct competition for the same species, but these impacts are not considered to be significant. The long-term climate change could adversely effect groundfish stocks.

Subsistence Use of Steller Sea Lions

- **Direct/Indirect Effects.** There is no indication that FMP 3.1 or FMP 3.2 would have an adverse impact on Steller sea lion subsistence activities or take over baseline conditions.

- **Persistent Past Effects.** The past/present effects on subsistence use of Steller sea lions include the following: a long-term decline in the population of Steller sea lions due to a number of factors; a long-term decline in the relative importance of marine mammals in local diets; commercial groundfish fishing taking prey species utilized by Steller sea lions; and Steller sea lion protection measures designed to assist in population recovery instituted in 2000. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, economic development, and long-term climate change have the potential to adversely contribute to Steller sea lion subsistence activities. Sport and personal use is not likely to adversely contribute to subsistence use of Steller sea lions. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, while an adverse cumulative effect is identified for subsistence use of Steller sea lions, the effect is judged to be insignificant. However, the cumulative effects of take, the continuing endangered status, and long-term decline in abundance are likely having population-level effects, but not enough to have significant indirect impacts to subsistence. The external impacts of other fisheries, other economic development activities, and sport and personal use of subsistence use of Steller sea lions are not likely to contribute adversely to the groundfish fisheries.

Subsistence Use of Western Alaskan Salmon and Bycatch in the Groundfish Fishery

- **Direct/Indirect Effects.** Salmon bycatch would likely be decreased due to a moderate reduction in PSC limits under FMP 3.1 and significantly reduced under FMP 3.2. However, available information does not suggest that such reductions, while presumably beneficial for salmon subsistence resource use, would result in significant increases in salmon returns to salmon subsistence fishery areas.

- **Persistent Past Effects.** The past/present effects on subsistence use of salmon include the following: utilization for subsistence since pre-contact times, and Area M closures implemented to decrease intercept of salmon. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts could all adversely contribute to salmon subsistence activities. Sport and personal use are not likely to adversely contribute to salmon subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, no adverse cumulative effect is identified for subsistence use of salmon, and is judged to be insignificant. There may be benefits to subsistence use from reduced bycatch in the groundfish fisheries. However, given the depressed stock status of salmon runs in western Alaska, adverse contributions from external factors, and the salmon bycatch in the BSAI and GOA, sustainability of depressed salmon stocks could be adversely impacted, but are considered insignificant.

Indirect Impacts on Other Subsistence Activities

- **Direct/Indirect Effects.** Under this FMP, catcher vessel activity and labor income are anticipated to increase under FMP 3.1 or FMP 3.2 Therefore no adverse indirect impacts to subsistence are expected to occur through a decline in income or joint production opportunities.

- **Persistent Past Effects.** The past/present effects on the indirect impacts on other subsistence activities include joint production as a part of local groundfish and other commercial fishery development from the outset; and income from fishing used for investment in subsistence is similar to use of income from other activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts could all have indirect adverse or beneficial contributions to subsistence activities. Sport and personal uses not likely to adversely contribute to indirect impacts on other subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, a cumulative effect is identified for indirect subsistence use, and the effect is judged to be insignificant. Income catcher vessel activity, and joint production opportunities are not expected to be effected adversely. However, the external impacts of other fisheries, other economic development activities, and long-term climate change and regime shifts could potentially have indirect adverse contributions to subsistence use.

4.7.9.5 Environmental Justice

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described below. The past/present effects on Environmental Justice are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The external effects used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, other sources of municipal/state revenue, and long-term climate change and regime shifts (Table 4.7-6).

Direct/Indirect Effects of FMP 3.1

Potential impacts that drive Environmental Justice issues include employment/municipal revenue and taxes in communities with significant percentages of special populations (Alaska Native and minority processing workforce); revenue to Alaska Native-owned catcher vessels; revenue to Alaska Native-owned catcher processors; subsistence activities associated with groundfish, Steller sea lion, and salmon; the loss of income from fishing that would be otherwise directed toward subsistence pursuits; and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. The regions that could experience potential impacts include the Alaska Peninsula and Aleutian Islands, Kodiak Island, southcentral Alaska, southeast Alaska, Washington inland waters, Oregon coast, the CDQ regions, and western Alaska communities that harvest salmon for subsistence purposes.

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which several have predominantly Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 370 jobs; therefore, no Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $514 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities and therefore no associated Environmental Justice impacts would occur. In this region, the ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under this FMP, the total value of catcher vessel operations would decrease as would corresponding labor income and employment; therefore, an apparent Environmental Justice impact would result. However, as described above, these apparent declines are likely to be attributable in large part to a shortcoming in the model regarding distribution of western GOA catch to Alaska Peninsula and Aleutian Islands region vessels, so the actual Environmental Justice impact is unknown, given current data.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would decrease over baseline conditions by about 25 jobs; therefore, no Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $85 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the City and the Kodiak Island Borough, and but given local and regional demographics, this is not likely to be an Environmental Justice issue. Ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the City of Kodiak itself, and therefore the local fleet associated population is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under this FMP, the total value of catcher vessel operations would increase as would corresponding labor income and employment. But given demographic assumptions, this is unlikely to be relevant as an Environmental Justice issue.

Southcentral Alaska. As described in existing conditions, Environmental Justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and thus it is unlikely that Environmental Justice issues will be associated with any employment change. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to Environmental Justice concerns. Similarly, processing value increases, but these changes are not relevant to Environmental Justice concerns.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall Environmental Justice concerns appear not to apply in this region. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to Environmental Justice concerns. Processing value decreases but this change is not associated with Environmental Justice concerns.

Washington inland waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, Environmental Justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under this FMP, at-sea processing labor income and FTEs both increase (if by less than significant amounts), so there are no Environmental Justice impacts associated with this change.

Oregon coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are not linked to Environmental Justice concerns. See

CDQ region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve Environmental Justice concerns. Under this FMP, the structure of the CDQ program would not change from baseline conditions and, as noted above, no adverse impacts to the program are anticipated, therefore no Environmental Justice impacts are likely to occur.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve Environmental Justice concerns. Subsistence activities where there are potential Environmental Justice issues include the following:

- Harvest of groundfish (which occurs to some extent in all four Alaska regions), Steller sea lion (primarily and activity in the Alaska Peninsula/Aleutian Islands region), and salmon (primarily an issue in western Alaska, where poor runs have adversely affected subsistence harvests).

- The loss of income from fishing that would otherwise be directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production (which occurs to some extent in all four Alaska regions).

While there are some concerns about the effect of the groundfish fishery on Steller sea lions and salmon bycatch, it has been determined that fishing under FMP 3.2 is not having significantly adverse contributions to Steller Sea lion and salmon populations and their availability for subsistence harvest. Income available for subsistence activities and joint income opportunities are likely to be similar to FMP 1, with slight increases over the baseline likely. Therefore, no associated Environmental Justice impacts are anticipated.

Cumulative Effects of FMP 3.1

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 are described above. The past/present effects on Environmental Justice issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicator used in this analysis is the same as that used in the direct/indirect analysis (Table 4.7-6).

- **Direct/Indirect Effects.** Under FMP 3.1, direct/indirect impacts range from beneficial (subsistence harvests) to adverse (reductions in catcher vessel activity in the Alaska Peninsula/Aleutian Islands, reduction in processing workforce in several regions), but they are not significant. Any changes in the commercial fishery that are anticipated would result in insignificant impacts to the Environmental Justice baseline.

- **Persistent Past Effects.** Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. Other sources of municipal state revenue have the potential to adversely affect Environmental Justice issues. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 an insignificant cumulative effect is identified for Environmental Justice. The direct/indirect effects on income for subsistence pursuits, and participation and employment opportunities for Alaska Natives in the fishery generally increase. Reductions in revenues to local communities in the Alaska Peninsula/Aleutian Islands, in conjunction with the external effects from the crab closures and downturn in the salmon industry could potentially effect Environmental Justice issues, but not of a magnitude to be significant. Effects from by-catch of salmon and Steller sea lion subsistence activities are beneficial, and effects on income and joint production activities related to subsistence in the Alaska Peninsula/Aleutian Islands region are adverse but cumulatively insignificant.

Direct/Indirect Effects of FMP 3.2

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominantly Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 336 jobs; therefore, insignificant Environmental Justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $510 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities and therefore no associated Environmental Justice impacts would occur. In this region the ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under this FMP, the total overall net value of catcher vessel operations would decrease. Similarly, the corresponding labor income and employment would also decrease. Therefore, an apparent Environmental Justice impact would result, but as discussed under other alternatives, this may in part be an artifact of the model. The impacts to the local fleets are considered conditionally significant adverse (resulting from MPA and rationalization design features) as impacts to Alaska Native communities with support service businesses may occur. These effects are conditional and depend on the ultimate design of the programs.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would decrease over baseline conditions by about 53 jobs, which may result in an Environmental Justice impact, but it is not significant. The total in-region groundfish processing value would decrease from $81 million to $74 million. Decreased in-region processing values would correspond to reduced municipal revenue and taxes to the City and the Kodiak Island Borough, but given local and regional demographics, this is not likely to be an Environmental Justice issue. Ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the City of Kodiak, and therefore the associated local fleet is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under this FMP, the total value of catcher vessel operations would decrease as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be an Environmental Justice issue.

Southcentral Alaska. As described in existing conditions, Environmental Justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and thus it is unlikely that Environmental Justice issues will be associated with any employment change. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs decrease, but this change is not linked to Environmental Justice concerns. Similarly, processing value decreases, as do catcher vessel associated values, but these changes are not tied to Environmental Justice concerns.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall Environmental Justice impacts in this region are insignificant. In general, combined direct, indirect, and induced labor income and FTEs decrease, but this change is not linked to Environmental

Justice concerns. Similarly, processing value decreases as do analogous catcher vessel associated values, but this change is not associated with Environmental Justice concerns.

Washington inland waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, Environmental Justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under this FMP, at-sea processing labor income and FTEs both increase but not significantly, so there are no Environmental Justice impacts associated with this change.

Oregon coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. Under this FMP, the direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are insignificant Environmental Justice concerns.

CDQ region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve Environmental Justice concerns. Under this FMP, the structure of the CDQ program would not change from baseline conditions and, as noted above, no adverse impacts to the program are anticipated. Therefore, no Environmental Justice impacts are likely to occur.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve Environmental Justice concerns. With regard to potential adverse impacts to subsistence activities, salmon-bycatch and habitat protection measures associated with this FMP are likely to benefit subsistence harvest of salmon and Steller sea lions, therefore no associated Environmental Justice impacts are anticipated. Fishery income available to support subsistence activities and opportunities for joint production in the Alaska Peninsula/Aleutian Islands region may decrease slightly under this FMP 3.2, but will not result in significantly adverse Environmental Justice issues.

Cumulative Effects of FMP 3.2

The predicted direct and indirect effects of the groundfish fishery under FMP 3.2 are described above. The past/present effects on Environmental Justice issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicator used in this analysis is the same as that used in the direct/indirect analysis (Table 4.7-6).

- **Direct/Indirect Effects.** Under FMP 3.2, direct/indirect impacts on Environmental Justice issues in the Alaska Peninsula and Aleutian Islands region are conditionally significant adverse, due to reductions in catcher vessel activity and associated effects on opportunities for Alaska Natives to participate in groundfish fisheries, and on income and joint production opportunities related to subsistence. For all other regions, however, insignificant Environmental Justice effects are expected.

- **Persistent Past Effects.** Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Other fisheries, other economic development activities, and long-term climate change and regime shifts have the potential to adversely or beneficially affect Environmental Justice issues. Other sources of municipal state revenue have the potential to adversely affect Environmental Justice issues. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.2, direct/indirect effects related to Environmental Justice are insignificant for all regions except for conditionally significant adverse effects in the Alaska Peninsula/Aleutian Islands due to reductions in catcher vessel activity. The external effects from the crab closures, downturn in the salmon industry, reductions in employment funded by public revenue, and reductions in revenue to Native communities are adverse. This is particularly true in the Alaska Peninsula/Aleutian Islands, where cumulative effects are conditionally significant adverse for Environmental Justice issues. While direct/indirect effects on income and joint production activities related to subsistence in the Alaska Peninsula/Aleutian Islands region are adverse but insignificant, cumulative effects are conditionally significant adverse due to downturns in other fisheries and decreased income and opportunities for joint production.

4.7.9.6 Market Channels and Benefits to U.S. Consumers

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described below. The past/present effects on market channels and benefits to U.S. consumers are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is benefits to U.S. consumers (Table 4.7-6).

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

FMP 3.1 and FMP 3.2 are not expected to have a significant effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. Under FMP 3.1 and FMP 3.2, the BSAI and GOA groundfish fisheries are expected to continue to provide high and relatively stable levels of seafood products to domestic and foreign markets. An estimate of the final market value of BSAI and GOA seafood products is not available; however, it would be substantially greater than $1.5 billion, the projected 5-year mean of the wholesale product value of BSAI and GOA groundfish after primary processing under FMP 3.1 and FMP 3.2. This wholesale product value mean is higher than the comparative baseline, but the increase is not significant.

The rationalization of groundfish fisheries occurring under FMP 3.2 could increase consumer benefits by resulting in an increase in the quality of groundfish products available to consumers relative to the comparative baseline. Moreover, rationalization has the potential to increase the proportion of Alaska groundfish products that are purchased by U.S. consumers because there will be more incentive to create the fresh and value-added products that are popular in the domestic market. With current technology and tastes, the greatest gains for U.S. consumers are likely to result from a greater supply of fresh and value-added products from Pacific cod and rockfish. However, these species currently account for less than one-third of all Alaska groundfish production. Furthermore, it is unlikely that all Pacific cod and rockfish will be sold to U.S. consumers. Consequently, the increased benefits to U.S. seafood consumers are not expected to be significant.

Cumulative Effects of FMP 3.1 and FMP 3.2

For a summary of the direct/indirect and cumulative ratings, see Table 4.7-6.

Market Channels and Benefits to U.S. Consumers

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2, increases in benefits to U.S. consumers of groundfish products are expected to occur, but are insignificant.

- **Persistent Past Effects.** These effects on benefits to U.S. consumers of groundfish products include: Alaska Seafood Marketing Institute product promotion activities, research and public awareness regarding the health benefits of seafood consumption, aquaculture development increasing overall availability and demand for seafood products, and changes in processing technology increasing seafood quality.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable effects include other fisheries (supply of product) and long-term climate change and regime shift. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, a cumulative effect is identified for benefits to U.S. consumers of groundfish products, and the effect is judged to be insignificant. The external impacts of other fisheries have the potential to contribute adversely or beneficially to the U.S. consumers of groundfish products and the groundfish market channels. However, the wholesale groundfish product value in conjunction with products from other fisheries is not expected to change benefits to U.S. consumers. The long-term climate change and regime shift could adversely effect availability for market channels due to the natural fluctuations in groundfish stocks.

4.7.9.7 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (Including Non-Consumptive and Non-Use Benefits)

The predicted direct and indirect effects of the groundfish fishery under FMP 3.1 and FMP 3.2 are described below. Benefits derived from marine ecosystems and associated species are used as a surrogate to evaluate non-consumptive and non-use benefits. The past/present effects on non-consumptive and non-use benefits to U.S. general public are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits) (Table 4.7-6).

Direct/Indirect Effects of FMP 3.1 and FMP 3.2

FMP 3.1 is predicted to have no significant effects on the level of benefits the Bering Sea and GOA marine ecosystems and associated species provide relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 3.1 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.7.10 of the Programmatic SEIS.

As described in Section 3.9.7, the Bering Sea and GOA marine ecosystems and species associated with them provide a broad range of benefits to the American public. Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. While there are difficulties in estimating the value the public places on protecting ecological conditions, Section 3.9.7 provides a qualitative discussion of possible benefits provided by the Bering Sea and GOA marine ecosystems. In addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing. Furthermore, some people may not directly interact with the Bering Sea and GOA marine ecosystems and the various species associated with them but derive satisfaction from knowing that the structure and function of these ecosystems are protected.

The focus in this analysis is on the direct and indirect effects of the alternatives on ecosystem benefits other than those that accrue to members of society who make a living harvesting, processing and distributing BSAI and GOA groundfish products or who purchase and consume these products. The direct and indirect effects of the alternatives on firms and communities that derive value from the commercial harvest and processing of groundfish are described elsewhere in this SEIS. Similarly, the effects of the alternatives on consumers of groundfish products are discussed in a separate section of this SEIS.

The value people assign to those marine ecosystem benefits that are unrelated to commercial groundfish fisheries are thought to be considerable. For example, the value of protecting the Steller sea lion alone may be substantial. As discussed in Section 3.9.7, a contingent valuation study suggests that there is a significant willingness to pay on the part of the American public for an expanded federal Steller sea lion recovery program. At this time, however, there is insufficient information to provide a comprehensive measure of the benefits derived from these ecosystems and the various species associated with them.

FMP 3.1 would maintain current management measures that mitigate the adverse effects of the groundfish fisheries on the Bering Sea and GOA marine ecosystems and associated species. These measures include a network of spatial/temporal closed areas that disperse fisheries geographically and seasonally, a prohibition on the use of non-pelagic trawl gear to fish for pollock in the BSAI, bycatch reduction measures such as the full retention requirement for Pacific cod and pollock, and measures to reduce the incidental catch of seabirds. Furthermore, as discussed in Section 4.7.10, FMP 3.1 is not expected to result in a significant change in the quantitative measures of any indicators of fishing impacts on marine ecosystems relative to the baseline. Consequently, the change in the level of benefits these ecosystems provide is not expected to be significant.

FMP 3.2 is predicted to significantly increase the level of benefits provided by the Bering Sea and GOA marine ecosystems and associated species, relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 3.2 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.7.10 of this SEIS.

FMP 3.2 would maintain current management measures that mitigate the adverse effects of the groundfish fisheries on the Bering Sea and GOA marine ecosystems and associated species. In addition, FMP 3.2 closes off 20 percent of the EEZ as a "no-take" marine reserve (3 percent) or "no-bottom contact" marine protected area (17 percent) covering a full range of marine habitats within the 1,000-m bathymetric line (Figure 4.2-5). The closures aim to provide protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species.

Furthermore, FMP 3.2 would undertake a comprehensive rationalization of all fisheries. By extending rights-based management to additional groundfish fisheries and thereby ending the race for fish in those fisheries, this FMP has the potential to provide increased protection to the Bering Sea and GOA ecosystems. If rights-based management systems include individual quotas on bycatch, they provide strong incentives to reduce bycatch because they internalize the cost of that bycatch. In turn, a reduction in bycatch can help protect bycatch species from overexploitation and maintain the overall ecosystem of which they may be an important part. Moreover, the experience with cooperatives in the BSAI pollock fishery shows that fishing may be spread out temporally as a result of rights-based management systems. This dispersal of fishing effort would reduce the potential for local depletions of fish stocks and the associated adverse impacts on marine mammals and other species.

As discussed in Section 4.7.10, the measures implemented under FMP 3.2 are expected to have significant or conditionally significant beneficial consequences for predator-prey relationships and diversity. In turn, these beneficial effects on the Bering Sea and GOA marine ecosystems and associated species are expected to lead to a significant increase in the levels of some of the benefits these ecosystems and species provide.

Cumulative Effects of FMP 3.1 and FMP 3.2

For a summary of the direct/indirect and cumulative ratings, see Table 4.7-6.

Benefits Derived from Marine Ecosystems and Associated Species

- **Direct/Indirect Effects.** Under FMP 3.1 and FMP 3.2 the risks of adverse effects that the Alaska groundfish fishery could have on marine ecosystems are reduced. FMP 3.1 is predicted to have a beneficial but insignificant impact on the levels of benefits these ecosystems and associated species generate; FMP 3.2 is predicted to have a beneficial significant impact.

- **Persistent Past Effects.** Persistent past effects on non-consumptive and non-use benefits include: an increase in public awareness of marine ecosystems; increased participation in recreational fishing and eco-tourism activities; and public perceptions with regard to fisheries management. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects include other fisheries, and long-term climate change and regime shifts. These factors do not vary among alternatives; for more detail see the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 3.1 and FMP 3.2, a cumulative effect is identified for benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits), and the effect is judged to be insignificant and significantly beneficial, respectively. Both alternatives result in some direct/indirect benefits. However, the external impacts of other fisheries, development activities and natural cycles contribute adversely to benefits the public derives from marine ecosystems and associated species. Fishery management measures under FMP 3.1 and FMP 3.2 could continue the introduction of non-native species and effect a change in pelagic forage availability. The spacial and temporal concentration of fishery impact on forage could reduce the following: spatial/temporal pressures of the groundfish fisheries on forage species, removal of top predators (potential for seabird bycatch and subsistence harvests of marine mammals), and risk of changes in species, functional, and structural habitat diversity for the ecosystem. The long-term climate change and regime shift could adversely effect ecosystems and associated species due to the natural fluctuations in groundfish stocks.

4.7.10 Ecosystem Alternative 3 Analysis

Ecosystems are populations (consisting of single species) and communities (consisting of two or more species) of interacting organisms and their physical environment that form a functional unit with a characteristic trophic structure (food web) and material cycles (movement of mass and energy among the groups). The following analyses of potential direct/indirect and cumulative effects of Alternative 3 apply to the BSAI and GOA ecosystems. Where available information allows, each ecosystem is addressed separately. In most cases, however, information is insufficient to allow individual consideration, and the two ecosystems are treated as a single entity.

As explained in Section 4.5.10, the analysis includes numerous indicators representing potential direct, indirect, and cumulative effects of Alternative 3, as well as specifics of FMB 3.1 and 3.2 where applicable. Significance thresholds for the effect categories are presented in Table 4.1-7.

Direct/Indirect Effects FMP 3.1 and FMP 3.2 – Ecosystems

This section assesses the potential direct/indirect and cumulative effects of FMP 3.1 and FMP 3.2 on the BSAI and GOA ecosystems.

Change in Pelagic Forage Availability

Pelagic forage availability is assessed by evaluating population trends in pelagic forage biomass for species with age-structured population models. This includes walleye pollock in the GOA (Figure H.4-17 of Appendix H) and Bering Sea walleye pollock and Aleutian Islands Atka mackerel (Figure H.4-18 of Appendix H). Trends in bycatch of other forage species (herring, squid, and forage species group) in the groundfish fisheries are a measure of the potential impact on those groups in the BSAI and GOA (Figures H.4-19 and H.4-20 of Appendix H). Table 4.5-81 summarizes the average values from 2003-2008 for these measures and the percent change in the average values from the baseline amounts. Under FMP 3.1, pelagic forage biomass in the BSAI (Bering Sea walleye pollock + Aleutian Islands Atka mackerel) would decline by about 10 percent from the baseline and pelagic forage biomass (specifically, walleye pollock) in the GOA would increase by about 53 percent over the baseline. Twenty-year biomass projections show similar trends. Average biomass would still be within the bounds of estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species would increase by more than 85 percent in the BSAI and decline by about 25 percent in the GOA. The projected absolute quantity of bycatch in each region is relatively small (3,500 mt and 190 mt, respectively). Estimates of forage biomass from food web models of the EBS indicate that this bycatch is probably a small proportion of the total forage biomass (Aydin *et al.* 2002). However, lack of population-level assessments for some species in the forage species group means that corresponding species-level effects are unknown. On the basis of this analysis, FMP 3.1 is determined to have an insignificant effect on the BSAI and GOA ecosystems with respect to pelagic forage availability.

In FMP 3.2, pelagic forage biomass in the BSAI (Bering Sea walleye pollock + Aleutian Islands Atka mackerel) would show a 10 percent average decline from the baseline and pelagic forage biomass (specifically, walleye pollock) in the GOA would increase about 55 percent over the baseline. Twenty-year biomass projections show similar trends. As in FMP 3.1, average biomass would be within the range of estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species would increase more than 50 percent in the BSAI and decline by about 43 percent in the GOA. However, the extensive fishing closure areas put forth under this FMP may change bycatch estimates in many ways but cannot be accurately predicted. The projected absolute quantity of bycatch in each region is relatively small (2,460 mt and 150 mt, respectively). This bycatch would be a small proportion of the total forage biomass estimated in EBS food web models (Aydin *et al.* 2002). Lack of population-level assessments for some of the species in the forage species group means that corresponding species-level effects are unknown. FMP 3.2 is determined to have an insignificant effect on the BSAI and GOA ecosystems with respect to pelagic forage availability.

Spatial and Temporal Concentration of Fishery Impact on Forage

Spatial and temporal concentration of fishery impact on forage species is assessed qualitatively by considering the potential for the alternatives to concentrate fishing on forage species in regions utilized by predators that are tied to land, such as pinnipeds and breeding seabirds. Additionally, the possibility for concentration of fishing effort to result in an ESA listing or lack of recovery to an ESA-listed species is also considered. FMP 3.1 would continue the existing closures around Steller sea lion rookeries, the ban on forage fish, and the spatial/temporal allocation of TAC for pollock and Atka mackerel, resulting in an insignificant effect of the spatial/temporal concentration of the fishery on forage species. BS pollock fisheries have shown increasing catch in northern fur seal foraging habitat but more research is required to evaluate whether the amounts of pollock removed are having a population-level effect on the fur seals. FMP 3.2 would continue the existing closures around Steller sea lion rookeries with the addition of a frameworked buffer zone based on telemetry data. The existing ban on forage fish and the spatial/temporal allocation of TAC for pollock and Atka mackerel would also be continued. These measures would be improvements relative to the baseline with respect to the spatial/temporal concentration of the fisheries on forage species. Objectives and criteria for allocating TAC in space and time would be developed under this FMP. The no-trawling MPAs around the Pribilof Islands under this FMP could provide increased protection to northern fur seal foraging habitat from potential fishing effects. For these reasons, groundfish fisheries under FMP 3.2 are determined to have a conditionally significant beneficial effect on the spatial/temporal availability of forage, particularly for some marine mammals. These measures would not result in any significant change in spatial/temporal availability of forage to seabirds.

Removal of Top Predators

Removal of top predators, either through directed fishing or bycatch, is assessed by evaluating the trophic level of the catch relative to the trophic level of the groundfish biomass (Figures H.4-21 through H.4-24 of Appendix H), bycatch levels of sensitive top predator species such as birds and sharks (Figures H.4-25 and H.4-26 of Appendix H), and a qualitative evaluation of the potential for catch levels to cause one or more top-level predator species to fall below biologically acceptable limits (minimum stock size threshold for groundfish, lead to ESA listing or prevent recovery of an ESA-listed species). Trophic level of the catch in both the BSAI and GOA is a very stable property, changing less than 3 percent on average from the baseline. Trophic level of the groundfish species for which we have age-structured models changes less than one percent on average. Under FMP 3.1, top predator bycatch amounts would increase in the BSAI (7 percent) and decrease in the GOA (12 percent) relative to the baseline. The absolute values of average catch of these species are estimated to be 724 mt and 1,150 mt in the respective regions under this FMP. For FMP 3.2, top predator bycatch amounts would decrease from the baseline in both the BSAI (27 percent) and the GOA (36 percent). The absolute values of average catch of these species are estimated to be 490 mt and 840 mt in the respective regions under FMP 3.2, the lowest amounts estimated over all the alternatives.

The above indicators result in no change in the evaluation of the importance of this effect relative to the baseline. The baseline determination was that historical whaling has resulted in low present-day abundance of whale species in the North Pacific Ocean. FMP 3.1 and FMP 3.2 would not further impair the recovery of these species through direct takes. Similarly, levels of seabird and pinniped bycatch in groundfish fisheries in these FMPs would not lead to an ESA listing for any of those populations or prevent any of the species from recovery under the ESA. Sections 4.7.7 and 4.7.8 discuss the effects of groundfish fishery direct takes on specific seabird and marine mammal populations. The effect of shark bycatch on shark populations is unknown at present, and research directed at better assessing population levels of these sensitive (late maturing, low fecundity, low natural mortality) species is needed to better assess the potential effects from groundfish fisheries. Breaking sharks out of the "Other Species" group for TAC setting means that this FMP would provide some level of increased protection for sharks through a more group-specific TAC. Section 4.6.3 contains further information on sharks. Stability in trophic level of the catch is indicative of little effect of the fishery on target species and PSC top predators (Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut). See Section 4.6.1 for details on these target species and Section 4.6.2 for Pacific halibut. Overall, FMP 3.1 and FMP 3.2 would have insignificant and unknown effects on top predators.

Introduction of Non-Native Species

The introduction of non-native species through ballast water exchange and hull-fouling organism release from fishing vessels could potentially disrupt Alaskan marine food web structures (Fay 2002). There have been 24 non-indigenous species of plants and animals documented primarily in shallow-water marine and estuarine ecosystems of Alaska, with 15 species recorded in PWS. It is possible that most of these introductions were from tankers or other large commercial vessels that have large amounts of ballast exchange. However, a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002) identified fishery vessels as another potential threat. Fishery vessels may take on ballast from areas where invasive species have already been established and then transit through Alaskan inshore waters. Consequently, this effect is evaluated as conditionally significant adverse in the baseline.

Total groundfish catch levels are used as an indicator of potential changes in the amount of these releases via groundfish fishery vessels (Figures H.4-27 and H.4-28 of Appendix H, Table 4.1-7). Under FMP 3.1, total catch would increase by about 2 percent in the BSAI and by about 13 percent in the GOA relative to the baseline. FMP 3.2 would result in catches increasing by about one percent in the BSAI and decreasing by 8 percent in the GOA relative to baseline. These projected catch levels are similar to recent catches in these areas, indicating a similar level of effort and thus a similar potential for fishing vessel introduction of non-native species through ballast water exchange or hull-fouling organism release. Consequently, FMP 3.1 and FMP 3.2 would result in insignificant changes from the baseline with respect to the potential for introducing non-native species from fishing vessels and gear.

Energy Flow and Balance

As discussed in Section 3.10, fishing may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal back into the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. Baseline energy removals, in the form of total catch, were less than one percent of the total system energy as determined by mass-balance modeling of the system and were determined to have an insignificant impact on the ecosystem. FMP 3.1 catch removals (Figures H.4-27 and H.4-28 of Appendix H, change approximately 13 percent from the baseline and are determined to be insignificant with respect to the potential for producing changes in system biomass, respiration, production, or energy cycling that are outside the range of natural variability (Table 4.1-7). Predicted catch removals under FMP 3.2 (Figures H.4-27 and H.4-28 of Appendix H, Table 4.5-81), increase by one percent in the BSAI and decrease by 7 percent in the GOA relative to the baseline. These changes are also determined to be insignificant.

Energy re-direction, in the form of discards or fishery offal production or unobserved gear-related mortality, can potentially change the natural pathways of energy flow in the system. Animals damaged when passing through the meshes of trawls may later die and be consumed by scavengers. Bottom trawls can expose benthic organisms and make them more vulnerable to predation. Discards and offal production can cause local enrichment and changes in species composition or water quality if discards or offal returns are concentrated there. These effects were determined to be insignificant at the ecosystem level in the baseline. Trends in total discards (Figures H.4-29 and H.4-30 of Appendix H) under FMP 3.1 show increases by less than one percent in the BSAI and about an 8 percent decrease in the GOA relative to the baseline. Trends in total discards (Table 4.5-81, Figures H.4-29 and H.4-30 of Appendix H) under FMP 3.2 show a 24 percent decrease in the BSAI and a 42 percent decrease in the GOA relative to the baseline. These changes are determined to be small in comparison to historical amounts of discards and are determined to have insignificant potential effects on ecosystem-level energy cycling characteristics.

Change in Species Diversity

Fishing can alter different measures of diversity. Species-level diversity, or the number of species, can be altered if fishing essentially removes a species from the system. Fishing can alter functional diversity from a trophic standpoint if it selectively removes or depletes a trophic guild member and thus changes the way biomass is distributed within a trophic guild. Functional diversity from a structural habitat standpoint can be altered if fishing methods such as bottom trawling remove or deplete organisms such as corals, sea anemones, or sponges that provide structural habitat for other species. Fishing can alter genetic diversity by selectively removing faster-growing fish or removing spawning aggregations that might have genetic characteristics that are different from other spawning aggregations. Larger, older fishes may be more heterozygous (i.e., have more genetic differences or diversity), and some stock structures may have a genetic component (Jennings and Kaiser 1998). Consequently, one would expect a decline in genetic diversity to result from heavy exploitation of a fishery.

Significance thresholds for effects of fishing on species diversity are catch removals high enough to cause the biomass of one or more species (target or nontarget) to fall below, or to be kept from recovering from levels already below, minimum biologically acceptable limits (MSST for target species, ESA listing for nontarget) (Table 4.1-7). Indicators of significance are population levels of target and nontarget species relative to MSST or ESA listing thresholds, linked to fishing removals. Bycatch amounts of sensitive (low population turnover rates) groups that lack population estimates (skates, sharks, grenadiers, and sessile invertebrates, such as corals, inhabiting HAPC may also indicate potential for fishing impact on these species (Figures H.4-31 and H.4-32 of Appendix H). Closed areas also provide protection, particularly to less-mobile species like HAPC biota, so the amount of area closures across habitat types can indicate the degree of species-level diversity protection. Baseline determinations were insignificant for most of these indicators, and unknown for skates and sharks.

Under FMP 3.1, closed areas would remain the same, and bycatch of HAPC biota would stay the same in the BSAI and decrease by almost 14 percent in the GOA. Although it is unknown whether bycatch amounts of HAPC biota would be at levels high enough to bring these species to minimum population thresholds, area closures would likely be sufficient to prevent species removal for these sessile animals. These area closures would most likely be sufficient to prevent species extinction for these sessile animals. Under FMP 3.2, bycatch of HAPC biota would decrease by about 25 percent in the BSAI and by about 40 percent in the GOA (Table 4.5-81). This FMP would also provide substantial increases in closed areas in the form of no-trawling MPAs and no-take reserves. These closures would produce even greater reductions in HAPC biota bycatch that are not modeled here. Catch amounts of target species, prohibited species, seabirds, and marine mammals resulting from both of these FMPs would be insufficient to bring species within these groups below minimum population thresholds. It is unknown whether bycatch amounts of skates, sharks and grenadiers would be at levels high enough to bring species within these groups to minimum population thresholds. Breaking sharks and skates out of the “Other Species” group for TAC setting would provide further protection by establishing additional group-specific TACs. The adoption and use of ecosystem indicators for modifying TAC may also provide further protection to sensitive groups such as these until more is learned about their life histories. Although forage species population levels are not known, their relatively high turnover rates and the ban on forage fish fisheries in these FMPs are considered sufficient protection from population-level effects.

On the basis of the preceding considerations, FMP 3.1 and FMP 3.2 are considered to result in insignificant and unknown effects on species diversity. More years of survey data and life history parameter determination for skates, sharks and grenadier species may better define population trends as to further protect these species from experiencing adverse impacts from fishing. Sections 4.7.1 though 4.7.8 present the detailed analyses of the potential for fishery removals to affect minimum population thresholds for each of these groups and thus to ultimately affect species diversity.

Change in Functional Diversity

Functional (either trophic or structural habitat) diversity can be altered through fishing if fishing selectively removes one member of a functional guild, which may result in increases in other guild members. A functional guild is a group of species that use resources within the ecosystem in similar ways. Significance thresholds are catch removals high enough to cause a change in functional diversity outside the range of natural variability observed for the system (Table 4.1-7). Indicators of the possible magnitude of effects include qualitative evaluation of guild or size diversity changes relative to fishery removals, bottom gear effort changes that would provide a measure of benthic guild disturbance, and bycatch amounts of HAPC biota, a structural habitat guild. Members of the HAPC biota guild serve important functional role in providing fish and invertebrates with habitat and refuge from predation. The abundance of these structural species necessary to provide protection is not known, and it may be important to retain populations of these organisms that are well distributed spatially in order to fulfill their functional role. Some of these organisms have life-history traits that make them very sensitive to fishing removals. The long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. Present-day Steller sea lion trawl closures are spread throughout the Aleutian chain, but these closures may be more inshore than most of the coral. For this reason, the areas closed to trawling in this FMP may not be sufficient to provide additional protection beyond the baseline for these sensitive organisms.

Under FMP 3.1, the species composition and amounts of removals, bottom gear effort, and bycatch amounts of HAPC biota (Table 4.5-81, Figures H.4-31 and H.4-32 of Appendix H) would be relatively similar to the comparative baseline, in which fishing impacts on functional guild diversity are determined to be insignificant for trophic diversity and conditionally significant and adverse for structural habitat diversity, Some of the area closures for FMP 3.2 have been designed with corals in mind and, if implemented, will ensure that there is a broad spatial distribution of corals, particularly in the Aleutian Islands. Thus, FMP 3.2 is determined to have a significantly beneficial effect relative to the baseline on structural habitat diversity while FMP 3.1 would result in is an insignificant change from the baseline. In addition, FMP 3.2 is determined to have a insignificant effect on trophic diversity, species composition, and amounts of removals for target species relative to the baseline.

Change in Genetic Diversity

Genetic diversity can be affected by fishing through heavy exploitation of certain spawning aggregations or systematic targeting of older age classes that tend to have greater genetic diversity. Under FMP 3.1 and FMP 3.2, no target species would fall below MSST, spatial/temporal management of TAC would not change, and similar catch and selectivity patterns in the fisheries would apply. These FMPs would result in insignificant impacts of fishing on genetic diversity. However, a baseline condition for genetic diversity remains unknown for most species and the potential effects that fishing may have on genetic diversity under FMP 3.1 and FMP 3.2 are also largely unknown.

Cumulative Effects Analysis FMP 3.1 – Ecosystems

The following sections briefly discuss the potential cumulative effects of FMP 3.1 on the ten ecosystem indicators explained in Section 4.5.10. These potential cumulative effects are summarized in Table 4.7-7. Data and calculations supporting the energy removal analyses for all alternatives are presented in Table 4.5-81.

Change in Pelagic Forage Availability

- **Direct/Indirect Effects.** The effects of FMP 3.1 on pelagic forage availability are expected to be insignificant. Fishery-induced changes, including bycatch-related effects on forage species, would be within the natural level of abundance or variability for prey species relative to predator demands (Table 4.1-7).

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from about 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability would occur in the event of a large petroleum spill. The conditions under which this effect would be significant relate to the areas affected by, and seasonal timing of, the spill. If these coincide with spawning locations and times, a significantly adverse cumulative effect on pelagic forage availability would most likely result. Additive or interactive contributions from State of Alaska commercial fisheries and subsistence fish harvests are not expected to be significant. A future climatic regime shift would not appreciably offset, but could intensify, this potential cumulative effect if the productivity of pelagic forage species is reduced.

Spatial/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** The direct/indirect effects of the spatial/temporal concentration of fishing efforts under FMP 3.1 on pelagic forage availability are expected to be insignificant. FMP 3.1 would continue the existing closures around Steller sea lion rookeries, the ban on forage fish, and the spatial/temporal allocation of TAC of pollock and Atka mackerel, which have been determined to result in an insignificant impact on spatial/temporal concentration of fishery on forage species.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may have persisted into the present and future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have shown effects on recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlapping with the groundfish fishery is more likely temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing efforts and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines and adversely impact other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that are synergistic with spatial/temporal concentrations of fishing efforts, in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could result in the future, synergistic with the spatial/temporal concentration of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries, principally for herring, and subsistence fish harvests, converge in space and time with a fuel or oil spill, forage fish populations could be depressed sufficiently to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species in ways that might reduce or intensify this potential cumulative effect.

Removal of Top Predators

- **Direct/Indirect Effects.** The implementation of FMP 3.1 is predicted to have insignificant effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This FMP would not impair the continued recovery of whale populations still reduced through direct take in the past, and levels of seabird and marine mammal bycatch in the groundfish fisheries would not lead to any of these species being listed, or prevent their recovery under the ESA. Because there is little available information on shark bycatch, the direct/indirect effect of this FMP on shark populations is unknown.

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the low present-day abundance of whale species in the North Pacific. State of Alaska directed groundfish fisheries, which are small and sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, and past harvests may have had a sustained effect on some populations that persist today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a sustainable portion of the Pacific halibut population, a top predator. The current management plan is likely to continue in the reasonably foreseeable future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea would result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on total numbers of top predators could result primarily from continued high levels of seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, there is a likelihood that the present high levels of seabird bycatch will continue in the future. The conditions under which this cumulative effect could be significant are the continuation of high external seabird bycatch rates in conjunction with a large fuel or oil spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and this could intensify or reduce the potential cumulative effect by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** Under FMP 3.1, projected catch levels would maintain about the same potential for fishing-vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms that currently exists under baseline conditions. Therefore, the direct/indirect effect of FMP 3.1 on predator-prey relationships through the introduction of exotic species is evaluated as insignificant.

- **Persistent Past Effects.** For decades, the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the reasonably foreseeable future. In addition, commercial shipping, including cruise ships and barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with FMP 3.1, it is conceivable that viable populations could eventually become established in the BSAI and/or GOA, producing a conditionally significant adverse cumulative effect (Table 4.1-7). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that might allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA. External sources that could contribute to this potential cumulative effect in the future include fishing vessels participating in the IPHC and State of Alaska commercial fisheries, and commercial ships such as tankers and cruise ships, all of which can introduce non-native species through the release of ballast water and hull-fouling organisms (Fay 2002). In addition, Atlantic salmon released or escaped from coastal net-pen farms may establish viable runs at some point in the reasonably foreseeable future (ADF&G 2002a).

Energy Removal

- **Direct/Indirect Effects.** The effects of FMP 3.1 on energy removal are expected to be insignificant. Baseline energy removals, in the form of total catch, are less than one percent of the total ecosystem energy, as estimated by mass-balance modeling, and were determined to have an insignificant impact on the ecosystem. Total retained catch removals under FMP 3.1 are still less than one percent of the total system energy as estimated from mass-balance modeling for the EBS. Therefore, estimated energy removals under FMP 3.1 would not have the potential to produce changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 4 percent of the cumulative biomass that would be removed annually under this FMP (Table 4.5-81). The State of Alaska directed groundfish and subsistence fisheries will remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (doughnut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that are viewed as only partly comparable systems, and their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 3.1 is predicted to have an insignificant cumulative effect on energy removal in the future. The total domestic groundfish catch under this FMP is estimated to remove less than one percent of the total system energy. If the annual total catches of the State of Alaska herring and crab and IPHC halibut fisheries in the future are similar to the 1997-2001 averages, the combined total catch of these external fisheries will represent an approximate 6 percent addition to the estimated total catch for the groundfish fisheries alone under this FMP (Table 4.5-81). This additional increment of biomass removal is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability due to expected energy removals by the BSAI and GOA groundfish fisheries (Table 4.1-7).

Energy Redirection

- **Direct/Indirect Effects.** The effects of FMP 3.1 on energy redirection are expected to be insignificant. Predicted effects would be small relative to the baseline and would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability due to fishery discarding and offal production practices (Table 4.1-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 3.1 is predicted to have an insignificant cumulative effect on energy redirection. The cumulative effect in combination with these external sources is not expected to depart from the comparative baseline condition sufficiently to produce long-term changes outside the range of natural variability. The discharge of offal from fish processing facilities and of graywater and other refuse from marine vessels into Alaskan waters is regulated through EPA and ADEC permitting programs.

Change in Species Diversity

- **Direct/Indirect Effects.** The expected direct/indirect effects of FMP 3.1 on species diversity are rated as unknown for skates, sharks, and grenadiers and insignificant for other groups. Under FMP 3.1, closed areas would remain the same, and bycatch of HAPC biota would stay the same in the BSAI and decrease by almost 14 percent in the GOA (Table 4.5-81). Although it is unknown whether bycatch amounts of HAPC biota would be at levels high enough to bring these species to minimum population thresholds, area closures would likely be sufficient to prevent species removal for these sessile animals. Catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate (including HAPC) species are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated in some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show positive correlations with prey abundance, and that cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 3.1, a conditionally significant adverse effect on species diversity could result from a cumulative high level of seabird bycatch by the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may, at some time in the future, establish a viable population that could change species diversity in an adverse way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species. Under some combination of these conditions, the biomass of one or more species could fall below, or be kept from recovering from levels already below, minimum biologically acceptable limits (Table 4.1-7).

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** Under FMP 3.1, the predicted effects of the groundfish fisheries on trophic diversity are rated as insignificant, because they are expected to be similar to the comparative baseline conditions, for which fishing effects on trophic diversity are also rated as insignificant.

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, little research on this type of effect was conducted in the BSAI and GOA in past decades.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 3.1 could produce a conditionally significant adverse effect on trophic diversity. The primary condition for this effect is largely speculative: a climatic regime shift could make a trophic guild containing one or more groundfish fishery target species more vulnerable to fishing pressure. A regime shift in the future, similar to well-documented examples that have occurred in the past (Sections 3.3 and 3.10.1.5), could decrease species diversity within a trophic guild by reducing the productivity or shifting the distributional range of one or more member species. If this climatic effect went undetected and without compensatory adjustments to fishing effort, the continued removal of particular target species could decrease their representation within trophic guilds. This would particularly affect slow-growing species such as the rockfishes that are taken by bottom trawl, are subject to removal as bycatch, and have been reduced by overfishing in the past (Heifitz *et al.* 2001).

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to functional diversity in terms of structural habitat is the removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures for habitat of other species, including economically important groundfish species and their prey. Present (comparative baseline) trawl closures to protect the Steller's sea lion are spread throughout the Aleutian chain, but these closures are in waters shallower than where corals tend to be found. In FMP 3.1, the species composition and amounts of removals, bottom gear effort and bycatch amounts of HAPC biota, and areas closed to trawling relative to coral distribution are relatively similar to the baseline. Therefore, the change from baseline conditions that would result from this FMP is evaluated as insignificant with respect to structural habitat diversity.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data, no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill from commercial shipping could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** Direct/indirect effects of FMP 3.1, rated insignificant, could contribute to a conditionally significant adverse cumulative effect on structural habitat diversity under any of the following three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could add to the direct/indirect effects of bottom trawling by the groundfish fishery on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity, and thus the population size, as well as the distribution, of bottom-dwelling invertebrates that provide structural habitat.

Change in Genetic Diversity

- **Direct/Indirect Effects.** Under FMP 3.1 it is not expected that target species would fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to the comparative baseline conditions. Consequently, the effect of the groundfish fisheries on genetic diversity are expected to be insignificant under this FMP. However, baseline genetic diversity remains unknown for most species and the actual direct/indirect effects that fishing would have on genetic diversity are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 3.1 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would affect the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. Thus, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the future.

Cumulative Effects Analysis FMP 3.2 – Ecosystems

The following sections briefly discuss the potential cumulative effects of FMP 3.2 on the ten ecosystem indicators explained in Section 4.5.10. These potential cumulative effects are summarized in Table 4.7-7. Data and calculations supporting the energy removal analyses for the alternatives are presented in Table 4.5-81.

Change in Pelagic Forage Availability

- **Direct/Indirect Effects.** The effects of FMP 3.2 on pelagic forage availability are expected to be insignificant. Fishery-induced changes, including bycatch-related effects on forage species, would be within the natural level of abundance or variability for prey species relative to predator demands (Table 4.1-7).

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from about 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below the threshold level (MSST). Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability would occur in the event of a large petroleum spill. The conditions under which this effect could be significant relate to the areas affected by, and seasonal timing of, the spill. If these coincide with spawning locations and times, a significantly adverse cumulative effect on pelagic forage availability would most likely result. A future climatic regime shift would not appreciably offset, but could intensify, this potential cumulative effect if the productivity of pelagic forage species is reduced.

Spatial/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** The effects of the spatial/temporal concentration of fishing efforts under FMP 3.2 on pelagic forage availability are expected to be conditionally significant beneficial for all predatory groups except seabirds, for which the effects are expected to be insignificant relative to the baseline. FMP 3.2 would continue the existing closures around Steller sea lion rookeries but add a buffer zone based on telemetry data. It would also maintain the existing ban on forage fish and the spatial/temporal allocation of TAC of pollock and Atka mackerel. Objectives and criteria for allocating TAC in space and time would be developed and may have more discriminating space/time

TAC allocations of forage to provide increased protection against the fisheries' ability to localize and deplete concentrations of prey species. These measures would not produce a significant change in the spatial/temporal availability of forage to seabirds, but they would be notable improvements over the baseline for top-predator fish and marine mammals.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may have persisted into the present and future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have shown effects on recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlapping with the groundfish fishery is more likely temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines and adversely impact other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that are synergistic with spatial/temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could result in the future, synergistic with the spatial/temporal concentration of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries, principally for herring, and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could be depressed sufficiently to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species in ways that might reduce or intensify this potential cumulative effect.

<u>Removal of Top Predators</u>

- **Direct/Indirect Effects.** The implementation of FMP 3.2 is predicted to have insignificant effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This FMP would not impair the continued recovery of whale populations still reduced through direct take in the past, and levels of seabird and marine mammal bycatch in the groundfish fisheries would not lead to any of these species being listed, or prevent their recovery under the ESA. Because there is little available information on shark bycatch, the effect of this FMP on shark populations is unknown.

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the low present-day abundance of whale species in the North Pacific. State of Alaska directed groundfish fisheries, which are small and sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, and past harvests may have had a sustained effect on some populations that persist today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a sustainable portion of the Pacific halibut population, a top predator. The current management plan is likely to continue in the reasonably foreseeable future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea would result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on total numbers of top predators could result primarily from continued high levels of seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, there is a likelihood that the present high levels of seabird bycatch will continue in the future. The conditions under which this cumulative effect could be significant are the continuation of high external seabird bycatch rates in conjunction with a large fuel or oil spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and this could intensify or reduce the potential cumulative effect by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** Under FMP 3.2, the predicted catch levels indicate that this FMP would maintain the same potential for fishing-vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms that currently exists under baseline conditions. Therefore, the effect of FMP 3.2 on predator-prey relationships through the introduction of exotic species is evaluated as insignificant.

- **Persistent Past Effects.** For decades, the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the reasonably foreseeable future. In addition, commercial shipping, including cruise ships and barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with FMP 3.2, it is conceivable that viable populations could eventually become established in the BSAI and/or GOA, producing a conditionally significant adverse cumulative effect (Table 4.1-7). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that might allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA. External sources that could contribute to this potential cumulative effect in the future include fishing vessels participating in the IPHC and State of Alaska commercial fisheries, and commercial ships such as tankers and cruise ships, all of which can introduce non-native species through the release of ballast water and hull-fouling organisms (Fay 2002). In addition, Atlantic salmon released or escaped from coastal net-pen farms may establish viable runs at some point in the reasonably foreseeable future (ADF&G 2002a).

Energy Removal

- **Direct/Indirect Effects.** The effects of FMP 3.2 on energy removal are expected to be insignificant. Baseline energy removals, in the form of total catch, are less than one percent of the total ecosystem energy, as estimated by mass-balance modeling, and were determined to have an insignificant impact on the ecosystem. The predicted catch removals for the BSAI and GOA are still less than one percent of the total system energy as estimated from mass-balance modeling for the EBS. Therefore, estimated energy removals under FMP 3.2 would not have the potential to produce changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 4 percent of the cumulative biomass that would be removed annually under this FMP (Table 4.5-81). The State of Alaska directed groundfish and subsistence fisheries will remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (doughnut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that are viewed as only partly comparable systems, and their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 3.2 is predicted to have an insignificant cumulative effect on energy removal in the future. If the combined total catch of the State of Alaska herring and crab and IPHC halibut fisheries in the future is similar to the 1997-2001 average, the cumulative total catch of these external fisheries plus the BSAI and GOA groundfish fisheries will increase by about 6.2 percent over the estimated total catch for FMP 3.2 alone (Table 4.5-81). This additional increment of biomass removal is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability due to expected energy removals by the BSAI and GOA groundfish fisheries (Table 4.1-7).

Energy Redirection

- **Direct/Indirect Effects.** The effects of FMP 3.2 on energy redirection are expected to be insignificant. These effects were determined to be insignificant at the ecosystem level in the baseline, and projected trends in total discards modeled for FMP 3.2 would decrease from the baseline by about 24 percent increase in the BSAI and 42 percent decrease in the GOA (Table 4.5-81). These effects, while decreasing the amount of energy redirected by discards, would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability due to fishery discarding and offal production practices (Table 4.1-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 3.2 is predicted to have an insignificant cumulative effect on energy redirection. Even with the substantial decreases in discards predicted (Table 4.5-81), the cumulative effect of FMP 3.2 in combination with external sources is not expected to depart from the comparative baseline condition sufficiently to produce long-term changes outside the range of natural variability. The discharge of offal from fish processing facilities and of graywater and other refuse from marine vessels into Alaskan waters is regulated through EPA and ADEC permitting programs.

Change in Species Diversity

- **Direct/Indirect Effects.** The expected effects of FMP 3.2 on species diversity are rated as unknown for skates, sharks, and grenadiers and insignificant for other groups. Under FMP 3.2, bycatch of

HAPC biota would decrease by about 25 percent in the BSAI and by about 40 percent in the GOA (Table 4.5-81). This FMP would also provide substantial increases in closed areas in the form of no-trawling MPAs and no-take reserves. These area closures would most likely be sufficient to prevent species extinction for these sessile animals. Catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds. Although forage species population levels are not known, their relatively high turnover rates and the ban on forage fish fisheries in this FMP are considered sufficient to protect them from falling below minimum biologically acceptable limits.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate (including HAPC) species are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated in some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show positive correlations with prey abundance, and that cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** Under FMP 3.2, a conditionally significant adverse effect on species diversity could result from a high level of seabird bycatch by the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may establish a viable population that would change species diversity in a adverse way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species.

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** Potential effects on trophic diversity relate to changes in the variety of species within trophic guilds. Under FMP 3.2, the predicted effects of the groundfish fisheries on trophic diversity are rated as insignificant, because they are expected to be similar to the comparative baseline conditions, for which fishing effects on trophic diversity are also rated as insignificant.

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, little research on this type of effect was conducted in the BSAI and GOA in past decades.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 3.2 could produce a conditionally significant adverse effect on trophic diversity. The primary condition for this effect is largely speculative: a climatic regime shift could make a trophic guild containing one or more groundfish fishery target species more vulnerable to fishing pressure. A regime shift in the future, similar to well-documented examples that have occurred in the past (Sections 3.3 and 3.10.1.5), could decrease species diversity within a trophic guild by reducing the productivity or shifting the distributional range of one or more member species. If this climatic effect went undetected and without compensatory adjustments to fishing effort, the continued removal of particular target species, could decrease their representation within trophic guilds. This would particularly affect slow-growing species such as the rockfishes that are taken by bottom trawl, are subject to removal as bycatch, and have been reduced by overfishing in the past (Heifitz *et al.* 2001).

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to structural habitat diversity is the removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures used as habitat of other species, including economically important groundfish species and their prey. FMP 3.2 is determined to have a significantly beneficial effect relative to the baseline on structural habitat diversity. Some of the area closures for this FMP have been designed with corals in mind and, if implemented, will ensure that there is a broad spatial distribution of corals, particularly in the Aleutian Islands. Also, bottom trawl effort would most likely decline, and area closures would provide additional protection to benthic communities.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data, no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill from commercial shipping could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** Direct/indirect effects of FMP 3.2, rated significantly beneficial, could contribute to a conditionally significant beneficial cumulative effect on structural habitat diversity. This rating is conditional because the direct/indirect effect of FMP 3.2 could be offset under any of the following three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could affect, to an unknown extent, some of the benefits of FMP 3.2 on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity, and thus the population size, as well as the distribution, of bottom-dwelling invertebrates that provide structural habitat.

Change in Genetic Diversity

- **Direct/Indirect Effects.** Under FMP 3.2 target species are not expected to fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to the comparative baseline conditions. Consequently, the effect of the groundfish fisheries on genetic diversity are expected to be insignificant under this FMP. However, baseline genetic diversity remains unknown for most species and the actual effects that fishing would have on genetic diversity are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 3.2 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would affect the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. Thus, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the future.

4.7.11 Summary of Alternative 3 Analysis

The direct, indirect and cumulative ratings for all resource categories analyzed under this alternative are summarized in Table 4.7-7.

Table number	Resource category	Components	Section 4.7 reference
4.7-1	Target groundfish species	Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) walleye pollock, BSAI and GOA Pacific cod, BSAI and GOA sablefish, BSAI and GOA Atka mackerel, BSAI yellowfin sole, GOA shallow water flatfish, BSAI rock sole, BSAI and GOA flathead sole, BSAI and GOA arrowtooth flounder, BSAI Greenland turbot, GOA deepwater flatfish, BSAI Alaska plaice, BSAI other flatfish, GOA rex sole, BSAI and GOA Pacific ocean perch, GOA thornyhead rockfish, BSAI and GOA northern rockfish, BSAI and GOA shortraker/rougheye rockfish, BSAI other rockfish, GOA slope rockfish, GOA pelagic shelf rockfish, GOA demersal shelf rockfish	4.7.1
4.7-2	Prohibited, other, forage and non-specified species	Pacific halibut, Pacific salmon and steelhead trout, Pacific herring, crab Other species category Forage fish category Grenadier	4.7.2 4.7.3 4.7.4 4.7.5
4.7-3	Habitat	BSAI, GOA	4.7.6
4.7-4	Seabirds	Black-footed albatross, Laysan Albatross, Short-tailed albatross, northern fulmar, shearwaters, storm-petrels, cormorants, spectacled eider, Steller's eider, jaegers, gulls, kittiwakes, terns, murres, guillemots, murrelets, auklets, puffins	4.7.7
4.7-5	Marine mammals	Steller sea lion, northern fur seals, Pacific walrus, harbor seals, spotted seal, bearded seal, ringed seal, ribbon seal, northern elephant, sea otter, blue whale, fin whale, sei whale, minke whale, humpback whale, gray whale, northern right whale, bowhead whale, sperm whale, beaked whales (Baird's, Cuvier's and Stejneger's), Pacific white-sided dolphin, killer whale, beluga whale, harbor porpoise, Dall's porpoise	4.7.8
4.7-6	Socioeconomics	Harvesting and processing sector (catcher vessels, catcher processors, inshore processors and motherships) Regional socioeconomic profiles (population, processing ownership and activity, catcher vessel ownership and activity, tax revenue, employment and income) CDQ allocations Subsistence (subsistence use of groundfish, subsistence use of Steller sea lions, salmon subsistence fisheries, indirect subsistence factors: income and joint production) Environmental justice Market channels and benefits to U.S. consumers (product quantity, product year-round availability, product quality, product diversity) Non-market goods (benefits derived from marine ecosystems and associated species)	4.7.9.1 4.7.9.2 4.7.9.3 4.7.9.4 4.7.9.5 4.7.9.6 4.7.9.7
4.7-7	Ecosystem	Forage fish availability, spatial/temporal concentration of fisheries, introduction of non-native species, removal of top predators, energy redirection, energy removal, species diversity, guild diversity, genetic diversity	4.7.10

4.8 Alternative 4 Analysis

The goal of Alternative 4 is to seek to adopt highly precautionary approaches to managing fisheries under scientific uncertainty. The intent is to minimize the likelihood that fisheries will impose detrimental effects on the environment. This alternative is described in detail in Section 2.6.5.

4.8.1 Target Groundfish Species Analysis

This section examines the potential direct, indirect, and cumulative effects that the implementation of Alternative 4 is expected to have on the target groundfish species. The potential effects of two policy "bookends" are analyzed, FMP 4.1 and FMP 4.2. These represent the policy boundaries of Alternative 4. As actually implemented, Alternative 4 could include policy measures anywhere within the range between the two bookends. The impact analyses start with the baseline (2002) status of the BSAI and GOA target groundfish stocks described in Section 3.5.1, including past trends that are likely to persist into the foreseeable future. Then, a computer-based analytic model is used to project how specific characteristics of the target groundfish stocks would respond directly and indirectly to management actions under each FMP. These projections from the model are the predicted direct and indirect effects (impacts) of the FMP on the target groundfish stocks. Section 4.1.5 describes the analytic model and explains how it is applied.

The model output for each target groundfish stock is defined in terms of collected data and calculated measures that are standards used by fisheries managers to regulate the number of fish removed from the sea so that the fisheries will be sustainable over the long-term. These data and measures include the fishing mortality rate (F), the overfishing level (OFL), total and spawning biomass levels (B), the minimum stock size threshold (MSST), maximum sustainable yield (MSY), mean age of the stock in years, and the sex ratio of the stock (number of males compared to number of females). As discussed in the following subsections, relevant data are not always available for all stocks. When data gaps prevent application of the model to a specific stock, the projected direct or indirect effect is evaluated as unknown (U).

Each target groundfish stock is modeled with respect to the following direct and indirect effects:

Direct Effects

Fishing Mortality: This is the rate at which the stock is depleted by direct mortality imposed by removing the fish from the sea.

Change in Biomass Level: This is the change over time in the biomass of the stock, as measured in metric tons (mt). Two measures are used: total biomass, which is the estimated biomass of the entire stock, and spawning biomass, which is the estimated biomass of all of the spawning females in the stock.

Spatial/Temporal Concentration of Catch: This is the degree to which the fishery will concentrate in a particular geographic area during a particular period of time each season. This pattern in space and time can affect fishing mortality and can also influence habitat suitability for spawning, rearing, and feeding.

Direct and/or Indirect Effects

Habitat Suitability: This is the degree to which habitat has the right characteristics to support the target stock at one or more life-history stages (spawning, rearing of juveniles, availability of food at all stages, availability of refuge areas to allow escape from predators at all stages). Habitat suitability can be affected directly, for example by mechanical damage from bottom trawling, or influenced indirectly, for example by the gradual depletion of corals that provide hard substrate.

Prey Availability: This is the extent to which prey species are present in the environment and available as food to the target stock. Like habitat suitability, this measure can be affected directly, for example by the direct removal of prey species by the fishery, or indirectly, for example by a change in the structure of the food web.

To determine their probable significance, the projected direct and indirect effects in each of the impact categories listed above are evaluated against significance criteria. The criteria are designed to be relevant and meaningful in terms of the target groundfish stocks. Each significance criterion includes a threshold value above (or below) which the projected effect would be considered significant. Each criterion also includes a definition of what would constitute a beneficial (positive, +) or adverse (negative, -) effect. The possible evaluations are significant and beneficial (S+), Insignificant (I), significant and adverse (S-), and Unknown (U). Evaluations of Conditionally Significant (CS + or -) are not made for projected direct and indirect effects on target groundfish species, because the model can show only whether the significance threshold is or is not exceeded. The significance criteria used for the target groundfish stocks are presented in Appendix A, Table 4.1-1.

Each of the following subsections presents the model results and rationale for the expected direct and indirect effects of FMPs 4.1 and 4.2 on the target groundfish stocks. The significance ratings for these potential direct and indirect effects are presented in Appendix A, Table 4.8-1. Following the direct and indirect effects discussions on each stock, the expected cumulative effects on that stock are evaluated and discussed. The evaluation of potential cumulative effects builds on the direct and indirect effects evaluations as a starting point, and then brings in persistent past effects as well as reasonably foreseeable future natural events and human activities external to fisheries management. The cumulative effects assessment method uses the same impact categories and significance criteria discussed above for direct and indirect effects. This method is described further in Section 4.1.4.

4.8.1.1 Pollock

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA pollock for each of the bookends under Alternative 4. Numerous fishery management actions have been implemented that affect the pollock fisheries in the EBS and GOA. These actions are described in more detail in Sections 3.5.1.1 and 3.5.1.15 of this Programmatic SEIS. Pollock is managed as separate stocks in the BSAI and GOA, and falls under Tier 1 in both the BSAI and GOA groundfish FMPs.

Direct/Indirect Effects FMP 4.1

FMP 4.1 includes the following measures:

- Individual stocks would be removed from stock complexes whenever possible.

- The max F_{ABC} would be capped at $F_{75\%}$ for all stocks of pollock, Pacific cod, Atka mackerel, and rockfish managed in Tiers 1-3, and the max F_{ABC} for each stock or stock complex in Tiers 1-5 would be adjusted downward based on the lower bound of a confidence interval surrounding the survey biomass estimate for that stock or stock complex.

- The OY would be specified separately for each stock or stock complex and set equal to the respective TAC.

- An MSST would be specified in the FMP for all tiers where possible, and a limit would be set equal to $B_{40\%}$ for Tier 3.

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H. Under FMP 4.1, model projections indicate that EBS pollock biomass is expected to increase to a value of about 14.7 million mt in 2007. The 2003-2007 average total biomass is 13.3 million mt.

In the Aleutian Islands region, the assessments are based trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Given that under FMP 4.1 there may be no directed fishing for pollock in this region (the exploitation level is quite low, <1 percent), the expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof region.

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,389,000 mt by 2007. The average biomass over this period is expected to be 1,110,000 mt (Table H.4-23 of Appendix H). This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels.

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-1 of Appendix H. Under FMP 4.1, projections indicate that EBS pollock spawning biomass will increase to about 20 percent of the 2002 level by 2007. The projected average for 2003- 2007 is 3.98 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Since these areas are likely to be kept at bycatch-only levels under FMP 4.1, it is expected that the spawning stock size will remain stable or increase in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 301,000 mt by 2007 under FMP 4.1. This is above the estimated B_{MSY} level of 210,000 mt as is the average from 2003-2007 of 217,000 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will decrease by about 76 percent and average 0.045 for the period 2003-2007 (Table H.4-1 of Appendix H). These values are well below the $F_{35\%}$ level of 0.448 and the $F_{75\%}$ level of 0.066, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. The proportion of SPR conserved under these mortality rates is 53 percent in 2002, increasing to 81 percent for 2003-2007. Fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than one percent under FMP 4.1 (Table H.4-2 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.029 in 2003 followed by increases to 0.043 by 2007 (Table H.4-23 of Appendix H). The values for $F_{35\%}$ and $F_{75\%}$ are 0.350 and 0.079, respectively. The SPR rate in 2002 is estimated at 55 percent and averages about 87 percent for the period 2003-2007. This fishing mortality rate pattern is due to the fact that under this FMP, the catch is affected by other factors (such as reduced PSC limits and survey uncertainty corrections).

Spatial/Temporal Concentration of Fishing Mortality

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (January 20-March). Under FMP 4.1, an average of 0.401 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial/temporal allocations as presented in Section 3.5.1.1. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period.

In the GOA, pollock fishery in a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.15 Under FMP 4.1, an average of 21,900 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 33,100 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery will likely change from the 2002 pattern. The effect of these changes is unknown.

Status Determination

Under FMP 4.1, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For FMP 4.1, GOA pollock spawning biomass is below the B_{MSY} (taken as $B_{35\%}$) in 2002 and remains below this level until 2005. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007. In FMP 4.1 $B_{40\%}$ is taken as a lower limit of stock size, so catches may be substantially lower than that presented from the projection model. Lower catches would likely lead to higher stock sizes.

Age and Size Composition

Under FMP 4.1, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.94 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.34 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under FMP 4.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 4.1.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under FMP 4.1 (for the period 2003-2007).

Summary of Effects of FMP 4.1 – Pollock

Because pollock are fished at less than the OFL and are above the MSST, the direct and indirect effects under FMP 4.1 are considered insignificant. Fishing rates are well below accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity. Based on extended 20-year projections (with the same model assumptions as used in the base 2003-2007 period), both the EBS and GOA pollock are expected to stabilize with catches lower than the expected long-term F_{ABC} catch levels and spawning biomass levels well above the B_{MSY} levels (Table 4.8-1).

Cumulative Effects of FMP 4.1 – EBS Pollock

Cumulative effects for pollock are summarized in Tables 4.5-1 and 4.5-2.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 4.1 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the BSAI pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Removals of pollock occur in the Russian pollock fishery, and the catch is not accounted for in the annual harvest rates set for the U.S. fishery. Therefore, the removals can be considered a potential adverse effect on fishing mortality. Catch and bycatch of pollock in the State of Alaska pollock fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is also identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of EBS pollock, and the effects are judged to be insignificant. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events are not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently above MSY and with the reduced or removed fishing pressure it is likely to remain well above MSY.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be insignificant under FMP 4.1 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the Russian and State of Alaska pollock fisheries. However, the effects of any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, and therefore would not directly affect biomass.

- **Cumulative Effects**. Cumulative effects for change in biomass are identified; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized. The stock is presently above MSST and the reduced fishing and removal of fishing under the FMP will allow it to remain as such.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had a beneficial effect on pollock recruitment by reducing the adult pollock biomass, lingering beneficial effects are identified for change in reproductive success. In addition, past commercial whaling and sealing also removed large predators of pollock adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (refer to Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** The Russian and State of Alaska pollock fisheries, have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. On the other hand, removals in these fisheries, with the exception of the herring fishery, could have a potential beneficial effect on pollock recruitment by reducing the adult pollock biomass. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects**. Cumulative effects are possible under FMP 4.1 for the spatial/temporal concentration; and the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 4.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on pollock prey availability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on pollock prey species could have potentially beneficial or potential adverse effects. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the FMP; however, the effects are insignificant since the combination of internal and external removals of prey species is not expected to increase prey availability such that the ability of the pollock stock to sustain itself at or above MSST is enhanced.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that FMP 4.1 would have insignificant effects on pollock habitat suitability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects identified for EBS pollock stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (refer to Section 3.5.1.1) Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the EBS. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the Russian and State of Alaska fisheries, since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, their significance on the EBS pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is enhanced.

Cumulative Effects of FMP 4.1 – GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 4.1 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, State of Alaska, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** Catch and bycatch of pollock in the State of Alaska pollock fisheries and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of GOA pollock, but the effects are judged to be insignificant for the FMP. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently well above MSY and the reduction and/or complete removal of fishing will allow it to remain well above MSY.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMP 4.1 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.15), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the State of Alaska pollock fisheries. However, any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects**. Cumulative effects for change in biomass are identified; however, the effects are judged to be insignificant. The combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is enhanced.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** As the density and quotas of pollock change during the modeled period, the concentration of the pollock fishery will change from the 2002 pattern; it is not possible to predict exactly how the pattern will change. However, for GOA pollock under FMP 4.1, the stock is expected to be above MSST for the years 2003-2007 (see Direct/Indirect Effects discussion in this section). Therefore, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.15) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** State of Alaska pollock fisheries, and the State of Alaska shrimp fishery are identified as potential adverse contributors. However, these fisheries are unlikely to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration under FMP 4.1; however, the effects are judged to be insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is enhanced.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 4.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, as described under direct/indirect effects, the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign, State of Alaska, and domestic fisheries catch and bycatch of pollock prey species, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for EBS pollock, climate changes and regime shifts could have potential adverse or beneficial effects on pollock prey species. The other fisheries shown on Table 4.5-2 are determined to be potential adverse contributors.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effects are judged to be insignificant. The combination of internal and external removals of prey is not expected to increase prey availability such that the ability of the pollock stock to sustain itself at or above MSST is enhanced.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 4.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on pollock habitat suitability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects**. Past effects on habitat suitability identified for GOA pollock stocks include past foreign, JV, and State of Alaska, domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.15). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska Pollock and Shrimp fisheries, since any of these may impact bottom habitat through the use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock would either be adverse or beneficial since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, their significance on the GOA pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is enhanced.

Direct/Indirect Effects of FMP 4.2

Under FMP 4.2, it would be required that each individual TAC be set to zero unless it is proven that a higher TAC would have no adverse effect on the environment. For the purposes of the projection model, this was taken to be zero in all cases (since it can be argued that it is impossible to prove that any level of fishing is without adverse effects on the environment).

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-1 of Appendix H. Under FMP 4.2, model projections indicate that EBS pollock biomass is expected to increase to a value of about 15.9 million mt in 2007. The 2003-2007 average total biomass is 13.9 million mt.

In the Aleutian Islands region, the assessments are based trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. The expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof Island region.

For GOA pollock, the age 2-10+ biomass is expected to increase under this FMP from a 2003 low of 800,000 mt to 1,450,000 mt by 2007. The average biomass over this period is expected to be 1,136,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels (Table H.4-23 of Appendix H).

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-1 of Appendix H. Under FMP 4.2, projections indicate that EBS pollock spawning biomass will increase to about 120 percent of the 2002 level by 2007. The projected average for 2003-2007 is 4.31 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Since under FMP 4.2 these areas are kept at bycatch-only levels, it is expected that the spawning stock size will remain stable or increase in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 327,000 mt by 2007 under FMP 4.2. This is above the estimated B_{MSY} level of 210,000 mt as is the 2003-2007 average of 228,000 mt. Model projections of future levels are shown in Table H.4-23 of Appendix H.

Fishing Mortality

Under FMP 4.2, the projected TAC has been set to zero for all species unless the harvesting of a species has been shown to have no adverse effect on the environment. Thus, there is no fishery for GOA and BSAI pollock from 2003-2007 (Tables H.4-1, H.4-2, and H.4-23 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 4.2, there is no projected fishing mortality.

Status Determination

The EBS and GOA pollock are above their MSST in the year 2002. Because of the removal of fishing mortality under FMP 4.2, these stocks of pollock are also projected to be above the MSST level from 2003-2007.

Age and Size Composition

Under FMP 4.2, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 3.11 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.45 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while EBS pollock is modeled from age 1-15+).

Sex Ratio

It is unknown how the sex ratio may change under FMP 4.2. For model purposes, a 50:50 sex ratio was assumed for all pollock stocks.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this FMP 4.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 4.2.

Summary of Effects of FMP 4.2 – Pollock

With the removal of fishing for pollock, the direct and indirect effects under FMP 4.2 are considered insignificant with the exception of change in biomass which is rated as significantly beneficial. The removal of fishing is anticipated to move the stock to above $B_{60\%}$, and the spawning biomass is expected to increase by more than 15 percent (Table 4.8-1).

Cumulative Effects of FMP 4.2 – EBS Pollock

Cumulative effects for pollock are summarized in Tables 4.5-1 and 4.5-2.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS pollock stock is insignificant under FMP 4.2 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the BSAI pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, removals of pollock that occur in the Russian pollock fishery are considered to be a potential adverse contribution while removals in the State of Alaska pollock fisheries are not considered to be contributors to fishing mortality in the cumulative case. Marine pollution is also identified as having a reasonably foreseeable potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of EBS pollock, but the effects are judged to be insignificant. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events are not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently above MSY and with the reduced or removed fishing pressure it is likely to remain well above MSY.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the EBS pollock stock is expected to be significantly beneficial under the FMP (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are the same as those described for FMP 4.1 and include the Russian and State of Alaska pollock fisheries and marine pollution.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified; the effects are judged to be significantly beneficial since the reduction in pollock biomass is such that the ability of the stock to maintain itself at or above MSST is enhanced. The stock is presently above MSST and the reduced fishing and removal of fishing under the FMP will allow it to remain as such.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.2, model projections assume that 0 mt of pollock would be harvested over the same period. There is no spatial/temporal distribution of catch so there is an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects under FMP 4.2 are identical to those described for FMP 4.1 and include lingering beneficial effects on reproductive success.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, the Russian and State of Alaska pollock fisheries, have the potential to cause adverse effects on genetic structure and on pollock recruitment by reducing the adult pollock biomass. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible under FMP 4.2 for the spatial/temporal concentration; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on pollock prey availability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on pollock prey species could have potential beneficial or potential adverse effects (see Direct/Indirect Effects discussion in this section). Marine pollution has been identified as a reasonably foreseeable future external contributing factor and the other fisheries shown on Table 4.8-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue since these other fisheries are assumed to continue.

- **Cumulative Effects**. Cumulative effects are identified for prey availability; however, the effects are insignificant since the combination of internal and external removals of prey species is not expected to increase prey availability such that the ability of the pollock stock to sustain itself at or above MSST is enhanced.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on pollock habitat suitability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects identified for EBS pollock stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.1) Intense bottom trawling for pollock in past fisheries likely disrupted habitat in areas of the EBS. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, adverse effects are possible from the Russian and State of Alaska fisheries, and marine pollution. Impacts on habitat from climate changes and regime shifts on the EBS pollock stock could be beneficial or adverse.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, their significance on the EBS pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is enhanced.

Cumulative Effects of FMP 4.2 – GOA Pollock

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under FMP 4.2 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, State of Alaska, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, catch and bycatch of pollock in the State of Alaska pollock fisheries and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Marine pollution is identified as having a potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of GOA pollock, but the effects are judged to be insignificant for FMP 4.2. Pollock are fished at less than the OFL and are above the minimum stock size. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently well above MSY and the reduction and/or complete removal of fishing will allow it to remain well above MSY.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under FMP 4.2 (see Section 4.8.1.1).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.15), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, effects on biomass are indicated due to removals in the State of Alaska pollock fisheries. Marine pollution is identified as having a potential adverse contribution, and climate changes and regime shifts are not identified as being contributors to pollock mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified, but the effects are judged to be insignificant for FMP 4.2. The combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is enhanced.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** As described in the direct/indirect discussion, impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.15) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, the State of Alaska pollock fisheries, the State of Alaska shrimp fishery, and marine pollution could contribute adversely to genetic changes and reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration, but the effects are judged to be insignificant for FMP 4.2. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that the FMP would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.15).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, climate changes and regime shifts could have potential adverse or beneficial effects on pollock prey species. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor, and the other fisheries shown on Table 4.5-2 are determined to be potential adverse contributors since they are assumed to continue.

- **Cumulative Effects**. Cumulative effects are identified for prey availability, but the effects are judged to be insignificant for FMP 4.2. The combination of internal and external removals of prey is not expected to increase prey availability such that the ability of the pollock stock to sustain itself at or above MSST is enhanced.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see Direct/Indirect Effects discussion in this section). However, it is determined that the FMP would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stocks include past foreign, JV, and, State of Alaska, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.15). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska pollock and shrimp fisheries, since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock would be either adverse or beneficial as described for EBS pollock, although a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability for FMP 4.2; however, their significance on the GOA pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is enhanced.

4.8.1.2 Pacific Cod

This section provides the direct, indirect, and cumulative effects analysis for BSAI and GOA Pacific cod for each of the bookends under Alternative 4. The goal of Alternative 4 is to seek to adopt highly precautionary approaches to managing fisheries under scientific uncertainty. The intention is to minimize the likelihood that fisheries impose any detrimental effects on the environment.

Direct/Indirect Effects of FMP 4.1

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-3 of Appendix H. Under FMP 4.1, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,683,000 mt in 2007, with a 2003-2007 average value of 2,401,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-24 of Appendix H. Under FMP 4.1, model projections indicate that total GOA biomass is expected to increase steadily to a value of 793,000 mt in 2007, with a 2003-2007 average value of 688,000 mt.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-3 of Appendix H. Under FMP 4.1, model projections indicate that BSAI spawning biomass is expected to increase steadily to a value of 672,000 mt in 2007, with a 2003-2007 average value of 557,000 mt. Projected spawning biomass never decreases below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-24 of Appendix H. Under FMP 4.1, model projections indicate that GOA spawning biomass is expected to decrease to a value of 91,100 mt in 2003, then increase to a value of 127,200 mt in 2007, with a 2003-2007 average value of 106,600 mt. Projected spawning biomass never decreases below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-3 of Appendix H. Under FMP 4.1, model projections indicate that BSAI fishing mortality will decrease to a value of 0.066 in 2003, then remain there through 2007, with a 2003-2007 average of 0.066. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for stocks above $B_{40\%}$.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-24 of Appendix H. Under FMP 4.1, model projections indicate that GOA fishing mortality is expected to decrease steadily to a value of 0.066 in 2007, with a 2003-2007 average of 0.068. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for stocks above $B_{40\%}$.

Under FMP 4.1, the TAC for a stock complex would be computed by applying the appropriate max_{ABC} control rule to each of the component stocks and then setting the TAC equal to the minimum of the resulting values. Therefore, TAC for stock complexes under FMP 4.1 would be lower than under the existing policy, all else being equal. This aspect of FMP 4.1 was not included in the projection model, meaning that some projected fishing mortality rates may have been overestimated to some extent. For example, some projected rates for fisheries associated with bycatch of stocks belonging to stock complexes may have been overestimated. Because the fisheries for Pacific cod impose bycatch mortality on several stock complexes, it is possible that projected fishing mortality rates for Pacific cod under FMP 4.1 were overestimated. If this is the case, it would also follow that projected biomasses for Pacific cod under FMP 4.1 were underestimated.

Spatial/Temporal Concentration of Fishing Mortality

Certain areas that are currently open to fishing would be closed under FMP 4.1. If these closures had been in place in 2001, it is estimated that the following proportions of the 2001 Pacific cod catch would have been displaced from each sub-region:

Area:	Bering Sea	Aleutian Islands	Western GOA	Central GOA	Eastern GOA
Proportion of catch displaced:	0.451	0.659	0.612	0.627	0.164

Under FMP 4.1, catches of Pacific cod are projected to decrease substantially in both the BSAI and GOA, meaning that the imposition of new closed areas will not necessarily tend to increase the amount of catch taken from the remaining open areas.

Under FMP 4.1, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under FMP 4.1. In every year throughout the period 2003-2007, the BSAI and GOA Pacific cod stocks are projected to be above $B_{40\%}$,which is the MSST for Tier 3 under this FMP (Tables H.4-3 and H.4-24 of Appendix H).

Age and Size Composition

Under FMP 4.1, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 4.1, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this FMP.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 on Pacific cod would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under this FMP.

Summary of Effects of FMP 4.1 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 4.1, both stocks are projected to remain above MSST throughout the period 2003-2007, the biomass of both stocks is projected to be above $B_{40\%}$ throughout the period 2003-2007, the biomass of both stocks is expected to show an overall increase during the period 2003-2007 and beyond, and all catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 4.1 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 4.1 on BSAI or GOA Pacific cod.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 4.1 on fishing mortality is rated "insignificant," because the projection model indicates that fishing mortality would be less than the OFL throughout the period 2003-2007.

For the GOA Pacific cod stock, the impact of FMP 4.1 on biomass is rated "insignificant," because the projection model indicates that biomass would be above the MSST throughout the period 2003-2007. For the BSAI Pacific cod stock, the impact of FMP 4.1 on biomass is rated "significant (beneficial)," because the projection model indicates not only that biomass would be above the MSST throughout the period 2003-2007, but also that the expected biomass in 2007 is greater than $B_{60\%}$ and the difference between the expected biomass in 2007 and the estimated biomass in 2002 is greater than 15 percent of the equilibrium unexploited biomass.

Because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on genetic structure under FMP 4.1 are expected to be no greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on reproductive success under FMP 4.1 are expected to be no greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of groundfish harvest under FMP 4.1 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success in the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of habitat disturbance under FMP 4.1 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks (Table 4.8-1).

Cumulative Effects of FMP 4.1 – BSAI Pacific Cod

For further information regarding persistent past effects listed below in the text and in the tables, please refer to the past/present effects analysis section of Section 3.5.1.2. Cumulative effects for Pacific cod are summarized in Tables 4.5-3 and 4.5-4.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stock is insignificant under FMP 4.1 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for Pacific cod and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently above MSY and with the reduced or removed fishing pressure it is likely to remain well above MSY.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stock is expected to be significantly beneficial under the FMP (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/ personal use fishery in the BSAI. However, these removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under the FMP; the effects are significantly beneficial since the combination of internal and external factors could to sufficiently increase the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is enhanced.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion in this section). Pacific cod are migratory species and a large degree of genetic mixing appears to exist. This likely means that the spatial/temporal concentration of fishing effort is diluted to some extent.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, and subsistence use in the BSAI, have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 4.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on Pacific cod prey availability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.8-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the ability of the Pacific cod stock to sustain itself at or above MSST is enhanced.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on Pacific cod habitat suitability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod stock include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through the use of fishing gear. As described above for prey availability, impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stock could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, the effect is insignificant since any impacts on habitat suitability are not expected to affect the Pacific cod stock such that its ability to sustain itself at or above MSST is enhanced.

GOA Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stock is insignificant under FMP 4.1 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stock. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries in the GOA, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for Pacific cod and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently above MSY and with the reduced or removed fishing pressure it is likely to remain well above MSY.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stock is expected to be insignificant under the FMP (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.16), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery, and in the State of Alaska groundfish fisheries. However, these removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified under the FMP; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the GOA Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is enhanced.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.16) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment particularly in the GOA where the State of Alaska groundfish fishery is very localized, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, subsistence use, and State of Alaska groundfish fisheries, have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration under FMP 4.1; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of the FMP would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that FMP 4.1 would have insignificant effects on Pacific cod prey availability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While lingering population level effects from past foreign, domestic, and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for the Bering Sea, effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor and the other fisheries shown on Table 4.5-4 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the ability of the GOA Pacific cod stock to sustain itself at or above MSST is enhanced.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on Pacific cod habitat suitability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.16). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described for the Bering Sea, impacts on habitat from climate changes and regime shifts on the GOA Pacific cod stock could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects is identified for habitat suitability; however, the effect is insignificant since any impacts on habitat suitability are not expected to affect the Pacific cod stock such that its ability to sustain itself at or above MSST is enhanced.

Direct/Indirect Effects of FMP 4.2

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-3 of Appendix H. Under FMP 4.2, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,930,000 mt in 2007, with a 2003-2007 average value of 2,528,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-24 of Appendix H. Under FMP 4.2, model projections indicate that total GOA biomass is expected to increase steadily to a value of 841,000 mt in 2007, with a 2003-2007 average value of 713,000 mt.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-3 of Appendix H. Under FMP 4.2, model projections indicate that BSAI spawning biomass is expected to increase steadily to a value of 775,000 mt in 2007, with a 2003-2007 average value of 609,000 mt. Projected spawning biomass never decreases below the B_{MSY} proxy value of 361,000 mt for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-24 of Appendix H. Under FMP 4.2, model projections indicate that GOA spawning biomass is expected to decrease to a value of 91,800 mt in 2003, then increase to a value of 144,700 mt in 2007, with a 2003-2007 average value of 115,700 mt. Projected spawning biomass never decreases below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-3 of Appendix H. Under FMP 4.2, model projections indicate that BSAI fishing mortality will decrease to a value of 0 in 2003, then remain there through 2007, with a 2003-2007 average of 0. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for stocks above $B_{40\%}$.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-24 of Appendix H. Under FMP 4.2, model projections indicate that GOA fishing mortality is expected to decrease to a value of 0 in 2003, then remain there through in 2007, with a 2003-2007 average of 0. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 4.2, if fishing for BSAI or GOA Pacific cod is allowed, it is likely that such fishing would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under FMP 4.2. The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007 (Tables H.4-3 and H.4-24 of Appendix H).

Age and Size Composition

Under FMP 4.2, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under FMP 4.2, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this FMP.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.2 on Pacific cod would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under this FMP.

Summary of Effects of FMP 4.2 – Pacific Cod

Relationship to Comparative Baseline

The comparative baselines for BSAI and GOA Pacific cod are identical: Neither stock is overfished, the biomass of both stocks is below $B_{40\%}$ and has been decreasing for the last few years, and all catch and bycatch are accounted for in the management of both stocks. Under FMP 4.2, both stocks are projected to remain above MSST throughout the period 2003-2007, the biomass of both stocks is projected to be above $B_{40\%}$ throughout the period 2003-2007, the biomass of both stocks is expected to show an overall increase during the period 2003-2007 and beyond, and all catch and bycatch would continue to be accounted for in the management of both stocks.

Significance of Direct and Indirect Effects

The criteria used to rate the significance of impacts of FMP 4.2 on the BSAI and GOA stocks of Pacific cod are identical to those used for the other groundfish stocks. The rating of conditionally significant (either beneficial or adverse) is not applicable to any of the direct or indirect effects of FMP 4.2 on BSAI or GOA Pacific cod.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 4.2 on fishing mortality is rated "insignificant," because the projection model indicates that fishing mortality would be less than the OFL throughout the period 2003-2007.

For the BSAI and GOA Pacific cod stocks, the impact of FMP 4.2 on biomass is rated "significant (beneficial)," because the projection model indicates that the expected biomass in 2007 is greater than $B_{60\%}$ and the difference between the expected biomass in 2007 and the estimated biomass in 2002 is greater than 15 percent of the equilibrium unexploited biomass.

Because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the genetic structure of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on genetic structure under FMP 4.2 are expected to be no greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing spatial-temporal concentration of the catch does not appear to have led to changes in the reproductive success of the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the impacts of spatial-temporal concentration on reproductive success under FMP 4.2 are expected to be no greater than those of the existing concentration, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of groundfish harvest does not appear to have led to changes in prey availability for the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of groundfish harvest under FMP 4.2 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks.

Likewise, because the existing level of habitat disturbance does not appear to have led to changes in spawning or rearing success in the BSAI or GOA Pacific cod populations that materially impact either stock's ability to maintain itself at or above the MSST and because the level of habitat disturbance under FMP 4.2 is expected to be no greater than the existing level, the magnitude of this effect is rated insignificant for both stocks (Table 4.8-1).

Cumulative Effects FMP 4.2

Cumulative effects for Pacific cod are summarized in Tables 4.5-3 and 4.5-4.

BSAI Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and Pacific cod stock is insignificant under FMP 4.2 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI Pacific cod stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1 in the BSAI, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently above MSY and with the reduced or removed fishing pressure it is likely to remain well above MSY.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stock is expected to be significantly beneficial under the FMP (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery in the BSAI. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under the FMP; the effects are significantly beneficial since the combination of internal and external factors could sufficiently increase the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is enhanced.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, the IPHC longline and State of Alaska crab fisheries, and subsistence use in the BSAI have the potential to cause adverse effects. Marine pollution could also contribute adversely to genetic changes and reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that the FMP would have insignificant effects on Pacific cod prey availability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, the effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor and the other fisheries shown on Table 4.8-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to increase prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST is enhanced.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, the removal of fishing pressure is determined to have insignificant effects on habitat suitability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects**. Past effects identified for BSAI Pacific cod stock include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through the use of fishing gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stock could be either beneficial or adverse. Marine pollution has been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability. Under FMP 4.2, the significance of the cumulative effect is rated as insignificant.

GOA Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stock is insignificant under FMP 4.2 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stock. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries in the GOA, but these are not expected to be contributing factors to fishing mortality in the cumulative case. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently above MSY and with the reduced or removed fishing pressure it is likely to remain well above MSY.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stock is expected to be significantly beneficial under the FMP (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.16), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery, and in the State of Alaska groundfish fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass and climate changes and regime shifts are not identified as being contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified under the FMP; the effect is significantly beneficial. The reduction of the groundfish fisheries is expected to enhance the ability of the stock to maintain itself at or above the MSST.

Spatial/Temporal Concentration of Catch

- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.16) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment particularly in the GOA where the State of Alaska groundfish fishery is very localized, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, the IPHC longline and State of Alaska crab fisheries, subsistence use, State of Alaska groundfish fisheries, and marine pollution all have the potential to cause adverse effects.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration under FMP 4.2; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of the FMP would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that FMP 4.2 would have insignificant effects on Pacific cod prey availability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and State of Alaska fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.16).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, the effect of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor and the other fisheries shown on Table 4.8-1 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to increase prey availability such that the GOA Pacific cod stock is unable to sustain itself at or above MSST is enhanced.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify however the effect is judged to be insignificant (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.16). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** As described for FMP 4.1, effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through the use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA Pacific cod stock could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability. Under FMP 4.2, the cumulative effect is insignificant.

4.8.1.3 Sablefish

This section provides the direct, indirect, and cumulative effects analysis for sablefish for each of the bookends under Alternative 4. Sablefish are managed as one stock in the BSAI and GOA; therefore, BSAI and GOA areas are discussed together in this section.

The goal of Alternative 4 is to seek to adopt highly precautionary approaches to managing fisheries under scientific uncertainty. The intention is to minimize the likelihood that fisheries impose any detrimental effects on the environment. For further information regarding persistent past effects identified in this section, see the past/present effects analysis of Sections 3.5.1.3 and 3.5.1.17.

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Catch/ABC

FMP 4.1 is projected to significantly decrease sablefish yield compared to the baseline. In FMP 4.1, a risk-averse adjustment is applied to F_{ABC}. The amount of adjustment is affected by uncertainty in survey abundance estimates. Sablefish abundance is estimated by longline surveys with reasonable certainty, so that the adjustment should not be large. However, projected catch under FMP 4.1 is substantially reduced (500 mt) compared to baseline (Tables H.4-11 and H.4-30 of Appendix H). FMP 4.2 reduces sablefish yield to zero (Tables H.4-11 and H.4-30 of Appendix H).

Total Biomass

FMP 4.1 is projected to significantly increase sablefish total biomass (age 2-31+) compared to the baseline. In FMP 4.1, a substantial risk-averse adjustment is applied to F_{ABC}. As a result, catches significantly decrease thereby significantly increasing under total biomass FMP 4.1 (Tables H.4-11 and H.4-30 of Appendix H).

FMP 4.2 is projected to significantly increase sablefish total biomass (age 2-31+) compared to the baseline because FMP 4.2 closes the fishery (Tables H.4-11 and H.4-30 of Appendix H). However, for the combined stock, the lack of catch out to 2007 is not expected to affect the stock's ability to maintain itself above MSST and the effect is therefore insignificant.

Spawning Biomass

FMP 4.1 is projected to significantly increase sablefish spawning biomass compared to the baseline. In FMP 4.1, a substantial risk-averse adjustment is applied to F_{ABC}. As a result, catches significantly decrease thereby significantly increasing under spawning biomass (500 mt and 30,400 mt, respectively) FMP 4.1 (Tables H.4-11 and H.4-30 of Appendix H).

FMP 4.2 is projected to significantly increase sablefish spawning biomass compared to the baseline because FMP 4.2 closes the fishery (Tables H.4-11and H.4-30 of Appendix H).

Fishing Mortality

Under FMP 4.1, the fishing mortalities imposed on the sablefish stock are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Tables H.4-11 and H.4-30 of Appendix H).

No fishery mortality occurs because FMP 4.2 closes the fishery (Tables H.4-11 and H.4-30 of Appendix H). The effect is judged insignificant.

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. FMP 4.1 is projected to significantly increase the spatial/temporal concentration of fishing mortality compared to the baseline. The proposed closed areas in FMP 4.1 cover many of the areas where the sablefish fishery, both longline and trawl, currently operate, thus restricting the fishery to the remaining open areas. Sablefish undergo large migrations (e.g. Heifetz and Fujioka 1991) and substantial genetic mixing is expected for this stock. The degree of spatial/temporal concentration of the fishery is not likely to result in depletion of sub-populations of sablefish if they exist. For this reason, it is not likely that the amount of spatial/temporal concentration of fishing effort would inhibit the stock's ability to remain above the MSST.

Under FMP 4.2, sablefish is not overfished nor approaching an overfished condition.

Status Determination

Under FMP 4.1, sablefish is not overfished nor approaching an overfished condition.

Age and Size Composition

FMP 4.1 and FMP 4.2 are projected to have an insignificant impact on mean age compared to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

BSAI mean age likely is overestimated. The model assumes that the lower exploitation rate for the BSAI compared to the GOA will translate into greater mean age for the BSAI. However sablefish migration is substantial enough to erase the effects of differential exploitation rates between the GOA and BSAI. The mean age for the GOA best represents the mean age for the BSAI/GOA because sablefish abundance is much greater for the GOA.

Sex Ratio

The sex ratio of the adult population is 40 males:60 females, based on sex ratio data collected during sablefish longline surveys. These FMPs probably would have no significant effect on the sex ratio compared to the baseline.

Habitat Suitability

FMP 4.1 would decrease exploitation rates overall, but also will significantly increase the spatial/temporal concentration of fishing mortality compared to the baseline. The proposed closed areas in this FMP cover some longline and trawl fishing for sablefish, thus restricting the fishery to the remaining open areas. This would eliminate the local fishing mortality rates on sablefish in the closed areas, but effort also would increase in some areas or times as a result of area closures, thus concentrating the fishery at certain fishing locations and increasing fishing mortality rates on sablefish there. Under FMP 4.1, average catch is projected to decrease by about one-half compared to baseline. As long as at least one-half of the areas remain open, the remaining catch should not decrease habitat suitability in the open areas and the habitat suitability of closed areas should improve, to the extent that fishing affects habitat suitability. This FMP will have an insignificant overall effect.

FMP 4.2 would significantly improve habitat suitability compared to the baseline, to the extent that fishing affects habitat suitability. However, this improvement in habitat suitability is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is enhanced.

Predator-Prey Relationships

FMP 4.1 and FMP 4.2 is projected to significantly increase total biomass (age 2-31+) compared to the baseline, so this FMP should significantly increase the amount of sablefish biomass available to the ecosystem and the amount of predation due to sablefish. However, this improvement in prey availability is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is enhanced (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects on sablefish are summarized in Table 4.5-5.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under FMP 4.1 and FMP 4.2 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska groundfish fisheries are identified for sablefish. Large removals of Sablefish occurred, particularly in the JV and domestic fisheries. Catches that were under-reported during the late 1980s may have contributed to abundance declines in the 1990s. (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Sablefish are predicted to continue in the IPHC longline fishery, and the State of Alaska groundfish fishery, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels and do not add additional fishing mortality. Due the highly migratory nature, Canadian fisheries fishing within Canadian waters could be harvesting sablefish considered to be part of the GOA population. These removals are not accounted for in the TAC setting process and can be considered as having a potential adverse contribution to the cumulative case. Likewise, marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to direct Sablefish mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of sablefish, but the effect is judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. Under FMP 4.2, the sablefish fisheries would be suspended. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently above MSY and with the reduced or removed fishing pressure it is likely to remain well above MSY.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be significantly beneficial under FMP 4.1 and FMP 4.2 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While past large removals of Sablefish and other past effects on biomass have been identified (see Section 3.5.1.3 and 3.5.1.17), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to catch and bycatch in the IPHC longline, State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Sablefish mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified; and the effect is significantly beneficial since the combination of internal and external factors is expected to sufficiently increase the sablefish biomass such that the ability of the stock to maintain itself at or above MSST is enhanced. The stock is presently above MSST and the reduced fishing and removal of fishing under the FMP will allow it to remain as such.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the spatial/temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure or reproductive success. While spatial/temporal concentration of catch occurred in the State of Alaska directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects**. The IPHC longline, State of Alaska groundfish fisheries, and Canadian fisheries all have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population or affect recruitment. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that these FMPs would have insignificant effects on sablefish prey availability (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While lingering population level effects from past foreign, domestic, and State of Alaska fisheries catch and bycatch of Sablefish prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Sablefish prey species (see Sections 3.5.1.3 and 3.5.1.17).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Sablefish prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Sections 3.5.1.3 and 3.5.1.17). Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-5 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey is not expected to increase prey availability such that the ability for the sablefish stock to sustain itself at or above MSST is enhanced.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 will have an insignificant overall effect on habitat (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects identified for Sablefish include past foreign, JV, domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Sections 3.5.1.3 and 3.5.1.17). Fishing for Sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, and the IPHC fishery since any of these may impact bottom habitat through the use of fishing gear. As described for prey availability, impacts on habitat from climate changes and regime shifts on the Sablefish stock could be beneficial or adverse depending on water temperatures. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, its effect on the sablefish stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is enhanced.

4.8.1.4 Atka Mackerel

This section provides the direct, indirect and cumulative effects analysis for Atka mackerel for each of the bookends under Alternative 4. The goal of Alternative 4 is to seek to adopt highly precautionary approaches to managing fisheries under scientific uncertainty. The intention is minimize the likelihood that fisheries impose any detrimental effects on the environment. For further information regarding persistent past effects listed below in the text and in the tables, please refer to the past/present effects analysis of Sections 3.5.1.4 and 3.5.1.18.

External effects and the resultant cumulative effects associated with FMP 4.1 and 4.2 are depicted on Tables 4.8-1 and 4.5-7. For further information regarding persistent past effects identified in this section see past/present effects analysis of Sections 3.5.1.4 and 3.5.1.18.

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Model projections of future BSAI Atka mackerel catch and biomass levels under FMP 4.1 assume a max F_{ABC} of $F_{75\%}$. Furthermore, the max F_{ABC} for BSAI Atka mackerel is adjusted downward based on the lower bound of the confidence interval surrounding the survey biomass estimate.

FMP 4.1 requires that the TAC for a stock complex be determined by applying the appropriate max_{ABC} control rule to each of the component stocks and then setting the TAC equal to the minimum of the resulting values. This component was not implemented in the projection model used to generate the results. If this component of FMP 4.1 were implemented, it is likely that catches of BSAI Atka mackerel would impacted. Setting the TAC of all complexes to the lowest single species ABC would result in very low TACs for all rockfish and flatfish complexes as well as the other species complex. Low rockfish TACs could be quite constraining to the BSAI Atka mackerel fishery. Also, the temporal/spatial management of TAC was not modeled explicitly within the projection model. FMP 4.1 implements extensive spatial closures in the Aleutian Islands which would severely impact the directed fishery for Atka mackerel. As such, the projections of catch and biomass do not reflect actual expected levels under FMP 4.1. Actual catches are likely to be lower, and expected biomass levels likely to be higher.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced.

FMP 4.2 suspends all fishing until the fisheries can be shown to have no adverse effect on the resource and the environment. The TAC for all species is set to zero and all areas of the EEZ would be closed to all fishing. The projection model assumes no fishing for FMP 4.2.

Catch and Fishing Mortality

As noted above, the expected catch and fishing mortality values are not reflected in the projections if FMP 4.1 were to be fully implemented (Table H.4-17 of Appendix H). The average fishing mortality imposed on the BSAI Atka mackerel stock in 2002 is 0.251. Model projections show an 81 percent decrease in the average fishing mortality from 2002 to 2007. However, it is expected that fishing mortality would be even lower if FMP 4.1 were fully implemented. The projections show that the fishing mortality rates are well below the MSY proxy ($F_{35\%}$) value of 0.564 which is the rate associated with the OFL. Actual fishing mortality rates are expected to be even lower.

Projections of GOA Atka mackerel under FMP 4.1 indicate that catches will average less than 50 mt through 2007 (Table H.4-38 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g. Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

As noted above, there is no fishing under FMP 4.2. Model projections show no catch and fishing mortality of zero for 2003-2007 (Table H.4-17 of Appendix H). Fishing mortality rates of zero are well below the F_{MSY} proxy ($F_{35\%}$) value of 0.564 which is the rate associated with the OFL for BSAI Atka mackerel.

Total Biomass

Total (ages 1-15+) biomass of BSAI Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total BSAI total biomasses are shown in Table H.4-17 of Appendix H. As noted previously, the expected biomass levels under FMP 4.1 are not reflected in the projections which should be considered minimal estimates. Under FMP 4.1, model projections indicate a 22 percent increase in total biomass from 2002 to 2007. Actual biomass levels are expected to be even higher if FMP 4.1 were fully implemented.

Under FMP 4.2, model projections indicate a 28.5 percent increase in total biomass from 2002 to 2007 in the absence of fishing.

Spawning Biomass

Female spawning biomass of BSAI Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-17 of Appendix H. As noted above, the actual expected biomass levels under FMP 4.1 are not reflected in the projections which should be considered minimal estimates. Model projections indicate a 32.5 percent increase in spawning biomass from 2002 to 2007 under FMP 4.1. Actual spawning biomass levels are expected to be even higher if FMP 4.1 were fully implemented. The minimal estimates of projected spawning biomass exceed the B_{MSY} proxy value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007).

Model projections indicate a 48 percent increase in spawning biomass from 2002 to 2007 in the absence of fishing under FMP 4.2. Estimates of projected spawning biomass exceed the B_{MSY} proxy value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007).

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 4.1, 20-50 percent of the EEZ is designated as no-take marine reserves. Additionally, Special Management Areas (no trawl areas) are designated in the Aleutian Islands to protect coral and other live bottom habitats. The spatial closures in the Aleutian Islands under FMP 4.1 would close most of the preferred fishing areas of the directed fishery for Atka mackerel. A large proportion of the BSAI Atka mackerel catch (>90 percent) is expected to be displaced to a very few remaining open areas under FMP 4.1. However, in conjunction with the spatial closures, the TACs are significantly reduced under FMP 4.1. As such, it is difficult to predict the net changes in the spatial/temporal concentration of the catch under FMP 4.1. The spatial/temporal concentration of the catch under FMP 4.1 is not expected to adversely affect the sustainability of the stock (at least in the short-term), either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain its MSST. However, because Atka mackerel are a patchily distributed fish and the harvest is concentrated in specific locations, the elimination of the directed Atka mackerel fishery in most of the fishery locations may be expected to lead to significantly beneficial increases in recruitment success in these locations. This may enhance the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST.

Under FMP 4.2, all areas of the EEZ are closed to all fishing. Catches are zero, therefore there is no spatial/temporal concentration of the catch under FMP 4.2. As such, the spatial/temporal concentration of zero catch assumed under FMP 4.2 is not likely to adversely affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. However, because Atka mackerel are a patchily distributed fish and the harvest is concentrated in specific locations, the elimination of a directed Atka mackerel fishery may be expected to lead to significantly beneficial increases in recruitment at these locations. Therefore, elimination of the directed fishery for BSAI Atka mackerel may enhance the ability of the stock to sustain itself at or above its MSST.

Status Determination

Model projections of future catches of BSAI Atka mackerel are below the OFL in all years under FMP 4.1 (Table H.4-17 of Appendix H). Actual catches are expected to be even lower. Minimal estimates of female spawning biomass in each of the projection years (2003-2007), are above $B_{35\%}$ (B_{MSY} proxy) and also above $B_{40\%}$ (designated as a limit under FMP 4.1), thus the BSAI Atka mackerel stock is not overfished and is determined to be above its limit and its MSST under FMP 4.1. FMP 4.1 requires that an MSST would be specified for all tiers. However, MSSTs were not implemented in the projection model for stocks in Tiers 4-6 and a status determination for GOA Atka mackerel which are in Tier 6, cannot be made.

Model projections of future catches of BSAI Atka mackerel are below the OFL in all years under FMP 4.2 (Table H.4-17 of Appendix H). Estimates of female spawning biomass in each of the projection years (2003-2007), are above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is not overfished and is determined to be above its MSST under FMP 4.2.

GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Age and Size Composition

Under FMP 4.1, the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 3.4 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven by the strengths of incoming recruitments during the intervening years. Also, the projection model assumed a level of catch that probably will not be realized under FMP 4.1. The mean age of BSAI Atka mackerel in 2007 should be considered a minimal estimate. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn, are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

Under FMP 4.2 the mean age of BSAI Atka mackerel in 2007, as computed in model projections, is 3.58 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven by the strengths of incoming recruitments during the intervening years, which are highly dependent on environmental conditions and unpredictable.

The level of catch of GOA Atka mackerel is so low and projected to remain at a low level, therefore, it is unlikely that the age and size compositions would change in the future under FMP 4.1 or FMP 4.2. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than to the effects of fishing.

Sex Ratio

A 50:50 sex ratio is assumed for the BSAI Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future is unknown.

Habitat Suitability

The spatial closures in the Aleutian Islands under FMP 4.1 would eliminate the directed fishery for Atka mackerel in most of the preferred fishing locations. The level of habitat disturbance would decrease in the closed areas, and may increase in the remaining open areas. The extent to which habitat disturbance would increase in the open areas under FMP 4.1 is unclear given the large TAC reductions. However, FMP 4.1 is not expected to affect the sustainability of the stock (at least in the short-term) as measured by the ability of the stock to maintain itself above its MSST. The removal of directed fishing may lead to habitat improvement, but whether this would translate into improved reproductive success is uncertain.

Under FMP 4.2 all areas of the EEZ are closed to all fishing. Therefore, the level of habitat disturbance caused by the fishery under FMP 4.2 is not likely to adversely affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. The removal of directed fishing may lead to habitat improvement, but whether this would translate into improved reproductive success is uncertain.

Predator Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions which are currently difficult to quantify. Total elimination of the directed fishery for Atka mackerel under FMP 4.2 and elimination in many areas and the reduced TAC under FMP 4.1, could impact the amount of Atka mackerel available to the ecosystem. More commercial-sized Atka mackerel would be available as prey and predators in the ecosystem. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 4.1 and FMP 4.2 will not impact prey availability for BSAI and GOA Atka mackerel.

Summary of Effects of FMP 4.1 and FMP 4.2 – Atka Mackerel

The criteria used to estimate the significance of impacts of the FMPs on the BSAI and GOA stock of Atka mackerel are outlined in Section 4.1.1.1. The ratings of conditionally significant (either beneficial or adverse) are not applicable in this analysis as the model projections yielded results that were deemed either significant (beneficial or adverse), insignificant, or unknown.

The ratings use the F_{OFL} and the MSST for the fishing mortality effect and the MSST for all other effects, as a basis for the beneficial or adverse impacts of FMP 4.1 and FMP 4.2. The spawning stock biomass of BSAI Atka mackerel in each of the projection years (2003-2007) is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is determined to be above its MSST under FMP 4.1 and FMP 4.2. Because the mean projected BSAI Atka mackerel fishing mortality rates are below the overfishing mortality rate for projection years (2003-2007), the overfishing aspect of the fishing mortality effect is insignificant for FMP 4.1 and FMP 4.2. The spawning stock biomass is above its MSST in each of the projection years (2003-2007), and increases to such a level that it is expected to enhance the ability of the stock to sustain itself at or above its MSST, therefore the rating for the change in biomass aspect of the fishing mortality effect is significantly beneficial.

As noted above, the spawning stock biomass of BSAI Atka mackerel in each of the projection years (2003-2007) is above $B_{35\%}$ (B_{MSY} proxy), thus the BSAI Atka mackerel stock is determined to be above its MSST under FMP 4.1 and FMP 4.2. Thus, for all other effects, it was determined that FMP 4.1 and FMP 4.2 did not jeopardize the ability of the BSAI Atka mackerel stock to sustain itself at or above its MSST. However, because BSAI Atka mackerel are a patchily distributed fish and the harvest is concentrated in specific locations, elimination of the directed fishery in many locations under FMP 4.1, or complete elimination under FMP 4.2, may lead to improved reproductive success in these locations, and the rating for that aspect of the spatial/temporal concentration of the catch effect is significantly beneficial. Because there is no current evidence of genetic sub-population structure, that aspect of the spatial/temporal concentration of the catch effect is insignificant. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 4.1 and FMP 4.2 will not impact prey availability for BSAI Atka mackerel and the impact to that effect is insignificant. The removal of directed fishing in certain areas may lead to habitat improvement, but whether this would translate into reproductive success is uncertain; therefore, this effect is determined to be insignificant.

Relative to the comparative baseline, under FMP 4.1 and FMP 4.2, the BSAI Atka mackerel stock is not overfished. Minimal estimates of projected spawning biomass increase through 2007. Long-term projections (10 and 20-year projections) of spawning biomass show a continued increasing trend.

The fishing mortality rate and the MSST for GOA Atka mackerel is unknown, thus the effect of fishing mortality is unknown under FMP 4.1. As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial/temporal concentration and habitat suitability effects is also unknown under FMP 4.1. Although the MSST cannot be estimated for GOA Atka mackerel, based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 4.1 will not impact prey availability for BSAI Atka mackerel and the impact to the prey availability effect is insignificant.

Relative to the comparative baseline, under FMP 4.1 and FMP 4.2, the GOA Atka mackerel stock is likely to remain at low abundance under continued low exploitation (or no exploitation under FMP 4.2) as a bycatch fishery only (Table 4.8-1).

Cumulative Effects FMP 4.1 and FMP 4.2

Cumulative effects on BSAI Atka mackerel are summarized in Table 4.5-6.

BSAI Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Atka mackerel stock is insignificant under FMP 4.1 and FMP 4.2 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the BSAI Atka mackerel stock. While large removals of Atka mackerel did occur in the past, there does not appear to be a lingering effect on the BSAI Atka mackerel populations (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as the only external event that could cause effects on the BSAI Atka mackerel population. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Atka mackerel, but the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis. The stock is presently above MSY and with the reduced or removed fishing pressure it is likely to remain well above MSY.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Atka mackerel stock is expected to be significantly beneficial under FMP 4.1 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While past large removals of Atka mackerel and other past effects on biomass have been identified (see Section 3.5.1.4), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a reasonably foreseeable potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified. The effect is determined to be significantly beneficial since the combination of internal and external factors could sufficiently increase the Atka mackerel biomass such that the ability of the stock to maintain itself at or above MSST is enhanced.

Spatial/Temporal Concentration of Catch
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Because BSAI Atka mackerel are a patchily distributed fish and the harvest is concentrated in specific locations, elimination of the directed fishery in many locations under FMP 4.1 may lead to improved reproductive success in these locations, and the rating for that aspect of the spatial/temporal concentration of the catch effect is significantly beneficial.

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. Past commercial whaling and sealing removed large predators of Atka mackerel adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success.

A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; the effect is insignificant for change in the genetic structure of the population because there is no evidence of genetic sub-population structure. However, because BSAI Atka mackerel are a patchily distributed fish and the harvest is concentrated in specific locations, reduction of the directed fishery under the FMP may lead to improved reproductive success. The external factors identified above are unlikely to negate the beneficial determination.

Change in Prey Availability

- **Direct/Indirect Effects.** Severe reduction or elimination of fishing levels and distribution of harvest would not impact prey availability such that it affects the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST and the effect is judged insignificant (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of Atka mackerel prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Climate changes and regime shifts could have potential beneficial or potential adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey species is not expected to increase prey availability such that the ability of the Atka mackerel stock to sustain itself at or above MSST is enhanced.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The effect on the stock's ability to maintain itself above its MSST is judged insignificant (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects identified for BSAI Atka mackerel stocks include past foreign, JV, domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.4). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects**. Impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, its effect on the BSAI Atka mackerel stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Atka mackerel stock to sustain itself at or above MSST is enhanced.

GOA Atka Mackerel – Cumulative Effects FMP 4.1 and FMP 4.2

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced. Therefore, the internal effects of the FMP are unknown for all categories. In addition, the external effects and cumulative effects are the same for each FMP. Cumulative effects of GOA Akta mackerel are summarized in Table 4.5-7.

<u>Mortality</u>

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Atka mackerel stock is unknown under FMP 4.1 and FMP 4.2. The fishing mortality rate and the MSST for GOA Atka mackerel is unknown, thus the effect of fishing mortality is unknown under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects of the past foreign, JV, and domestic fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, and JV fisheries, and have had a lingering effect on the GOA Atka mackerel population that has not yet recovered (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the population is jeopardized. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA Atka mackerel, but the significance of the effect is unknown. GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the GOA Atka mackerel stock is unknown for FMP 4.1 and FMP 4.2. Current reliable estimates of total and spawning biomass are unknown for GOA Atka mackerel.

- **Persistent Past Effects.** Past effects of the past foreign, JV, and domestic fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, and JV fisheries, and have had a lingering effect on the GOA Atka mackerel population that has not yet recovered (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potential adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the population is affected. Climate changes and regime shifts are not identified as being contributors to Atka mackerel mortality, therefore, would not directly affect biomass.

- **Cumulative Effects.** A cumulative effects for change in biomass is identified; however, the significance of the effect is unknown.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial/temporal concentration effects is also unknown under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. The past highly localized fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Also, there are lingering past effects due to Climate Changes and Regime Shifts (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Also, climate changes and regime shifts could impact spawning success since a shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** Although the MSST cannot be estimated for GOA Atka mackerel, due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that FMP 4.1 and FMP 4.2 will not impact prey availability for GOA Atka mackerel and the impact to the prey availability effect is determined to be insignificant.

- **Persistent Past Effects.** While lingering population level effects on the invertebrate prey of Atka mackerel from past foreign, state, and domestic fisheries, and the effects of EVOS on these species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.18).

- **Reasonably Foreseeable Future External Effects**. Future external effects of climate changes and regime shifts on Atka mackerel prey species could be either beneficial or adverse depending on the direction of change. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, since the direction of the external effects is unknown, the significance of the cumulative effect is unknown.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the habitat suitability effects is also unknown under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA Atka mackerel stocks include past foreign, JV, domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.18). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from climate changes and regime shifts on the GOA Atka mackerel could be either favorable or unfavorable depending on the direction of change. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects**. Cumulative effects are identified for habitat suitability; however, its significance on the GOA Atka mackerel stock is unknown.

4.8.1.5 Yellowfin Sole and Shallow Water Flatfish

Numerous fishery management actions have been implemented that affect the yellowfin sole fisheries in the BSAI. These actions are described in more detail in Section 3.5.1.5 of this Programmatic SEIS. Yellowfin sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species.

Eight flatfish species inhabit shallow waters and are managed in the shallow water flatfish assemblage in the GOA. They include: northern and southern rock sole, yellowfin sole, starry flounder, butter sole, English sole, Alaska plaice and sand sole. Survey results from 2001 indicate that over half of the estimated biomass

(54 percent) of this assemblage are northern and southern rock sole. The shallow water group is managed as Tier 4 and Tier 5 species in the GOA (Turnock *et al*. 2001).

External effects associated with FMP 4.1 and FMP 4.2 are depicted on Tables 4.5-8 and 4.8-1. For further information regarding persistent past effects identified see Sections 3.5.1.5 and 3.5.1.19.

BSAI Yellowfin Sole – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total Biomass

The total biomass of yellowfin sole at the start of 2002 is estimated to be 1,552,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 4.1, model projections indicate that the total BSAI biomass is expected to decline slightly more than 5 percent of the 2002 value to 1,471,000 mt by 2007, with a 2003-2007 average value of 1,495,000 mt. Under FMP 4.2, model projections indicate that the total BSAI biomass is expected to increase 12 percent of the 2002 value to 1,806,000 mt by 2007, with a 2003-2007 average value of 1,672,000 mt.

Spawning Biomass

Spawning biomass of female yellowfin sole at the start of 2002 is estimated to be 450,700 mt. Model projections of future yellowfin sole spawning biomass estimates are shown in Table H.4-4 of Appendix H. Under FMP 4.1, model projections indicate that female spawning biomass is expected to decline 14 percent of the 2002 value to 388,000 mt by 2007, with a 2003-2007 average value of 416,600 mt. Under FMP 4.2, model projections indicate that female spawning biomass is expected to increase about 21 percent of the 2002 value to 547,800 mt by 2007, with a 2003-2007 average value of 505,800 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 336,900 mt throughout the 5-year projection.

Fishing Mortality

The average annual fishing mortality imposed on the yellowfin sole stock in 2002 is 0.064. Model projections show this value will increase to 0.94 for all five projection years (Table H.4-4 of Appendix H). These values are well below the F_{MSY} proxy value of 0.138, the rate associated with the OFL. Under FMP 4.2, no fishing would occur, and thus the stock would not be overfished.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where yellowfin sole concentrations are sufficient to support a commercial fishery. It is estimated that 40 percent of the catch under this FMP would be redistributed relative to the 2001 catch distribution. Under FMP 4.2, no fishing would occur for yellowfin sole since 100 percent of the BSAI would be closed.

Status Determination

Model projections of future catches of BSAI yellowfin sole are below the OFLs in all years under FMP 4.1 and FMP 4.2. The yellowfin sole stock is above the MSST for all five projected years as in the baseline year 2002.

Age and Size Composition

Under FMP 4.1, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 6.2 years. Under FMP 4.2, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-4 of Appendix H), is 6.9 years. This compares with a mean age in the equilibrium unfished BSAI stock of 8.0 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of yellowfin sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 and FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on yellowfin sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – BSAI Yellowfin Sole

Table 4.5-8 summarizes the effects of FMP 4.1 on BSAI yellowfin sole. The rating of conditionally significant (either beneficial or adverse) is not applicable in this analysis as the model projections yielded results that were determined either significant (beneficial or adverse), insignificant, or unknown.

The ratings utilize the F_{OFL} and the MSST as a basis for beneficial or adverse impacts fishing mortality and changes in reproductive success for each FMP. FMP 4.1 redefines the MSST with $B_{40\%}$ as the limit, rather than the target abundance level as found in the National Standard Guidelines 50 CFR Part 600 (Federal Register Vol. 63, No. 84, 24212-24237). Under FMP 4.1 and FMP 4.2, the spawning stock biomass of BSAI yellowfin sole is expected to be above the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the stock is expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.8-1).

Relative to the 2002 comparative baseline, the yellowfin sole stock is projected to continue to not be overfished under these FMPs. The 20-year projection indicates that the female spawning stock is expected to decline until 2010 to an abundance level below B_{ABC} , but will increase thereafter to a level above B_{ABC} for the last ten years of the projection.

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects on BSAI yellowfin sole are summarized in Table 4.5-8.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI yellowfin sole is rated as insignificant under FMP 4.1 and FMP 4.2 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of yellowfin sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI yellowfin sole, but is rated as insignificant. Fishing mortality at projected levels is below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 will result in insignificant effects to these stocks (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the yellowfin sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.5 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI yellowfin sole, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the spawning biomass is above the B_{MSY} value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

<u>Spatial/Temporal Concentration of Catch</u>

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI yellowfin sole catch.

- **Reasonably Foreseeable Future External Effects.** As described for biomass, effects on the reproductive success of yellowfin sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as having a potential adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI yellowfin sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the yellowfin sole catch; these effects are ranked as insignificant. The spatial/temporal distribution of yellowfin sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is enhanced.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the BSAI yellowfin sole is ranked as insignificant (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI yellowfin sole stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted. See Sections 3.5.1.5 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** As described for biomass and spatial/temporal concentration, effects of the climate changes and regime shifts on the BSAI yellowfin sole stock are potential beneficial or adverse. Marine pollution has been identified as having a potential adverse contribution.

- **Cumulative Effects.** Cumulative effects are identified for change in prey availability; however, these effects are considered insignificant. The combination of internal and external removals of prey is not expected to enhance the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the BSAI yellowfin sole is ranked as insignificant (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects identified for BSAI yellowfin sole include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past contributions of the foreign, JV, and domestic fisheries gear impacts are described in Sections 3.5.1.5 and 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI yellowfin sole stock are potential beneficial or adverse as described for prey availability. Marine pollution has been identified as having a potential adverse contribution since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for BSAI yellowfin sole habitat suitability; however, these effects are considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the yellowfin sole stock to sustain itself at or above the MSST is enhanced.

GOA Shallow Water Flatfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

<u>Total Biomass and Spawning Biomass</u>

Estimated total and spawning biomass is not available for GOA shallow water flatfish species.

<u>Fishing Mortality</u>

The catch of GOA shallow water flatfish in 2002 was estimated to be 6,800 mt. Model projections of future catch are shown in Table H.4-27 of Appendix H. Under FMP 4.1, model projections indicate that the catch is expected to decrease to 3,900 mt each year of the 5-year projection. Under FMP 4.2 no fishing would occur from 2003-2007.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where shallow water flatfish species concentrations are sufficient to support a commercial fishery. It is estimated that under this FMP, the catch of Alaska plaice and butter sole would be mostly displaced from the western and central areas relative to the 2001 catch distribution. No fishing would be allowed for GOA shallow water flatfish under FMP 4.2.

Status Determination

The available information for flatfish species in the shallow water complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition projections are not available for GOA shallow water flatfish species.

Sex Ratio

The sex ratio of shallow water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on shallow water flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Shallow Water Flatfish

The direct and indirect effects of FMP 4.1 and FMP 4.2 on GOA shallow water flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the 5-year projection under these FMPs. The catches predicted under FMP 4.1 and FMP 4.2 are well below the OFL for this stock, therefore, insignificant effects on shallow water flatfish are predicted through mortality (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects on GOA shallow water flatfish are summarized in Table 4.5-9.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shallow water flatfish is rated as insignificant under FMP 4.1 and FMP 4.2 (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past JV and domestic fisheries have been identified as having lingering past adverse effects on the GOA shallow water flatfish complex (see Section 3.5.1.19).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shallow water flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since shallow water flatfish species bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA shallow water flatfish, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** Although the total and spawning biomass estimates for GOA shallow water species is unavailable, the effects of FMP 4.1 and FMP 4.2 on change in biomass is considered to be insignificant (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** The past JV and domestic fisheries are identified as having past lingering adverse effects on the biomass levels of GOA shallow water flatfish (see Section 3.5.1.19).

- **Reasonably Foreseeable Future External Events.** Future external effects on the change in biomass are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions on the shallow water flatfish species biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.19 and 3.10. The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for change in biomass of GOA shallow water flatfish, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effects of internal removals and removals are unlikely to enhance the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, fishing would shift to the remaining open areas where shallow water flatfish species concentration are sufficient to support a commercial fishery. We conclude that the effects of the fishery on GOA shallow water flatfish under FMP 4.1 are insignificant (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects have not been identified for the change in genetic structure or the change in reproductive success of GOA shallow water flatfish.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of shallow water flatfish species due to climate changes and regime shifts are potentially beneficial or adverse as described above for change in biomass. Marine pollution has also been identified as having a potential adverse contribution, and the State of Alaska scallop fishery has been identified as a non-contributing factor to the change in genetic structure and reproductive success since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** Cumulative effects are possible for change in genetic structure and reproductive success of GOA shallow water flatfish, and are rated as insignificant. The combined effects of internal and external removals are unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the GOA shallow water flatfish is determined to be insignificant (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA shallow water flatfish stock complex and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted. See Sections 3.5.1.19 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potential beneficial or adverse as described for biomass. Marine pollution has also been identified as having a potential adverse contribution, and the State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of shallow water flatfish prey species is not expected to occur in this fishery.

- **Cumulative Effects**. Cumulative effects for change in prey availability are insignificant. The predation-mediated impacts of FMP 4.1 and FMP 4.2 on shallow water flatfish are governed by a complex web of indirect interactions which are currently difficult to quantify; however, it is unlikely that prey availability would be increased to levels that would enhance the ability of the GOA shallow water flatfish complex to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the GOA shallow water flatfish complex is considered to be insignificant (see Direct/Indirect Effects discussion in this section).

- **Persistent Past Effects**. Past effects identified for GOA shallow water flatfish include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Section 3.5.1.19 and Section 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potential beneficial or adverse as described for prey availability. Marine pollution has also been identified as having a potential adverse contribution, and the State of Alaska scallop fishery is also identified as a potential adverse contributor to GOA shallow water flatfish habitat suitability. See Section 3.6 for information of the impacts of fishery gear on EFH.

- **Cumulative Effects.** Cumulative effects are identified for GOA shallow water flatfish habitat suitability, and are rated as insignificant. The combination of internal and external habitat disturbances is unlikely to lead to a detectable change in spawning or rearing success such that the ability of the GOA shallow water flatfish stock to maintain current population levels is enhanced.

4.8.1.6 Rock Sole

Rock sole is described in more detail in Section 3.5.1.6 of this Programmatic SEIS. Rock sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species.

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total Biomass

The total biomass of rock sole at the start of 2002 is estimated to be 970,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-7 of Appendix H. Under FMP 4.1, model projections indicate that the total BSAI biomass is expected to decline slightly more than 26 percent of the 2002 value to 717,000 mt by 2007, with a 2003-2007 average value of 785,000 mt. Under FMP 4.2, model projections indicate that the total BSAI biomass is expected to decrease 13 percent of the 2002 value to 844,000 mt by 2007, with a 2003-2007 average value of 853,000 mt.

Spawning Biomass

Spawning biomass of female rock sole at the start of 2002 is estimated to be 331,000 mt. Model projections of future rock sole spawning biomass estimates are shown in Table H.4-7 of Appendix H. Under FMP 4.1, model projections indicate that female spawning biomass is expected to decline 41 percent of the 2002 value to 192,300 mt by 2007, with a 2003-2007 average value of 247,100 mt. Under FMP 4.2, model projections indicate that female spawning biomass is expected to decrease 25 percent of the 2002 value to 247,700 mt by 2007, with a 2003-2007 average value of 277,900 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 136,700 mt throughout the 5-year projection.

Fishing Mortality

The average annual fishing mortality imposed on the rock sole stock in 2002 is 0.055. Model projections show this value will steadily increase to 0.099 by 2007 (Table H.4-7 of Appendix H). These values are well below the F_{MSY} proxy value of 0.21, the rate associated with the OFL. Under FMP 4.2, no fishing would occur, and thus the stock would not be overfished.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where rock sole concentrations are sufficient to support a commercial fishery. It is estimated that 80 percent of the catch would be spatially displaced under this FMP relative to the 2001 catch distribution. Under FMP 4.2, no fishing would occur for rock sole since 100 percent of the BSAI would be closed.

Status Determination

Model projections of future catches of BSAI rock sole are below the OFLs in all years under FMP 4.1 and FMP 4.2 and the female spawning stock is above the MSST. The rock sole stock is above the MSST level in the baseline year 2002.

Age and Size Composition

Under FMP 4.1, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 4.9 years. Under FMP 4.2, the mean age of the BSAI rock sole stock in 2008, as computed in model projections (Table H.4-7 of Appendix H), is 5.9 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of rock sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 and FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on rock sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – BSAI Rock Sole

Under FMP 4.1 and FMP 4.2, the spawning stock biomass of BSAI rock sole is expected to be above the MSST. Since the fishing mortality is below the F_{OFL} level and the female spawning stock is currently above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime (Table 4.8-1).

Relative to the 2002 comparative baseline, the rock sole stock is projected to continue to not be overfished under this FMP. The 20-year projection indicates that the female spawning stock is expected to decline until 2010 to just above B_{ABC} levels and will increase thereafter through the end of the projection in 2023.

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects on BSAI rock sole are summarized in Table 4.5-10.

Mortality

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of fishing mortality on the BSAI rock sole is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rock sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI rock sole and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effects of the fisheries on BSAI rock sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the rock sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.6 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI rock sole, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the BSAI rock sole. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of BSAI rock sole. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of rock sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI rock sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rock sole catch, and is ranked as insignificant. The spatial/temporal distribution of rock sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in prey availability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do effect the availability of some forage species (i.e. capelin); however studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect identified for change in prey availability is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in habitat suitability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI rock sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect identified for BSAI rock sole habitat suitability is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the rock sole stock to sustain itself at or above the MSST is jeopardized.

4.8.1.7 Flathead Sole

BSAI and GOA flathead sole are described in more detail in Sections 3.5.1.7 and 3.5.1.20 of this Programmatic SEIS. Flathead sole is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2002, flathead sole were managed independent of the other flatfish complex in the GOA. Until recently, GOA flathead sole were managed under Tier 4; beginning in 2004, GOA flathead sole will be managed under Tier 3. However, for the purposes of this analysis, GOA flathead sole were modeled under the Tier 4 management category.

Direct/Indirect Effects of FMP 4.1 and FMP 4.2 – BSAI Flathead Sole

Total Biomass

Total biomass of BSAI flathead sole at the start of 2003 is estimated to be 513,000 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 4.1, model projections indicate that BSAI flathead sole total biomass is expected to decrease (8 percent) to a value of 501,000 mt in 2005, then increase (4 percent) to a value of 519,000 mt in 2008, with a 2003-2008 average value of 508,000 mt. Under FMP 4.2, model projections indicate that BSAI flathead sole biomass is expected to increase to a value of 546,000 mt in 2008, with a 2003-2008 average value of 522,000 mt.

Spawning Biomass

Spawning biomass of BSAI flathead sole at the start of 2003 is estimated to be 231,900 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-8 of Appendix H. Under FMP 4.1, model projections indicate that BSAI flathead sole spawning biomass is expected to decrease (25 percent) to a value of 186,000 mt in 2008, with a 2003-2008 average value of 209,100 mt. Under FMP 4.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 198,900 mt in 2008, with a 2003-2008 average value of 214,300 mt.

Fishing Mortality

The projected fishing mortality imposed on the BSAI flathead sole stock is approximately 0.024 in 2003 and increases to 0.049 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 89 percent in 2003 and decreases to 80 percent in 2008, with an average of 85 percent from 2003-2008 (Table H.4-8 of Appendix H). Under FMP 4.2, the projected TAC has been set to zero for all species unless the harvesting of a species has been shown to have no adverse effect on the environment (Table H.4-8 of Appendix H). Thus, there is no fishery for BSAI flathead sole from 2003-2008.

Spatial/Temporal Concentration of Fishing Mortality

The average annual projected harvest of flathead sole under FMP 4.1 was 7,400 mt, with 3,000 mt (40 percent) of the harvest occurring in the EBS shelf yellowfin sole fishery, 2,000 mt (26 percent) in the rock sole fishery, and 1,300 mt (17 percent) in the flathead sole fishery. It is estimated that 40 percent of the catch under this FMP will be displaced relative to the catch distribution in 2001. Under FMP 4.2, there is no projected fishing mortality.

Status Determination

Under FMP 4.1 and FMP 4.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI flathead sole are below the ABC and OFL levels from 2003 to 2008.

Age and Size Composition

Under FMP 4.1, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-8 of Appendix H), is 4.66 years. Under FMP 4.2, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-8 of Appendix H), is 4.84 years. This compares with a mean age in the equilibrium unfished stock of 5.39 years.

Sex Ratio

The sex ratio of BSAI flathead sole is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change under FMP 4.1 or FMP 4.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 4.1 or FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – BSAI Flathead Sole

Because the BSAI flathead sole are fished at less than the ABC and are above the MSST, the direct and indirect effects under FMP 4.1 and FMP 4.2 are considered insignificant. Fishing rates are below accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.8-1).

Relative to the 2002 comparative baseline, the flathead sole stock is projected to continue to not be overfished under these FMPs. The twenty year projection indicates that the female spawning stock is expected to decrease until 2009 at which time it will be begin to steadily increase throughout the end of the projection. The female spawning stock is estimated to remain above B_{ABC} throughout the projection.

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects on BSAI flathead sole are summarized in Table 4.5-11.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI flathead sole is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI flathead sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on BSAI flathead sole is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the flathead sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.7 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI flathead sole, and is rated as insignificant. Model projections indicate that BSAI flathead sole spawning biomass is above the MSST for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI flathead sole catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch, and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects are not identified for the change in prey availability of the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to enhance the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI flathead sole include climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI flathead sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at or above the MSST is enhanced.

GOA Flathead Sole – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

Estimates of total and spawning biomass are currently unavailable for this species.

Fishing Mortality

The catch of GOA flathead sole in 2002 was estimated to be 2,000 mt. Model projections of future catch are shown in Table H.4-28 of Appendix H. Under FMP 4.1, model projections indicate that the catch is expected to decrease from the 2002 level and will range from 500 mt in 2003 to 700 mt in 2007. The 2003-2007 average catch is 600 mt (35 percent of the 2002 catch). Under FMP 4.2 no fishing would occur from 2003-2007.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where GOA flathead sole concentrations are sufficient to support a commercial fishery. No fishing would occur for GOA flathead sole because fishing would not be allowed under FMP 4.2.

Status Determination

The available information for GOA flathead sole requires that they are classified into the Tier 4 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are currently unavailable for this species.

Sex Ratio

The sex ratio of flathead sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 and FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next 5 years under these FMP.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on flathead sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Flathead Sole

The direct and indirect effects of FMP 4.1 and FMP 4.2 on GOA flathead sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of this stock is over the 5-year projection under these FMPs. The predicted catches under FMP 4.1 and FMP 4.2 are well below the OFL for this stock, therefore, FMP 4.1 and FMP 4.2 would have insignificant effects on GOA flathead sole through mortality (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of GOA flathead sole are summarized in Table 4.5-12.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA flathead sole is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Removals by these fisheries have had a lingering adverse effect on GOA flathead sole (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole. The State of Alaska scallop fishery has also been identified as a non-contributing factor since GOA flathead sole bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA flathead sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in biomass level is rated as insignificant due to the significant reduction in the groundfish fisheries and the anticipated low harvest of GOA flathead sole.

- **Persistent Past Effects.** Past effects have been identified for the change in biomass in the GOA flathead sole stock and include past JV and domestic fisheries. Large removals of flathead sole by these fisheries is determined to have had a lingering effect on the GOA flathead sole stock (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the flathead sole biomass level. For more information on climate changes and regime shifts (see Sections 3.5.1.20 and 3.10). The State of Alaska scallop fishery is identified as a non-contributing factor for change in biomass level since flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA flathead sole and is rated as insignificant. The MSST cannot be determined and the total and spawning biomass estimates are currently unavailable. However, due to the anticipated low levels of exploit, the combined effect of internal and external removals is unlikely to enhance the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is insignificant.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA flathead sole stock. However, climate changes and regime shifts have been identified as having a beneficial or adverse effect on GOA flathead sole reproductive success. See Section 3.5.1.20 for more information on the effects of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA flathead sole. The State of Alaska scallop fishery has been identified as a non-contributing factor to change in genetic structure and change in reproductive success since GOA flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the flathead sole catch and is rated as insignificant. The spatial/temporal distribution of flathead sole catch is not expected to change significantly. The predation-mediated is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the GOA flathead sole is rated as insignificant. Due to the reduction of the groundfish fishery effort, it is unlikely that the groundfish fisheries would significantly impact flathead sole prey availability.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA flathead sole stock and include climate changes and regime shifts. For more information on the effects of climate changes and regime shifts on the GOA flathead sole stock (see Section 3.5.1.20).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole prey availability. The State of Alaska scallop fishery gear could impact flathead sole benthic prey availability and/or quality.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to enhance the ability of the stock to sustain itself at current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for GOA flathead sole is insignificant. The reduced groundfish fishery effort is unlikely to significantly impact flathead sole habitat suitability.

- **Persistent Past Effects.** Past effects identified for GOA flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.20.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as a potential adverse contributor to GOA flathead sole habitat suitability. For information on the effects of fishery gear on essential fish habitat (see Section 3.6).

- **Cumulative Effects.** A cumulative effect is identified for GOA flathead sole habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at current population levels is enhanced.

4.8.1.8 Arrowtooth Flounder

BSAI and GOA arrowtooth flounder are described in more detail in Sections 3.5.1.8 and 3.5.1.21 of this Programmatic SEIS. Arrowtooth flounder is managed as its own stock under the BSAI and GOA groundfish FMPs under the Tier 3 management category, thus MSSTs are defined for this species.

BSAI Arrowtooth Flounder – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total Biomass

The total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-6 of Appendix H. Under FMP 4.1, model projections indicate that the total BSAI biomass is expected to decline 23 percent of the 2002 value to 621,000 mt by 2007, with a 2003-2007 average value of 687,000 mt. Under FMP 4.2, model projections indicate that the total BSAI biomass is expected to decrease 22 percent of the 2002 value to 633,000 mt by 2007, with a 2003-2007 average value of 694,000 mt.

Spawning Biomass

Spawning biomass of female BSAI arrowtooth flounder at the start of 2002 is estimated to be 475,900 mt. Model projections of future arrowtooth flounder spawning biomass estimates are shown in Table H.4-6 of Appendix H. Under FMP 4.1, model projections indicate that female spawning biomass is expected to decline 27.5 percent of the 2002 value to 345,000 mt by 2007, with a 2003-2007 average value of 396,600 mt. Under FMP 4.2, model projections indicate that female spawning biomass is expected to decrease 26 percent of the 2002 value to 353,100 mt by 2007, with a 2003-2007 average value of 401,000 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 182,900 mt throughout the 5-year projection.

Fishing Mortality

The average annual fishing mortality imposed on the BSAI arrowtooth flounder stock in 2002 is 0.015 (Table H.4-6 of Appendix H). Model projections show that the values between 2003-2007 are below the F_{MSY} proxy value of 0.38, the rate associated with the OFL. Under FMP 4.2, no fishing would occur, and thus the stock would not be overfished.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where BSAI arrowtooth flounder concentrations are sufficient to support a commercial fishery. It is estimated that 60 percent of the Bering Sea catch will be displaced under this FMP relative to the 2001 catch distribution. Under FMP 4.2, no fishing would occur for arrowtooth flounder since 100 percent of the BSAI would be closed.

Status Determination

Model projections of future catches of BSAI arrowtooth flounder are below the OFLs in all years under FMP 4.1 and FMP 4.2. The BSAI arrowtooth flounder stocks are above the MSST level throughout the 5-year projection, as in the 2002 baseline year.

Age and Size Composition

Under FMP 4.1, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-6 of Appendix H), is 4.9 years. Under FMP 4.2, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-6 of Appendix H), is 5.0 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.4 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the BSAI have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on BSAI arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – BSAI Arrowtooth Flounder

Under FMP 4.1 and FMP 4.2, the spawning stock biomass of BSAI arrowtooth flounder is expected to be above the MSST and $B_{40\%}$. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under FMP 4.1 and FMP 4.2. Thus, the indirect and direct effects under these FMPs are considered insignificant (Table 4.8-1).

Relative to the 2002 comparative baseline, the BSAI arrowtooth flounder stocks are projected to continue to not be overfished under these FMPs. The 20-year projection indicates that both female spawning stocks are expected to remain above B_{ABC} levels through the end of the projection in 2023.

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects for BSAI arrowtooth flounder are summarized in Table 4.5-13.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI arrowtooth flounder is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of arrowtooth flounder. The IPHC longline fishery is identified as a potential adverse contributor to BSAI arrowtooth flounder mortality since arrowtooth flounder are caught as bycatch in this fishery. Finally, the state herring fishery is identified as a non-contributing factor to BSAI arrowtooth flounder mortality since bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the arrowtooth flounder biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.8 and 3.10). The IPHC longline fishery has been identified as a potential adverse contributor to BSAI arrowtooth flounder biomass level since bycatch is expected to occur in this fishery. Finally, the State of Alaska herring fishery is identified as a non-contributing factor since arrowtooth flounder bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI arrowtooth flounder, and but is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI arrowtooth flounder. Climate changes and regime shifts are identified as having had potential adverse or beneficial effects on the reproductive success of BSAI arrowtooth flounder (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of arrowtooth flounder due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI arrowtooth flounder. The IPHC longline fishery is identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since the removals are not expected to be significant. The state herring fishery is also identified as a non-contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch; however, these effects are ranked as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified include the past foreign, JV, domestic fisheries, State of Alaska groundfish fisheries, state herring fisheries and climate changes and regime shifts (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potential beneficial or adverse. Some forage species (i.e. capelin and herring), shrimp and pollock respond to variations in water temperatures which vary with the climate. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor to prey availability since the bycatch of prey species is not expected in this fishery. The state herring fishery is identified as a potential adverse contributor to prey availability by reducing the availability of herring.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to enhance the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI arrowtooth flounder include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.8.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery and the State of Alaska herring fishery are both identified as non-contributing factors to BSAI arrowtooth flounder habitat suitability. The impacts from the fishery gear are expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for BSAI arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is enhanced.

GOA Arrowtooth Flounder – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

<u>Total Biomass</u>

The total biomass of GOA arrowtooth flounder at the start of 2002 is estimated to be 1,816,000 mt. Model projections of future total GOA biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 4.1, model projections indicate that the total GOA biomass is expected to increase 17 percent of the 2002 value to 2,120,000 mt by 2007, with a 2003-2007 average value of 2,000,000 mt. Under FMP 4.2, model projections indicate that the total GOA biomass is expected to increase 17.5 percent of the 2002 value to 2,134,000 mt by 2007, with a 2003-2007 average value of 2,006,000 mt.

Spawning Biomass

Spawning biomass of female GOA arrowtooth flounder at the start of 2002 is estimated to be 1,113,800 mt. Model projections of future arrowtooth flounder spawning biomass estimates are shown in Table H.4-29 of Appendix H. Under FMP 4.1, model projections indicate that female spawning biomass is expected to increase 6 percent of the 2002 value to 1,182,000 mt by 2007, with a 2003-2007 average value of 1,156,700 mt. Under FMP 4.2, model projections indicate that female spawning biomass is expected to increase 7 percent of the 2002 value to 1,192,500 mt by 2007, with a 2003-2007 average value of 1,161,600 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 432,700 mt throughout the 5-year projection.

Fishing Mortality

The average annual fishing mortality imposed on the GOA arrowtooth flounder stock in 2002 is 0.017 (Table H.4-29 of Appendix H). Model projections indicate that fishing mortality will range from 0.002 to 0.004 from 2003-2007. These values are well below the F_{MSY} proxy value of 0.165, the rate associated with the OFL. Under FMP 4.2, no fishing would occur, and thus the stock would not be overfished.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where GOA arrowtooth flounder concentrations are sufficient to support a commercial fishery. It is estimated that 74 percent and 80 percent of the GOA western region and GOA central region catch, respectively, will be displaced under this FMP relative to the 2001 catch distribution. Under FMP 4.2, no fishing would occur for arrowtooth flounder since 100 percent of the GOA would be closed.

Status Determination

Model projections of future catches of GOA arrowtooth flounder are below the OFLs in all years under FMP 4.1 and FMP 4.2. The GOA arrowtooth flounder stocks are above the MSST level throughout the 5-year projection, as in the 2002 baseline year.

Age and Size Composition

Under FMP 4.1 and FMP 4.2, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-29 of Appendix H), is 5.1 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.1 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the GOA have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on GOA arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Arrowtooth flounder

Under FMP 4.1 and FMP 4.2, the spawning stock biomass of GOA arrowtooth flounder is expected to be above the MSST and $B_{40\%}$. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stocks are expected to remain above the MSST, the expected changes under this FMP are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant.

Relative to the 2002 comparative baseline, the GOA arrowtooth flounder stocks are projected to continue to not be overfished under these FMPs. The 20-year projection (Table H.4-29 of Appendix H) indicates that both female spawning stocks are expected to remain above B_{ABC} levels through the end of the projection in 2023.

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects for GOA arrowtooth flounder are summarized in Table 4.5-14.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA arrowtooth flounder is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI arrowtooth flounder under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated earlier in the direct/indirect effects section, the effect of the fisheries on biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass levels are the same as those described for BSAI arrowtooth flounder under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
  - Change in Genetic Structure of Population
  - Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of GOA arrowtooth flounder. Climate changes and regime shifts are identified as having had potential adverse or beneficial effects on the reproductive success of GOA arrowtooth flounder (see Section 3.5.1.21).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure are the same as those described for BSAI arrowtooth flounder under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch, and is rated as insignificant. The spatial/temporal distribution of arrowtooth flounder catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects**. Past effects identified include climate changes and regime shifts (see Section 3.5.1.21).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey availability are the same as those described for BSAI arrowtooth flounder under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to enhance the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for habitat suitability of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects on habitat suitability are the same as those described for BSAI arrowtooth flounder under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for GOA arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is enhanced.

4.8.1.9 Greenland Turbot and Deepwater Flatfish

BSAI Greenland turbot and GOA deepwater flatfish are described in more detail in Sections 3.5.1.9 and 3.5.1.22 of this Programmatic SEIS. Greenland turbot is managed as its own stock under the BSAI groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. The reference fishing mortality rate and ABC for the GOA deepwater flatfish management group are determined by the amount of population information available. ABCs for Dover sole were calculated using Tier 5. Greenland turbot and deepsea sole are in Tier 6 because no reliable biomass estimates exists.

BSAI Greenland Turbot – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 4.1, model projections indicate that the total BSAI biomass is expected to decline 12 percent of the 2002 value to 93,000 mt by 2007, with a 2003-2007 average value of 96,000 mt. Under FMP 4.2, model projections indicate that the total BSAI biomass is expected to increase 3 percent of the 2002 value to 109,000 mt by 2007, with a 2003-2007 average value of 104,000 mt.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-5 of Appendix H. Under FMP 4.1, model projections indicate that female spawning biomass is expected to decline 22 percent of the 2002 value to 52,800 mt by 2007, with a 2003-2007 average value of 57,100 mt. Under FMP 4.2, model projections indicate that female spawning biomass is expected to decrease three percent of the 2002 value to 65,800 mt by 2007, with a 2003-2007 average value of 64,900 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,600 mt throughout the 5-year projection.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Model projections show this value will increase to 0.112 in 2003-2006 and then decrease to 0.109 in 2007 (Table H.4-5 of Appendix H). These values are well below the F_{MSY} proxy value of 0.48, the rate associated with the OFL. Under FMP 4.2, no fishing would occur, and thus the stock would not be overfished.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where Greenland turbot concentrations are sufficient to support a commercial fishery. Also, harvesting would be restricted to only longline fishing under this FMP. It is estimated that 62 percent of the catch would be spatially displaced under this FMP relative to the 2001 catch distribution. Under FMP 4.2, no fishing would occur for Greenland turbot since 100 percent of the BSAI would be closed.

Status Determination

Model projections of future catches of BSAI Greenland turbot are below the OFLs in all years under FMP 4.1 and FMP 4.2. The Greenland turbot female spawning stock is above the MSST level throughout the 5-year projection, as in the baseline year 2002.

Age and Size Composition

Under FMP 4.1, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.7 years. Under FMP 4.2, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-5 of Appendix H), is 4.9 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.9 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on Greenland turbot would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – BSAI Greenland Turbot

Under FMP 4.1 and FMP 4.2, the spawning stock biomass of BSAI Greenland turbot is not expected to drop below the MSST. Since the fishing mortality rate does not exceed F_{OFL} and the female spawning stock is not expected to decline below the MSST, the expected changes under these FMPs are not substantial enough to expect that the genetic diversity or the reproductive success of the spawning stocks would change under the new management regime. Thus, the indirect and direct effects under these FMPs are considered insignificant. However, the female spawning biomass does decline below the $B_{40\%}$ limit in 2006 and 2007 which would initiate a rebuilding plan that would most likely reduce future harvests (Table 4.8-1).

Relative to the 2002 comparative baseline, the Greenland turbot stock is projected to not be overfished under these FMPs. The 20-year projection indicates that the female spawning stock is expected to decline below B_{ABC} levels in 2006 and 2007 and will increase thereafter above B_{ABC} through the end of the projection in 2023.

Cumulative Effects Analysis FMP 4.1 and FMP 4.2

Cumulative effects for BSAI Greenland turbot are summarized in Table 4.5-15.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Greenland turbot and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As indicated in the direct/indirect effects section, the effect of the fisheries on the change in biomass level is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the Greenland turbot biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.9 and 3.10).

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Greenland turbot, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the female spawning biomass is above the B_{MSY} value from 2003-2006. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the spatial/temporal concentration of BSAI Greenland turbot catch. Climate changes and regime shifts are suspected of having an effect on the reproductive success of the Greenland turbot stock (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Greenland turbot catch and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is enhanced.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI Greenland turbot stock. Past foreign, JV, and domestic fisheries have been identified as having influenced the availability of Greenland turbot prey, mainly pollock which is their main prey item in the BSAI. Climate changes and regime shifts have also been identified as influencing Greenland turbot prey availability (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to enhance the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects**. Past effects identified for BSAI Greenland turbot include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of Greenland turbot, largely through the impacts of fishing gear on benthic habitats. See Section 3.5.1.9 for more information on the persistent past effects on Greenland turbot.

- **Reasonably Foreseeable Future External Effects**. Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Greenland turbot habitat suitability and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Greenland turbot stock to sustain itself at or above the MSST is enhanced.

GOA Deepwater Flatfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

The catch of GOA deepwater flatfish in 2002 was estimated to be 600 mt. Model projections of future catch are shown in Table H.4-25 of Appendix H. Under FMP 4.1, model projections indicate that the catch is expected to decrease to 500 mt in 2004-2007 with a 2003-2007 average value of 500 mt. Under FMP 4.2 no fishing would occur from 2003-2007.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where species of the deepwater flatfish complex were in concentrations sufficient to support a commercial fishery. It is estimated that the Dover sole catch would be displaced 87 percent in the western area and 71 percent in the central area under this FMP relative to the 2001 catch distribution. No fishing would be allowed for GOA deepwater flatfish under FMP 4.2.

Status Determination

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 5 or Tier 6 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratio of deepwater flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 and FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on deepwater flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Deepwater Flatfish

The direct and indirect effects of FMP 4.1 and FMP 4.2 on GOA deepwater flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the 5-year projection. The predicted catch rates under FMP 4.1 and FMP 4.2 are well below the OFL for this stock, therefore, the effects of these FMPs would be insignificant on GOA deepwater flatfish through mortality (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects for GOA deepwater flatfish are summarized in Table 4.5-16.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA deepwater flatfish is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA deepwater flatfish stock.

- **Reasonably Foreseeable Future External Effects**. Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since bycatch of deepwater flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA deepwater flatfish, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Total and spawning biomass estimates are unavailable for the deepwater flatfish species. However, the effects of FMP 4.1 and FMP 4.2 on the change in biomass level are rated as insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the GOA deepwater flatfish stock complex.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause deepwater flatfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the deepwater flatfish species biomass level. For more information on climate changes and regime shifts (see Sections 3.5.1.22 and 3.10). The State of Alaska scallop fishery has been identified as a non-contributing factor for change in biomass level since deepwater flatfish species bycatch is not expected to occur.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA deepwater flatfish and is rated as insignificant. The combined effect of internal and external removals is unlikely to enhance the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

  - Change in Genetic Structure of Population
  - Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is rated as insignificant for the stock.

- **Persistent Past Effects**. Past effects include climate changes and regime shifts which are suspected of having an effect on the reproductive success of the deepwater flatfish stock complex. See Section 3.5.1.22 for more information on the effects of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA deepwater flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor to change in genetic structure and reproductive success since bycatch of GOA deepwater flatfish species is not expected to occur.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the GOA deepwater flatfish catch and is rated as insignificant. The combined effect of internal and external removals is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is enhanced.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the GOA deepwater flatfish complex is insignificant.

- **Persistent Past Effects**. Past effects are identified for the change in prey availability of the GOA deepwater flatfish stock complex and include climate changes and regime shifts (see Section 3.5.1.22).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The state scallop fishery has been identified as a potential adverse contributor to benthic prey availability. See Section 3.6 for information of the impacts of fishery gear on essential fish habitat.

- **Cumulative Effects.** A cumulative effect is identified as insignificant for change in prey availability. The combination of internal and external removals of prey is not expected to enhance the ability of the stock to maintain current populations.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the GOA deepwater flatfish complex is rated as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA deepwater flatfish include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of deepwater flatfish, largely through the impacts of fishing gear on benthic habitats. See Section 3.5.1.22 for more information on the persistent past effects on deepwater flatfish.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deepwater flatfish stock complex are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The state scallop fishery has been identified as a potential adverse contributor to habitat suitability. See Section 3.6 for more information on the impacts of fishery gear on essential fish habitat.

- **Cumulative Effects.** A cumulative effect is identified as insignificant for GOA deepwater flatfish habitat suitability. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the deepwater flatfish stock complex to maintain current population levels is enhanced.

4.8.1.10 Alaska Plaice, Other Flatfish, and Rex Sole

BSAI Alaska plaice and other flatfish and GOA rex sole are described in more detail in Sections 3.5.1.10 and 3.5.1.23 of this Programmatic SEIS.

BSAI Alaska plaice – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total Biomass

Total biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 1,083,000 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4-9 of Appendix H. Under FMP 4.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,112,000 mt in 2008, with a 2003-2008 average value of 1,102,000 mt. Under FMP 4.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,159,000 mt in 2008, with a 2003-2008 average value of 1,123,000 mt.

Spawning Biomass

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 275,700 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4-9 of Appendix H. Under FMP 4.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 283,700 mt in 2008, with a 2003-2008 average value of 278,200 mt. Under FMP 4.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 301,200 mt in 2008, with a 2003-2008 average value of 288,800 mt.

Fishing Mortality

The projected fishing mortality imposed on the BSAI Alaska plaice stock is approximately 0.02 in 2003 and decreases to 0.017 in 2008. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 91 percent in 2003 and increases to 92 percent in 2008, with an average of 91 percent from 2003-2008 (Table H.4-9 of Appendix H). Under FMP 4.2, the projected TAC has been set to zero for all species unless the harvesting of a species has been shown to have no adverse effect on the environment (Table H.4-9 of Appendix H). Thus, there is no fishery for BSAI Alaska plaice from 2003-2008.

Spatial/Temporal Concentration of Fishing Mortality

The average annual projected harvest of Alaska plaice under FMP 4.1 was 10,400 mt, with 8,800 mt (85 percent) of the harvest occurring in the EBS shelf yellowfin sole fishery. It is estimated that 40 percent of the catch under this FMP will be displaced relative to the 2001 catch distribution due to area closures. Under FMP 4.2, there is no projected fishing mortality.

Status Determination

Under FMP 4.1 and FMP 4.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below the ABC and OFL levels from 2003 to 2008.

Age and Size Composition

Under FMP 4.1, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections (Table H.4-9 of Appendix H), is 4.40 years. Under FMP 4.2, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections (Table H.4-9 of Appendix H), is 4.47 years. This compares with a mean age in the equilibrium unfished stock of 4.51 years.

Sex Ratio

The sex ratio of BSAI Alaska plaice is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 4.1 or FMP 4.2. Because the BSAI Alaska plaice are fished at less than the ABC and are above the MSST, the direct and indirect effects under FMP 4.1 and FMP 4.2 through habitat suitability are considered insignificant.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 4.1 or FMP 4.2. Because the BSAI Alaska plaice are fished at less than the ABC and are above the MSST, the direct and indirect effects under FMP 4.1 and FMP 4.2 through prey availability are considered insignificant.

Summary of Direct/Indirect Effects of FMP 4.1 and FMP 4.2 – BSAI Alaska Plaice

Because the BSAI Alaska plaice are fished at less than the ABC and are above the MSST, the direct and indirect effects under FMP 4.1 and FMP 4.2 are considered insignificant. With the removal of fishing for BSAI Alaska plaice, the direct and indirect effects under FMP 4.2 are considered insignificant. Fishing rates are below accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity (Table 4.8-1).

Relative to the 2002 comparative baseline, the Alaska plaice stock is projected to continue to not be overfished under these FMPs. The 20-year projection indicates that the female spawning stock is expected to remain at a high and stable level well above B_{ABC}.

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects for BSAI Alaska plaice are summarized in Table 4.5-17.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Alaska plaice stock is insignificant under FMP 4.1 and FMP 4.2.
- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.
- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor to mortality of BSAI Alaska plaice. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as contributors to mortality since a change is not expected to be significant in magnitude to cause mortality.
- **Cumulative Effects.** Under FMP 4.1 and FMP 4.2, a cumulative effect is identified for BSAI Alaska plaice mortality and is considered insignificant. Alaska plaice are fished above the ABC and OFL values. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to enhance the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Alaska plaice stock is expected to be insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution events are identified as potential adverse contributors to BSAI Alaska plaice change in biomass level. Acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to change in biomass level, since recruitment is affected by climate changes and regime shifts through a combination of prey availability and habitat suitability effects.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Alaska plaice change in biomass and is rated as insignificant. The combination of internal and external factors is not expected to increase Alaska plaice biomass such that the ability of the stock to maintain itself at or above the MSST is enhanced.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 is determined to have an insignificant effect on BSAI Alaska plaice spatial/temporal characteristics.

- **Persistent Past Effects.** No persistent past effects have been identified for the genetic structure of the BSAI Alaska plaice population. Although, climate changes and regime shifts have been identified as having a potential beneficial or adverse effect on BSAI Alaska plaice reproductive success. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment tends to be favored.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contribution to BSAI Alaska plaice genetic structure and reproductive success. Acute and/or chronic events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and could also result in reduced recruitment. Climate changes and regime shifts have been identified as potential beneficial or adverse contributors to the reproductive success of BSAI Alaska plaice, but as non-contributing factors to the genetic structure of Alaska plaice. The reproductive success is affected through a combination of climate induced changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect has been identified for the spatial/temporal concentration of BSAI Alaska plaice and is rated as insignificant. The combined internal and external events are not expected to significantly alter the reproductive success or genetic structure such that it enhances the capacity of the stock to maintain itself above MSST.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 is determined to have an insignificant effect on BSAI Alaska plaice prey availability.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having potential adverse or beneficial effects on BSAI Alaska plaice prey availability. Little research has been conducted on benthic invertebrates, the main prey species of Alaska plaice, therefore the magnitude and direction of the effects imposed by climate changes and regime shifts are unknown.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor to the prey availability of BSAI Alaska plaice. Acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above the MSST. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to BSAI Alaska plaice prey availability. However, as stated above, since little research has been conducted on the effects of climate changes on benthic invertebrates, the magnitude and direction of the changes are unknown.

- **Cumulative Effects.** A cumulative effect has been identified for the BSAI Alaska plaice change in prey availability and is rated as insignificant. The combination of internal and external removals of prey species is not expected to increase prey availability such that the ability of BSAI Alaska plaice stock to maintain itself at or above MSST is enhanced.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 is determined to have an insignificant effect on Alaska plaice habitat suitability.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries have been identified as having adverse effects on BSAI Alaska plaice habitat. See Sections 3.5.1.10 and 3.6 for more information on the effects of fishing gear on flatfish habitat. Climate changes and regime shifts are also identified as having a potential adverse or beneficial effect on Alaska plaice habitat (see Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to BSAI Alaska plaice habitat suitability. Acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success of Alaska plaice. Climate changes and regime shifts have also been identified as having potential beneficial or adverse contributions to BSAI Alaska plaice habitat suitability. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment is favored.

- **Cumulative Effects.** A cumulative effect for BSAI Alaska plaice change in habitat suitability is identified and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the BSAI Alaska plaice stock to maintain itself at or above the MSST is enhanced.

BSAI Other Flatfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

Estimates of total and spawning biomass are not available for these species.

Fishing Mortality

The catch of BSAI other flatfish in 2002 was estimated to be 2,600 mt. Model projections of future catch are shown in Table H.4-10 of Appendix H. Under FMP 4.1, model projections indicate that the catch is expected to decrease from the 2002 value to 1,900 mt in 2003 and then further decrease to 1,800 mt in 2007 (31 percent decrease from 2002). The 2003-2007 average catch is 1,900 mt. Under FMP 4.2, catch in all five projected years would be zero.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where other flatfish concentrations are sufficient to support a commercial fishery. No fishing would occur for other flatfish since 100 percent of the BSAI would be closed.

Status Determination

The available information for flatfish species in the deepwater complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratios of the species of the BSAI other flatfish category are assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo a significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on other flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Direct/Indirect Effects of FMP 4.1 and FMP 4.2 – BSAI Other Flatfish

The direct and indirect effects of FMP 4.1 and FMP 4.2 on BSAI other flatfish cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of these stocks is over the 5-year projection under these FMPs. The predicted catches under these FMPs are well below the OFL for this stock, therefore, FMP 4.1 and FMP 4.2 would have insignificant effects on BSAI other flatfish through mortality (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects for BSAI other flatfish are summarized in Table 4.5-18.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other flatfish is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects have not been identified for BSAI other flatfish mortality.

- **Reasonably Foreseeable Future External Effects**. Future external effects on mortality are the same as those described for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other flatfish and is rated as insignificant. Fishing mortality rates for projected years are well below the other flatfish OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of changes in biomass level is rated as insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the BSAI other flatfish change in biomass level effect indicator.

- **Reasonably Foreseeable Future External Effects**. Future external effects on change in biomass level are the same as those indicated for BSAI Alaska plaice under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI other rockfish and is rated as insignificant. Fishing mortality at projected levels is below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is insignificant.

- **Persistent Past Effects.** Past effects identified for the genetic structure and reproductive success of BSAI other flatfish are the same as those described for BSAI Alaska plaice under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the genetic structure and reproductive success of other flatfish are the same as those described for BSAI Alaska plaice under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the other flatfish catch and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the BSAI other flatfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for the change in prey availability of the BSAI other flatfish are the same as those indicated for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for the change in prey availability are the same as those described for BSAI Alaska plaice under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the BSAI other flatfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for the change in habitat suitability of BSAI other flatfish are the same as those indicated for BSAI Alaska plaice under this FMP.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for the change in habitat suitability of BSAI other flatfish are the same as those indicated for BSAI Alaska plaice under this FMP.

- **Cumulative Effects.** A cumulative effect is identified for BSAI other flatfish habitat suitability and is rated as insignificant. The establishment of MPAs may be beneficial to other flatfish species habitat. The combined effect of internal habitat disturbances and reasonably foreseeable external habitat disturbances is unlikely to be sufficient to enhance the stock's ability to maintain current population levels.

GOA Rex Sole – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

Estimates of total and spawning biomass are not available for this species.

Fishing Mortality

The catch of GOA rex sole in 2002 was estimated to be 3,000 mt. Model projections of future catch are shown in Table H.4-26 of Appendix H. Under FMP 4.1, model projections indicate that the catch is expected to increase from 150 mt in 2003 to 1,700 mt in 2007. The 2003-2007 average catch is 900 mt. Under FMP 4.2 no fishing would occur from 2003-2007.

Spatial/Temporal Concentration of Fishing Mortality

Fishing which previously occurred in areas which would be closed under FMP 4.1 would presumably be shifted to the remaining open areas where rex sole concentrations are sufficient to support a commercial fishery. It is estimated that 48 percent of the catch in the western area would be displaced under this FMP and 67 percent in the central area relative to the 2001 catch distribution. No fishing would be allowed in the GOA under FMP 4.2.

Status Determination

The available information for GOA rex sole requires that they are classified into the Tier 5 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status.

Age and Size Composition

Age and size composition estimates are not available for this species.

Sex Ratio

The sex ratio of rex sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 on rex sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 or FMP 4.2.

Summary of Direct/Indirect Effects of FMP 4.1 and FMP 4.2 – GOA Rex Sole

The direct and indirect effects of FMP 4.1 and FMP 4.2 on GOA rex sole cannot be determined from the MSST criteria used for stocks in Management Category Tiers 1-3. It is unknown what the estimate of female spawning biomass of this stock is over the 5-year projection under these FMPs. The predicted catches under these FMPs are well below the OFL for this stock, therefore, FMP 4.1 and FMP 4.2 would have insignificant effects on GOA rex sole through mortality (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects for GOA rex sole are summarized in Table 4.5-19.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA rex sole is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Large removals of rex sole by the past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA rex sole stocks (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rex sole. The state scallop fishery has also been identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA rex sole and is rated as insignificant. Fishing mortality rates for projected years are well below the rex sole OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of changes in biomass level is rated as insignificant.

- **Persistent Past Effects.** Large removals of rex sole by past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA rex sole stocks (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts have also been identified as having an indirect potential beneficial or adverse effect on the rex sole biomass level. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and the temperatures cooler, recruitment tends to be weak. The state scallop fishery is identified as a non-contributing factor since it is not expected to contribute to direct mortality of rex sole. For more information on climate changes and regime shifts (see Sections 3.5.1.23 and 3.10).

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA rex sole and is rated as insignificant. Fishing mortality at projected levels is below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is ranked as insignificant.

- **Persistent Past Effects.** Past effects are not identified for genetic structure of the population; however, climate changes and regime shifts are identified as having persistent past effects on the reproductive success of the GOA rex sole stock. See Sections 3.5.1.23 and 3.10 for more information of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the genetic structure of rex sole include the potential adverse effects of marine pollution since an acute and/or chronic pollution event could alter the genetic structure of the population by causing localized mortality. The state scallop fishery and climate changes and regime shifts have both been identified as non-contributing factors to the change in genetic structure of rex sole stocks. These events are not expected to cause localized depletions that would alter the genetic sub-population structure of rex sole stock. Change in reproductive success of rex sole due to climate changes and regime shifts is identified as having a potential beneficial or adverse effect. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could also the reproductive success of GOA rex sole. Again, the state scallop fishery has been identified as a non-contributing factor since the scallop fishery is not expected to contribute to rex sole removals.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the rex sole catch and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the GOA rex sole is ranked as insignificant.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had effected the prey availability of the GOA rex sole stock. The actual effect of climate changes and regime shifts on rex sole prey availability is unknown, but could have had a potential beneficial or adverse effect. See Sections 3.5.1.23 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The state scallop fishery has been identified as having a potential adverse effect on rex sole prey availability since the habitat disturbances caused by dredging could influence the availability of benthic prey.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to enhance the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for GOA rex sole include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. Habitat disturbances caused by the past foreign, JV, and domestic fisheries have also been identified as having persistent past effects on the GOA rex sole stock. See Sections 3.5.1.23 and 3.10 for more information regarding the past fisheries and climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potential beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The state scallop fishery is identified as having potential adverse effects on rex sole habitat suitability that may cause changes in the spawning or rearing success of the stock.

- **Cumulative Effects.** A cumulative effect is identified for GOA rex sole habitat suitability and is considered to be insignificant. The establishment of MPAs may be beneficial to rex sole habitat. The combined effect of internal habitat disturbances and reasonably foreseeable external habitat disturbances is unlikely to be sufficient to enhance the stock's ability to maintain current population levels.

4.8.1.11 Pacific Ocean Perch

Pacific ocean perch (*Sebastes alutus*) are managed under Tier 3 in both the BSAI and GOA.

BSAI Pacific Ocean Perch – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total Biomass

Total biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 374,000 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 of Appendix H. Under FMP 4.1, model projections indicate that BSAI biomass is expected to increase to a value of 443,000 mt in 2008, with a 2003-2008 average value of 409,000 mt. Under FMP 4.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 448,000 mt in 2008, with a 2003-2008 average value of 411,000 mt.

Spawning Biomass

Spawning biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 136,500 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-12 and Figure H.4-15 of Appendix H. Under FMP 4.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 160,800 mt in 2008, with a 2003-2008 average value of 147,800 mt. Under FMP 4.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 162,700 mt in 2008, with a 2003-2008 average value of 148,800 mt.

Fishing Mortality

The projected fishing mortality imposed on the BSAI Pacific ocean perch stock is approximately 0.002 in each year from 2003 to 2008. This fishing mortality corresponds to an implied spawner-per-recruit fishing mortality rate of 94 percent from 2004-2008 (Table H.4-12 of Appendix H). Under FMP 4.2, the projected TAC has been set to zero for all species unless the harvesting of a species has been shown to have no adverse effect on the environment (Table H.4-12 of Appendix H). Thus, there is no fishery for BSAI Pacific ocean perch from 2003-2008.

Spatial/Temporal Concentration of Fishing Mortality

Under FMP 4.1, the average annual projected harvest of BSAI Pacific ocean perch is 850 mt, of which 660 mt (80 percent) is taken in the eastern Aleutian Islands. This harvest is taken as bycatch in the Atka mackerel fishery (620 mt), with very little taken in the directed Pacific ocean perch fishery in this region (40 mt). The dramatic reduction of catch under FMP 4.1 is consistent with the establishment of no-take reserves in the Aleutian Islands, which nearly completely covers the fishing grounds for the Pacific ocean perch fishery. Under FMP 4.2, there is no projected fishing mortality.

Status Determination

Under FMP 4.1 and FMP 4.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Pacific ocean perch are below the ABC and OFL levels from 2003 to 2008. The projected spawning stock biomass is projected to be greater than the B_{MSY} ($B_{35\%}$) level of 120,200 mt in each year of the projection, so BSAI Pacific ocean perch are above the MSST level under FMP 4.1 and FMP 4.2.

Age and Size Composition

Under FMP 4.1, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-12 of Appendix H), is 10.90 years. Under FMP 4.2, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-12 of Appendix H), is 10.95 years. This compares with a mean age in the equilibrium unfished stock of 14.01 years.

Sex Ratio

The sex ratio of BSAI Pacific ocean perch is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change under FMP 4.1 or FMP 4.2.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 4.1 and FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – BSAI Pacific Ocean Perch

A significant feature of FMP 4.1 is the use of the $F_{75\%}$ fishing rate as a maximum for BSAI Pacific ocean perch, and the projected fishing mortality rates are lowered from the $F_{75\%}$ level. An additional feature is establishment of extensive no-take reserves that would prevent targeting of Pacific ocean perch on currently used fishing grounds, essentially eliminating the Pacific ocean perch directed fishery in the BSAI. These two factors would be expected to lead to a significantly beneficial enhancement of the ability of BSAI Pacific ocean perch to sustain itself above the MSST. Because the Pacific ocean perch are patchily distributed fish and the harvest is concentrated in specific locations, the removal of directed Pacific ocean perch harvesting would also be expected to lead to significantly beneficial increases in recruitment success in these locations. The removal of directed fishing may also lead to habitat improvement, but whether this would translate into reproductive success is uncertain, therefore this effect is considered insignificant. Because the BSAI Pacific ocean perch are fished at less or equal to the ABC and are above the MSST, all other effects under FMP 4.1 are considered insignificant. Fishing rates are more conservative than accepted scientific standards based on studies of population dynamics and estimates of natural variation of recruitment.

Under FMP 4.2, the removal of fishing would be expected to lead to significantly beneficial enhancement of the ability of the BSAI Pacific ocean perch to sustain itself above the MSST. Because Pacific ocean perch are patchily distributed fish and the harvest is concentrated in specific locations, the removal of directed Pacific ocean perch harvesting would also be expected to lead to significantly beneficial increases in recruitment success in these locations. The removal of directed fishing may also lead to habitat improvement, but whether this would translate into reproductive success is uncertain; therefore, this effect is considered insignificant. Because the BSAI Pacific ocean perch are not fished and are above the MSST, all other effects under FMP 4.2 are considered insignificant (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects for BSAI Pacific ocean perch are summarized in Table 4.5-20.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific ocean perch stock is insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to BSAI Pacific ocean perch mortality since bycatch in this fishery is not expected. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to Pacific ocean perch mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific ocean perch stock is expected to be significantly beneficial under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had adverse effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute significantly to BSAI Pacific ocean perch mortality since bycatch is not expected in this fishery. Therefore, the IPHC longline fishery is also not expected to cause significant changes in biomass levels. Marine pollution is identified as making a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to Pacific ocean perch change in biomass levels as a function of reproductive success.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as significantly beneficial. The combination of internal and external factors is expected to increase the biomass toward levels that will enhance the ability of the stock to maintain itself at or above MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Due to the reduction in the groundfish fishery effort and the establishment of no-take zones, FMP 4.1 and FMP 4.2 is found to have a significantly beneficial effect on the reproductive success and insignificant effects on the genetic structure of BSAI Pacific ocean perch.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure . However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.11) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to changes in genetic structure or reproductive success of BSAI Pacific ocean perch since bycatch of BSAI Pacific ocean perch is not expected to occur. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. Generally, changes in climate that lead to increased advection of the Alaska current are believed to increase euphausiid production, a major prey item of BSAI Pacific ocean perch. Climate changes and regime shifts are not considered to contribute to changes in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of BSAI Pacific ocean perch and is rated as significantly beneficial. The genetic structure of BSAI Pacific ocean perch is not expected to be effected significantly; however, the reproductive success of the BSAI Pacific ocean perch is expected to increase, mainly due to the reduction of the groundfish fishery effort.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 would have an insignificant effect on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific ocean perch prey species (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific ocean perch prey species are identified as potential beneficial or adverse contributors. In general, it is believed that climate changes and regime shifts that lead to the increased advection of the Alaska current also increase production of euphausiids, a major prey item of BSAI Pacific ocean perch. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to increase prey availability such that the ability of Pacific ocean perch stock to sustain itself at or above MSST is enhanced.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for BSAI Pacific ocean perch stocks include past foreign, JV, and domestic fisheries, IPHC longline fisheries and climate changes and regime shifts (see Section 3.5.1.11). Intense bottom trawling on Pacific ocean perch habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries are also identified as having adverse effects on Pacific ocean perch habitat, although these fishing gear impacts are considered to be less significant than those associated with trawl gear (see Section 3.6). Climate changes and regime shifts have had both beneficial and adverse effects on Pacific ocean perch habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is identified as making adverse contributions to Pacific ocean perch habitat through fishing gear impacts. As stated above, these impacts are expected to be of lesser magnitude than those effects associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific ocean perch stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is enhanced.

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass and Fishing Mortality

FMP 4.1 would reduce catch of GOA Pacific ocean perch because it changes the biological reference point for determining rockfish F_{ABC} from $F_{40\%}$ to $F_{75\%}$ and further adjusts F_{ABC} downward as a function of the coefficient of variation of the mean survey biomass. FMP 4.1 also eliminates fisheries with more than 33 percent bycatch, which might redistribute the Pacific ocean perch fishery if it has a high bycatch rate. Average fishing mortality during the years 2003 - 2008 is expected to be less than F_{OFL} (0.060) (Table H.4-36 and Figure H.4-15 of Appendix H).

FMP 4.2 would eliminate catch of GOA Pacific ocean perch until it could be proven that fishing for GOA Pacific ocean perch would have no adverse effect on the environment. Consequently, average fishing mortality during the years 2003 - 2008 is expected to be less than F_{OFL} (0.060) (Table H.4-36 and Figure H.4-15 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 4.1 may potentially have a large impact on the spatial concentration of Pacific ocean perch catch if 20 percent to 50 percent of the GOA is set aside as no-take reserves or as MPAs. The Pacific ocean perch fishery is concentrated in slope areas which cover a small geographic area in the GOA. The proposed MPAs cover large portions of Portlock, Albatross, and Shumagin Banks and the "W" grounds west of Yakutat, all of which are major fishing grounds for Pacific ocean perch. Much of the past fishing effort concentrated on these proposed closure areas. If the proposed MPAs are closed to all bottom trawling, then the effects of FMP 4.1 would likely displace fishing effort to other localities. Whether this displacement would result in spreading out the fishing effort over a wider area, or would merely concentrate the effort in new localities depends on the decisions made by the NPFMC. If effort based management and the reduced fishing mortality proposed under FMP 4.1 are adopted then adoption of the MPAs is not likely to result in localized depletions.

FMP 4.1 would also have large effects on the temporal concentration of Pacific ocean perch catch. If the fishery remained a relatively short open-access type fishery, then the closure of major fishing areas may alter catch rates enough that more time is necessary to catch the ABC. If effort-based management is adopted under FMP 4.1, then the Pacific ocean perch trawl fishery would change from a short open-access fishery. This would likely allow directed Pacific ocean perch fishing to continue over a longer time period, which may allow better management oversight of the fishery and reduce the risk of overharvesting.

Under FMP 4.1, fisheries with more than 33 percent bycatch would be eliminated which could also change the distribution of fishing effort for GOA Pacific ocean perch if the bottom trawl fishery for Pacific ocean perch has high bycatch rates.

Fishing mortality for FMP 4.2 is zero, so there is no spatial or temporal concentration of fishing.

Status Determination

Under FMP 4.1, the projected 2003 biomass of 113,800 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected 2005 biomass of 119,200 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Under FMP 4.2, the projected 2003 biomass of 114,100 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected 2005 biomass of 121,600 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition

Under FMP 4.1 and FMP 4.2, the age composition of GOA Pacific ocean perch may be affected by fishing mortality as in FMP 1. Size composition of GOA Pacific ocean perch might change in proportion to the change in age composition. Age and size composition could also change if the elimination of fisheries with high bycatch rates substantially change the distribution of Pacific ocean perch fishing effort.

Sex Ratio

No information is available to suggest that the sex ratio would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Under FMP 4.1, damage to epifauna by bottom trawls would likely be reduced under less fishing pressure and result in less impact on juvenile Pacific ocean perch habitat. FMP 4.1 may also have a beneficial effect on the habitat of GOA Pacific ocean perch because it proposes to set aside 20 percent to 50 percent of the GOA as no-take reserves or as MPAs. If these MPAs are closed to all bottom trawling, then they may serve as additional refuge for Pacific ocean perch allowing for increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. If these MPAs are closed to all bottom trawling, then they would also provide protection from the potential effects of trawling on juvenile rockfish habitat in these areas.

Under FMP 4.2 further damage to epifauna by bottom trawls would be eliminated and result in no impact on juvenile Pacific ocean perch habitat. FMP 4.2 also provides a de facto no-take zone or refuge for GOA Pacific ocean perch in the stock's entire range.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under FMP 4.1 or FMP 4.2.

Summary of Direct/Indirect Effects of FMP 4.1 – GOA Pacific Ocean Perch

Under FMP 4.1 and FMP 4.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 4.1 and FMP 4.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability are believed to have an insignificant impact on stock sustainability (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of GOA Pacific ocean perch are summarized in Table 4.5-21.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific ocean perch stock is insignificant under FMP 4.1 and FMP 4.2 (Section 3.5.1.24).

- **Persistent Past Effects.** Past effects on mortality are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Cumulative Effects.** A cumulative effect under FMP 4.1 and FMP 4.2 is identified for mortality of GOA Pacific ocean perch and is rated as insignificant. Pacific ocean perch are fished below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific ocean perch stock is expected to be insignificant under FMP 4.1 and FMP 4.2 (Section 3.5.1.24).

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial/temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 would have an insignificant effect on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

4.8.1.12 Thornyhead Rockfish

GOA thornyhead rockfish are described in more detail in Section 3.5.1.23 of this Programmatic SEIS. Until recently, thornyhead rockfish were managed as its own stock under the GOA groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2004, thornyhead rockfish will be managed under Tier 5, however, for the purposes of this analysis, thornyhead rockfish were modeled under Tier 3.

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total Biomass

Total (ages 5 through 55+) biomass of GOA thornyheads at the start of 2002 is estimated to be 54,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-37 of Appendix H. Under FMP 4.1, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then increase to a value of 59,000 mt by 2007, with a 2003-2007 average value of 56,000 mt. Under FMP 4.2, model projections indicate that total GOA biomass is expected to remain at 54,000 mt by 2003, then increase to a value of 60,000 mt by 2007, with a 2003-2007 average value of 57,000 mt.

Spawning Biomass

Spawning biomass of female GOA thornyheads at the start of 2002 is estimated to be 23,500 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-37 of Appendix H. Under FMP 4.1, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and increasing to 25,800 mt by 2007, with a 2002-2007 average value of 24,700 mt. Under FMP 4.2, model projections indicate that GOA spawning biomass is expected to increase to a value of 23,600 mt by 2003, and increasing to 26,400 mt by 2007, with a 2002-2007 average value of 25,000 mt.

Fishing Mortality

The average fishing mortality imposed on the GOA thornyhead stock in 2002 is projected to be 0.032 under current management. Under FMP 4.1, fishing mortality is projected to decrease to 0.006 in 2003 and remain at 0.066 throughout the projection period until 2007 (Table H.4-37 of Appendix H). Under FMP 4.2, fishing mortality is projected to decrease to 0.0 beginning in 2003 and continuing for all projection years through 2007 (Table H.4-37 of Appendix H). These values are well below the F_{MSY} proxy value of 0.102 which is the rate associated with the OFL.

Spatial/Temporal Concentration of Fishing Mortality

Thornyhead catch is divided approximately evenly between longliners and trawlers under status quo management. Under FMP 4.1, there would be no more trawling for thornyheads because it is possible to catch them on longlines, and some portions of thornyhead habitat would be set aside as no-take marine reserves. At present, longline catches are spatially dispersed along the continental shelf break throughout the GOA (Figure 4.5-1), and temporally dispersed due to the nature of the IFQ sablefish fishery. For example, longline thornyhead catches in 2000 occurred year-round, with peaks in April and September which did not exceed 60 mt per week. Trawler catch (which is eliminated under this FMP) has been more concentrated in time, with some catches of 20-40 mt per week happening in late spring and a single large peak of 160 mt per week in 2000 during July, coincident with the rockfish trawl fishery. Between 1997 and 1999, trawl thornyhead catches appear to have become more concentrated in space (Figure 4.5-2). The distribution of thornyheads from surveys did not appear to change over the same time period (Figure 4.5-3). This apparent concentration may be the indirect result of changes in the trawl fisheries for deepwater flatfish and rockfish since thornyheads are not a primary target of trawl fisheries. However, it should be noted that the overall catch of thornyheads is low relative to both the estimated biomass and the ABC, such that this apparent concentration of catch is unlikely to have any adverse population effects. By the same token, the alleviation of this apparent concentration provided under FMP 4.1 is unlikely to have any beneficial population effects. Since thornyheads are taken as bycatch in sablefish longline fisheries, the additional no-take marine reserves implemented under FMP 4.1 are expected to result in the same level of concentration of catch as predicted for sablefish (see Section 4.8.1.3).

Since the fisheries are suspended under FMP 4.2, the spatial/temporal concentration of fishing mortality is not considered.

Status Determination

The GOA thornyhead stock is not overfished. At 23,500 mt, spawning stock biomass is expected to be well above both $B_{35\%}$ level (14,681 mt) as well as the $B_{40\%}$ level (16,045 mt) in the year 2002 and will remain above $B_{40\%}$ in all projection years under FMP 4.1 and FMP 4.2.

Age and Size Composition

Under FMP 4.1, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.50 years. Under FMP 4.2, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-37 of Appendix H), is 10.63 years. This compares with a mean age in the equilibrium unfished GOA stock of 12.67 years.

Sex Ratio

The sex ratio of GOA thornyheads is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 and FMP 4.2.

Habitat-Mediated Impacts

Under FMP 4.1, all current management measures would be maintained, and more closures would be added. Under FMP 4.2, the groundfish fisheries would be suspended. The level of habitat disturbance under FMP 1 does not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST, so the similar to lower level of habitat disturbance under FMP 4.1 and FMP 4.2 may not result in any perceptible population effects. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Predation-Mediated Impacts

In the GOA shortspine thornyheads prey on benthic invertebrates; according to the AFSC food habits database, much of their diet in the 1990s has been composed of shrimp. Thornyheads are rare in the diets of other groundfish, birds, or marine mammals in the GOA according to the present limited information. Therefore, the effects of status quo federal groundfish fisheries on trophic interactions involving GOA thornyheads are expected to be minor. The current levels and distribution of groundfish harvest do not appear to impact prey availability for thornyheads such that it affects the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under FMP 4.1 and FMP 4.2.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Thornyhead Rockfish

The GOA thornyhead stock appears to be healthy and stable under current management, and catches have generally been below the estimated ABCs because thornyheads are taken as bycatch in other directed fisheries. Thornyheads are thought to be widely distributed in the deeper habitats of the GOA, where fishing impacts have historically been low. As long as catches remain at or near the currently observed low levels, as predicted under FMP 4.1 and FMP 4.2, no significant population effects are expected to thornyheads (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of GOA thornyhead rockfish are summarized in Table 4.5-22.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA thornyhead rockfish is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. The removals of thornyhead rockfish that occurred in these fisheries have had a lingering adverse effect on the populations (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of thornyhead rockfish. The IPHC longline fishery is identified as a potential adverse contributor to thornyhead rockfish mortality since they are caught as bycatch in this fishery. However, the state shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA thornyhead rockfish and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass Level</u>

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 is expected to result in insignificant effects to these stocks.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. Past removals by these fisheries have had a lingering adverse effect on the GOA thornyhead rockfish populations (see Section 3.5.1.23).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass levels are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the thornyhead rockfish biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.23 and 3.10). The IPHC longline fishery is identified as a potential adverse contributor to the thornyhead rockfish biomass level since they are caught as bycatch in this fishery. The State of Alaska shrimp fishery is identified as a non-contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA thornyhead rockfish and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA thornyhead rockfish. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of GOA thornyhead rockfish. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the thornyhead rockfish stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of thornyhead rockfish due to climate changes and regime shifts are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA thornyhead rockfish. The IPHC longline fishery removals could be sufficiently concentrated as to alter the genetic structure and reproductive success of GOA thornyhead rockfish populations and is therefore identified as a potential adverse contributor. The state shrimp fishery is identified as a non-contributing factor since bycatch of thornyhead rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the thornyhead rockfish catch and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do effect the availability of some prey species (i.e. shrimp); however, studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is identified as a non-contributing factor since bycatch of GOA thornyhead rockfish prey species is not expected to occur in this fishery. The state shrimp fishery is identified as a potential adverse contributor to prey availability since removal of shrimp, the main prey species of GOA thornyhead rockfish, occurs in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA thornyhead rockfish include climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery has been identified as a potential adverse contributor to GOA thornyhead rockfish habitat suitability. See Section 3.6 for information on the impacts of fishery gear on essential fish habitat. The state shrimp fishery is identified as a non-contributing factor since habitat degradation by the shrimp fishery gear is not expected to occur.

- **Cumulative Effects.** A cumulative effect is identified for GOA thornyhead rockfish habitat suitability and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the thornyhead rockfish stock to sustain itself at or above the MSST is jeopardized.

4.8.1.13 Rockfish

Rockfish are described in more detail in Sections 3.5.1.12 through 3.5.1.14 and 3.5.1.24.

BSAI Northern Rockfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for this species.

Fishing Mortality

The catch of BSAI northern rockfish in 2003 was estimated as 1,200 mt. Projected catches from 2003-2008 are shown in Table H.4-15 of Appendix H. Under FMP 4.1, model projections indicate that the catch is expected to decrease to 2,600 mt in 2006, and remain at this level through 2008. The 2003-2008 average catch is 1,500 mt.

Under FMP 4.2, the projected TAC has been set to zero for all species unless the harvesting of a species has been shown to have no adverse effect on the environment. Thus, there is no harvest of BSAI northern rockfish from 2003-2008 (Table H.4-15 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Model projections indicate that the average harvest of 1,500 mt from 2003-2008 occurs largely in the eastern Aleutian Islands (1,300 mt, 87 percent), and the harvest in this area occurs largely in the Atka mackerel fishery. Under FMP 4.2, there is no projected fishing mortality.

Status Determination

The catch rates are below the ABC and OFL values for all years. The MSST cannot be determined.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for this species. The sex ratio of BSAI northern rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat- mediated impacts would undergo significant qualitative change under FMP 4.1 or FMP 4.2. Given the low level of exploitation by the groundfish fisheries under these FMPs, the effects of FMP 4.1 and FMP 4.2 on BSAI northern rockfish through habitat suitability are considered insignificant.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 4.1 or FMP 4.2. Given the low level of exploitation by the groundfish fisheries under these FMPs, the effects of FMP 4.1 and FMP 4.2 on BSAI northern rockfish through prey availability are considered insignificant.

Summary of Effects of FMP 4.1 and FMP 4.2 – BSAI Northern Rockfish

A significant feature of FMP 4.1 is the lowering of ABC levels for rockfish. For northern rockfish, the ABC was assumed to be 1,600 mt, a decrease from the baseline value of 9,500 mt in 2002. Because the BSAI northern rockfish are fished at less or equal to the ABC, the direct and indirect effects under FMP 4.1 are considered insignificant. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity.

With the removal of harvesting of BSAI northern rockfish, the direct and indirect effects under FMP 4.2 are considered insignificant (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of BSAI northern rockfish are summarized in Table 4.5-23.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI northern rockfish is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.12).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of northern rockfish. The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI northern rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of changes in biomass level is rated as insignificant due to the significant reduction in groundfish fishery effort.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI northern rockfish (see Section 3.5.1.12).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the northern rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.12 and 3.10. The IPHC longline fishery is identified as a non-contributing factor since bycatch of BSAI northern rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI northern rockfish and is determined to be insignificant. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>
 – Change in Genetic Structure of Population
 – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is determined to be insignificant due to the significant reduction in groundfish fishery effort.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI northern rockfish. Climate changes and regime shifts are identified as having a potential beneficial or adverse effect on BSAI northern rockfish (see Sections 3.5.1.12 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of northern rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of northern rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI northern rockfish. The IPHC longline fishery has been identified as a non-contributing factor to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the northern rockfish catch and is rated as insignificant. The combined effect of internal and external removals is not expected to be of a concentration that would change the reproductive success or genetic diversity such that it jeopardizes the ability of the BSAI northern rockfish stock to sustain current population levels.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the BSAI northern rockfish is determined to be insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Climate changes and regimes shifts have been identified as having had effected the prey availability of the BSAI northern rockfish stock. The actual effect of climate changes and regime shifts on northern rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect. See Sections 3.5.1.12 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of northern rockfish prey species occurs in this fishery. See Section 3.5.1.12 for more information on the trophic interactions of BSAI northern rockfish species.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is rated as insignificant. The combined effect of internal and external removals of prey species is not expected to jeopardize the ability of the BSAI northern rockfish stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the BSAI northern rockfish is insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past effects identified for BSAI northern rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in northern rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on northern rockfish species habitat suitability, possibly having disrupted northern rockfish species spawning and/or rearing habitats. See Section 3.5.1.12 for more information on the past events that have effected northern rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the northern rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt northern rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is identified for the change in habitat suitability. The combined internal and external effects are unlikely to make the BSAI northern rockfish stock vulnerable to spawning and rearing habitat disturbances due to fishing gear.

BSAI Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these stocks.

Fishing Mortality

The projected catch of BSAI shortraker/rougheye rockfish was 100 mt in each year from 2003 to 2008. Projected catches from 2003-2008 are shown in Table H.4-16 of Appendix H. Under FMP 4.2, the projected TAC has been set to zero for all species unless the harvesting of a species has been shown to have no adverse effect on the environment. Thus, there is no harvest of BSAI shortraker/rougheye rockfish from 2003-2008 (Table H.4-16 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Model projections indicate that the average harvest of 100 mt from 2003-2008 occurs largely in the EBS, with 90 mt (70 percent) of the harvest. Within this area, most of the shortraker/rougheye harvest is taken in the sablefish longline fishery. Under FMP 4.2, there is no projected fishing mortality.

Status Determination

The catch rates are below the ABC and OFL values for all years. The MSST for these stocks is unable to be determined.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. The sex ratio of BSAI shortraker/rougheye rockfish is assumed to be 50:50. No information is available to suggest that this would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under FMP 4.1 or FMP 4.2. Given the low level of exploitation by the groundfish fisheries under these FMPs, the effects of FMP 4.1 and FMP 4.2 on BSAI shortraker/rougheye rockfish through habitat suitability are considered insignificant.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of FMP 4.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under FMP 4.1. Given the low level of exploitation by the groundfish fisheries under these FMPs, the effects of FMP 4.1 and FMP 4.2 on BSAI shortraker/rougheye rockfish through prey availability are considered insignificant.

Summary of Effects of FMP 4.1 – BSAI Shortraker/Rougheye Rockfish

A significant feature of FMP 4.1 is the lowering of ABC levels for rockfish. For shortraker/rougheye rockfish, the ABC was assumed to be 100 mt. Because the BSAI shortraker/rougheye rockfish are fished at this low ABC level, the direct and indirect effects under FMP 4.1 are considered insignificant. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity.

With the removal of harvesting of BSAI shortraker/rougheye rockfish, the direct and indirect effects under FMP 4.2 are considered insignificant (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of BSAI shortraker/rougheye rockfish are summarized in Table 4.5-24.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI shortraker/rougheye rockfish is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and the state shrimp fishery are identified as non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI shortraker/rougheye rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of changes in biomass level is rated as insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.13 and 3.10). The IPHC longline fishery and the state shrimp fishery are identified as a non-contributing factors since bycatch of BSAI shortraker/rougheye rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI shortraker/rougheye rockfish and is rated as insignificant. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

- *Change in Genetic Structure of Population*
- *Change in Reproductive Success*

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the spatial/temporal concentration of catch is insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI shortraker/rougheye rockfish. Climate changes and regime shifts are identified as having a potential beneficial/adverse effect on BSAI shortraker/rougheye rockfish (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of shortraker/rougheye rockfish due to climate changes and regime shifts are potential beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of shortraker/rougheye rockfish. Marine pollution has been identified as a potential adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI shortraker/rougheye rockfish. The IPHC longline fishery and state shrimp fishery have been identified as non-contributing factors to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal characteristics of shortraker/rougheye rockfish and is determined to be insignificant. The combined effect of internal and external removal is unlikely to be of a concentration that would lead to change in the genetic diversity or genetic structure of the stocks such that it jeopardizes the ability of the stocks to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the BSAI shortraker/rougheye rockfish is insignificant due to the reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI shortraker/rougheye rockfish stock. The actual effect of climate changes and regime shifts on shortraker/rougheye rockfish prey availability is unknown, but could have had a potential beneficial or adverse effect. See Sections 3.5.1.13 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery has been identified as a non-contributing factor since it is unlikely that bycatch of shortraker/rougheye rockfish prey species occurs in this fishery. The state shrimp fishery is identified as a potential adverse contributor to BSAI shortraker/rougheye prey availability since shrimp is one of the main prey species of rougheye rockfish. See Section 3.5.1.13 for more information on the trophic interactions of BSAI shortraker/rougheye rockfish species.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability and is rated as insignificant. The combined effect of internal and external removals is unlikely to change prey availability such that it jeopardizes the ability of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the BSAI shortraker/rougheye rockfish is insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past effects identified for BSAI shortraker/rougheye rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potential beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in shortraker/rougheye rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on shortraker/ rougheye rockfish species habitat suitability, possibly having disrupted shortraker/rougheye rockfish species spawning and/or rearing habitats. The state shrimp fishery is identified as a non-contributing factor to shortraker/rougheye rockfish habitat suitability since habitat degradation by shrimp fishery gear is not expected to occur. See Section 3.5.1.13 for more information on the past events that have effected shortraker/rougheye rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potential adverse effect on the shortraker/rougheye rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt shortraker/rougheye rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect for habitat suitability is identified as insignificant. The combined effect of external and internal habitat disturbances are unlikely to lead to a change in spawning or rearing success such that it materially impacts the ability of the stock to maintain current population levels.

BSAI Other Rockfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

The projected catch of other rockfish species was 100 mt in each year from 2003 to 2008 in each of the Aleutian Islands and EBS subareas. Projected catches from 2003-2008 are shown in Tables H.4-13 and H.4-14 of Appendix H. This example FMP would require that these species be split out if possible and assigned species-specific ABCs. Until then, the other rockfish TAC would be based on the least abundant member of the assemblage. In addition, this FMP would require that a $F_{75\%}$ exploitation rate be used in determining ABCs.

The 2003 OFL for this species complex is 846 mt and 1,280 mt in the Aleutian Islands and EBS, respectively (Reuter and Spencer 2002). Fishing mortality at projected levels under FMP 4.1 is well below the OFL for other rockfish, so FMP 4.1 is not likely to result in any significantly adverse impacts to these stocks. Reduced mortality of other rockfish species would likely benefit the population over time but determining such benefits cannot be made at this time due to insufficient information. A reduced TAC would eliminate any directed fishery for other rockfish species in the BSAI. All other rockfish would be placed on "bycatch-only" status and could significantly constrain other groundfish and the halibut fishery if managers were to strictly limit the bycatch of other rockfish.

Under FMP 4.2, the projected TAC would be temporarily set to zero for all BSAI other rockfish species unless the harvesting of a species can be shown to have no adverse effect on the environment. Other rockfish species are long lived, slow growing fishes. Temporary suspension of fishing would provide only marginal benefits to these stocks assuming the suspension is within two years. Thus, we assume there is no fishing mortality of BSAI other rockfish from 2003-2008, in our analysis (Tables H.4-13 and H.4-14 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

In the Aleutian Islands, 93 percent of the average harvest of 100 mt occurs in the eastern Aleutian Islands, taken largely in the sablefish longline fishery. The sablefish longline fishery also accounts for most of the catch of EBS other rockfish. Bycatch of other rockfish species would be reduced under FMP 4.1 due to reductions in sablefish TAC. Therefore, we conclude that the spatial/temporal effects of groundfish fishing under FMP 4.1 will be insignificant to the current population status of the other rockfish category.

Under FMP 4.2, there is no projected fishing mortality, so there would be no concentration of harvest and no significant impact to other rockfish stocks.

Status Determination

The fishing mortality rates are below the ABC and OFL values for all years. The MSST is unable to be determined.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. Estimated sex ratios are not available for these species.

Habitat-Mediated Impacts

Any habitat suitability impacts of FMP 4.1, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing would be governed by a complex web of direct and indirect interactions which are difficult to quantify. FMP 4.1 includes establishing a network of MPAs along the continental shelf and slope of Alaska. It is unclear what benefits other rockfish species may receive from the illustrated closures. Regardless, at the low level of harvest authorized by this FMP, it can be concluded that there would be no significant effects on other rockfish habitat suitability indexes as a result of FMP 4.1.

Under FMP 4.2, the groundfish fisheries would be suspended. As with FMP 4.1, it is unclear what benefits other rockfish species may receive from the fishery closures, however, it can be concluded that there would be no significant effects on other rockfish habitat suitability under FMP 4.2.

Predation-Mediated Impacts

As with habitat suitability impacts, any effect of FMP 4.1 and FMP 4.2 on predator-prey relationships would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude whether trophic interactions would undergo any significant change under the FMP 4.1 or FMP 4.2. Given the low level of exploitation by the groundfish fisheries under these FMPs, the effects of FMP 4.1 and FMP 4.2 on BSAI other rockfish species through prey availability are considered insignificant.

Summary of Effects of FMP 4.1 – BSAI Other Rockfish

A significant feature of FMP 4.1 is the lowering of ABC levels for rockfish. For other rockfish, the Aleutian Islands and EBS ABCs were assumed at 100 mt and 200 mt, respectively. The model projections indicate that the other rockfish are fished at such a low level, and well below the OFL. An additional feature of FMP 4.1 is the specification of MSST levels for all stocks. With the MSST specification, two outcomes are possible regarding stock biomass: 1) the stock biomass may be determined to be above the MSST level, in which case the MSST specification may not change management practices, or 2) the stock biomass may be determined to be below the MSST level, in which case a rebuilding plan would be enacted in order to enhance the ability of the stock to move above the MSST level. Thus, the effect of FMP 4.1 on stock biomass is considered as either insignificant or significantly beneficial. Because the other rockfish species would be managed under FMP 4.1 to be above the MSST level, the remaining direct and indirect effects of fishing under FMP 4.1 are considered insignificant.

Under FMP 4.2, all directed fishing would be prohibited unless it could be shown that fishing activity would not adversely affect the environment. Under this scenario, fishing for other rockfish would not be allowed unless it is clear that the direct and effects would be insignificant. For stocks below the MSST, the suspension of fishing activities may have a significantly beneficial effect by enhancing the ability of the stock to rebuild to levels above the MSST (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of BSAI other rockfish are summarized in Table 4.5-25.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other rockfish is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of changes in biomass level is determined to be insignificant due to the reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those described for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those described for BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI other rockfish and is determined to be insignificant. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the fisheries on the spatial/temporal characteristics of BSAI other rockfish is rated as insignificant due to the reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI other rockfish catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure are the same as those described for BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal characteristics of other rockfish and is rated as insignificant. Bycatch under FMP 4.1 would be reduced due to reduction in sablefish TAC. Under FMP 4.2, the groundfish fisheries would be suspended. The combined effect of internal removals and removals due to reasonable foreseeable external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in prey availability for the BSAI other rockfish is determined to be insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past effects on the change in prey availability are the same as those described for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability are the same as those described for BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect for change in prey availability and is identified as insignificant. Future harvest levels are unlikely to lead to a change in prey availability such that it jeopardizes that ability of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the change in habitat suitability for the BSAI other rockfish is ranked as insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past effects on the change in habitat suitability are the same as those described for BSAI shortraker/rougheye rockfish under these FMPs.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability are the same as those described for BSAI shortraker/rougheye rockfish under these FMPs.

- **Cumulative Effects.** A cumulative effect is identified for the change in habitat suitability and is rated as insignificant. The reduced groundfish fishing effort and associated gear impacts and the establishment of MPAs proposed by this FMP, in combination with the past persistent and reasonably foreseeable future effects are not expected to produce levels of habitat disturbance that would lead to a detectable change in spawning or rearing success such that it jeopardizes the capacity of the stocks to maintain current population levels.

GOA Northern Rockfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass and Fishing Mortality

FMP 4.1 would reduce catch of GOA northern rockfish because it changes the biological reference point for determining rockfish F_{ABC} from $F_{40\%}$ to $F_{75\%}$ and further adjusts F_{ABC} downward as a function of the coefficient of variation of the mean survey biomass. FMP 4.1 also eliminates fisheries with more than 33 percent bycatch, which might redistribute or reduce the bycatch of northern rockfish in the Pacific ocean perch fishery. Average fishing mortality during the years 2003 to 2008 is expected to be less than F_{OFL} (0.066) (Table H.4-35 of Appendix H).

FMP 4.2 would eliminate catch of GOA northern rockfish until it could be proven that fishing for GOA northern rockfish would have no adverse effect on the environment. Consequently, average fishing mortality during the years 2003 to 2008 is expected to be less than F_{OFL} (0.066) (Table H.4-35 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 4.1 may potentially have a large effect on the spatial concentration of northern rockfish catch if 20 percent to 50 percent of the GOA is set aside as no-take reserves or as MPAs. The proposed MPAs cover large portions of Portlock Bank, Albatross Bank, and Shumagin Bank, all of which are major fishing grounds for northern rockfish. Much of the past fishing effort concentrated on these proposed closure areas. In particular, one area known as the Snakehead accounted for 45.8 percent of all GOA northern rockfish catches from 1990 to 1998 (Clausen and Heifetz in preparation.). The proposed closure areas appear to substantially overlap the Snakehead. Assuming that catches from 1990 to 1998 are representative of the true distribution of GOA northern rockfish and that this distribution is stable, the closure area could effectively reduce the size of the GOA northern rockfish population available to fishing pressure by at least 45.8 percent relative to no closures. If the proposed MPAs are closed to all bottom trawling, then fishing effort would likely be displaced to other localities. Whether this displacement would result in spreading out the fishing effort over a wider area, or would merely concentrate the effort in new localities depends on the decisions made by the NPFMC. If effort-based management and the reduced fishing mortality proposed under FMP 4.1 are adopted, then adoption of the MPAs is not likely to result in localized depletions.

FMP 4.1 would also have a substantial effect on the temporal concentration of northern rockfish catch. If the fishery remained a relatively short open-access type fishery, then the closure of major fishing areas may alter catch rates enough that more time is necessary to catch the ABC. If effort-based management is adopted under FMP 4.1, then the northern rockfish trawl fishery would change from a short open-access fishery. This would likely allow directed northern rockfish fishing to continue over a longer time-period, which may allow better management oversight of the fishery and reduce the risk of overharvesting.

Under FMP 4.1, fisheries with more than 33 percent bycatch would be eliminated, which could also change the distribution of fishing effort for GOA northern rockfish.

Fishing mortality for FMP 4.2 is zero, so there is no spatial or temporal concentration of fishing.

Status Determination

Under FMP 4.1, the projected 2003 biomass of 42,700 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected 2005 biomass of 41,200 mt for FMP 4.1, and 40,800 mt for FMP 4.2, are greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition and Sex Ratio

Under FMP 4.1 and FMP 4.2, the age composition of GOA northern rockfish may be affected by fishing mortality as in FMP 1. Size composition of GOA northern rockfish might change in proportion to the change in age composition. Age and size composition could also change if the elimination of fisheries with high bycatch rates substantially change the distribution of fishing effort. No information is available to suggest that sex ratio would change under FMP 4.1 or FMP 4.2.

Habitat-Mediated Impacts

Under FMP 4.1 damage to epifauna by bottom trawls would likely be reduced under less fishing pressure and result in less impact on juvenile northern rockfish habitat. FMP 4.1 may also have a beneficial effect on the habitat of GOA northern rockfish because it proposes to set aside 20 percent to 50 percent of the GOA as no-take reserves or as MPAs. If these MPAs are closed to all bottom trawling, then they may serve as refuge for northern rockfish allowing for increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. If these MPAs are closed to all bottom trawling, then they would also provide protection from the potential effects of trawling on juvenile rockfish habitat in these areas.

Under FMP 4.2 further damage to epifauna by bottom trawls would be eliminated and result in no impact on juvenile northern rockfish habitat. FMP 4.2 would also provide a de facto no-take zone or refuge for GOA northern rockfish in their entire range.

Given the low level of exploitation by the groundfish fisheries under these FMPs, the effects of FMP 4.1 and FMP 4.2 on GOA northern rockfish through habitat suitability are considered insignificant.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under FMP 4.1 or FMP 4.2. Given the low level of exploitation by the groundfish fisheries under these FMPs, the effects of FMP 4.1 and FMP 4.2 on GOA northern rockfish through prey availability are considered insignificant.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Northern Rockfish

Under FMP 4.1 and FMP 4.2, average fishing mortality during the years 2003 - 2008 is expected to be less than or equal to F_{OFL}. Consequently fishing mortality is believed to have an insignificant impact on stock sustainability. Under FMP 4.1 and FMP 4.2, the stock is projected to sustain itself at or above MSST. Consequently change in biomass is believed to have an insignificant impact on stock sustainability. Additionally, because the stock is projected to sustain itself at or above MSST, the direct effects of spatial/temporal concentration of catch on change in genetic integrity and reproductive success, as well as the indirect effects of both the change in prey availability and the change in habitat suitability are believed to have an insignificant impact on stock sustainability (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of GOA northern rockfish are summarized in Table 4.5-26.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA northern rockfish stock is insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries is identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to northern rockfish mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA northern rockfish and is rated as insignificant. Northern rockfish are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA northern rockfish stock is expected to be insignificant under FMP 4.1 and FMP 4.2 due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past effects of the past foreign fisheries is identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as making beneficial or adverse contributions to northern rockfish change in biomass levels as a function of change in reproductive success.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the northern rockfish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** The fisheries should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.24) for change in reproductive success.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management and is not expected to contribute to changes in genetic structure or reproductive success of northern rockfish. Marine pollution is identified as having a potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. The magnitude and direction of the change in reproductive success with water temperatures is currently unknown. Climate changes and regime shifts are not considered to be contributors to change in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal characteristics of GOA northern rockfish and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 would have insignificant effects on northern rockfish prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on northern rockfish prey species (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since northern rockfish prey species bycatch is not expected to occur. Climate changes and regime shifts are identified as making potential beneficial or adverse contributions on prey availability, although the magnitude and the direction of change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a reasonably foreseeable future external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for prey availability and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the northern rockfish stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** FMP 4.1 and FMP 4.2 would have insignificant effects on northern rockfish habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA northern rockfish stocks include past foreign, JV, and domestic fisheries, IPHC longline fishery, and climate changes and regime shifts (see Section 3.5.1.24). Intense bottom trawling on northern rockfish habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries have also been identified as having adverse effects on northern rockfish habitat, although these effects are not expected to have been as intense as those effects associated with trawl gear (see Section 3.6). Climate changes and regime shifts have had both beneficial and adverse effects on northern rockfish habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has been identified as an adverse contributing factor since the fishery gear could disrupt spawning and/or rearing habitats. Although, as stated above, the impacts associated with longline gear are not as significant as those associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the GOA northern rockfish stock are identified as potential beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potential adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the northern rockfish stock to sustain itself at or above MSST is jeopardized.

GOA Shortraker/Rougheye Rockfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter.

Fishing Mortality

This bookend is much more precautionary in its approach than the baseline situation or any of the other FMPs, with the exception of FMP 4.2. FMP 4.1 would have a significant impact on catch of shortraker/ rougheye because it includes a measure that changes the biological reference point for determining rockfish ABCs from the $F_{40\%}$ baseline to the much more conservative value of $F_{75\%}$. Using $F_{75\%}$ would substantially reduce the ABC value for shortraker/rougheye, which in turn would result in a large decrease in catch. Therefore, FMP 4.1 would greatly minimize the risk of overfishing shortraker/rougheye. One other measure in FMP 4.1 that would affect catch of shortraker/rougheye is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of shortraker/rougheye, thereby providing even greater protection against overfishing. The bycatch model projections for FMP 4.1 show shortraker/rougheye catch reductions of 70 percent compared to FMP 1 (the present management regime), and the projected catches are approximately 80 percent less than has been taken by the fishery in recent years. The projections appear reasonable given the stringent precautionary measures of this bookend (Table H.4-34 of Appendix H).

FMP 4.2 sets ABC equal to zero for all species in the GOA, so catch projections for shortraker/rougheye also become zero for all years (Table H.4-34 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 4.1 would have a great effect on the spatial/temporal concentration of shortraker/rougheye catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, FMP 3.1, and FMP 3.2. The spatial distribution of the catch would change substantially because FMP 4.1 sets aside between 20 percent and 50 percent of the GOA as no-take reserves or as MPAs. No-take reserves in this bookend cover large portions of the GOAs continental slope inhabited by shortraker and rougheye rockfish, including many important fishing grounds. Much of the past catch of shortraker/rougheye has been taken from the areas of the proposed reserves, so FMP 4.1 would displace this catch to other localities. This displacement would concentrate the catch in new localities, and it would likely be necessary to proportionately reduce TACs in the areas that remained open in order to prevent localized depletion of the resource.

Another important aspect of FMP 4.1 is that overcapacity problems in all fisheries would be addressed by adopting measures such as trip limits and LLPs. Such measures would especially affect trawl fisheries, and these fisheries would become less intense and more spread out in time. This would allow better management oversight of trawl fisheries and reduce of the risk of over-harvesting shortraker/rougheye.

Fishing mortality for FMP 4.2 is zero, so there is no spatial or temporal concentration of fishing.

Status Determination

The catch rates are below the ABC and OFL values. The MSST cannot be calculated for this stock.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter. There is no information on the sex ratio of shortraker/rougheye, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 4.1 or FMP 4.2 is unknown.

Habitat-Mediated Impacts

Because FMP 4.1 creates a series of large no-take reserves across the GOA, it would likely provide substantial habitat benefits to shortraker/rougheye. No-take reserves in this bookend cover large portions of the GOAs continental slope inhabited by shortraker and rougheye rockfish, including many important fishing grounds where these species appear to be especially abundant. The reserves may protect a significant portion of the shortraker/rougheye population and therefore be especially helpful as a habitat conservation measure compared to the baseline or to FMP 1, FMP 2.1, FMP 2.2, FMP 3.1, and FMP 3.2.

FMP 4.2 changes the entire GOA into one large no-take reserve. Such a large closed area would allow increased survival of larger and older shortraker and rougheye rockfish that may produce significantly more eggs and larvae to replenish the stocks. Damage to the benthic environment by fishing gear would be prevented throughout the GOA.

Predation-Mediated Impacts

Pacific cod and to a lesser extent walleye pollock are also species that are known to prey on shrimp, a major prey item of rougheye rockfish, so any changes in the abundance of these two fish as a result of FMP 4.1 hypothetically could affect the food supply of shortraker/rougheye. FMP 4.1 would change the biological reference point for determining ABC of Pacific cod and walleye pollock to the highly precautionary value of $F_{75\%}$, which results in greatly reduced catch projections for these two fish in this bookend compared to the baseline and FMP 1, FMP 2.1, FMP 2.2, FMP 3.1, and FMP 3.2. However, the model projections show that these reduced catches translate into only a modest increase in abundance (i.e., biomass) for Pacific cod and walleye pollock compared to the baseline situation and FMP 1. FMP 4.2 would prevent any fishing for Pacific cod or walleye pollock, but the model projections show that these zero catches translate into only a modest increase in abundance (i.e., biomass) for Pacific cod and walleye pollock compared to the baseline situation and FMP 1. Whether this relatively small increase in abundance of Pacific cod and walleye pollock would actually affect the food supply for shortraker/rougheye is unknown, as there is no quantitative information on trophic interactions between all these species. Moreover, shortraker and rougheye rockfish reside in deeper depths than Pacific cod or walleye pollock, so they may not be competing for the same spatial aggregations of food.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Shortraker/Rougheye Rockfish

The effects of FMP 4.1 and FMP 4.2 on shortraker/rougheye in the GOA are summarized in Table 4.8-1. The direct/indirect effects of mortality, change in biomass, change in the spatial/temporal characteristics, change in prey availability, and change in habitat suitability are all rated insignificant under FMP 4.1 and FMP 4.2.

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of GOA shortraker/rougheye rockfish are summarized in Table 4.5-27.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shortraker/rougheye rockfish is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery are identified as non-contributing factors since bycatch of rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA shortraker/rougheye rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Biomass Level</u>

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of changes in biomass level is insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery and State of Alaska shrimp fishery are identified as non-contributing factors to GOA slope rockfish biomass level since bycatch is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA shortraker/rougheye rockfish and is rated as insignificant. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the fisheries are determined to have an insignificant effect on the spatial/temporal characteristics of GOA shortraker/rougheye rockfish due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA shortraker/rougheye rockfish; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on shortraker/rougheye rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA shortraker/rougheye rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, they could affect reproductive success by driving changes in prey availability and habitat suitability. The IPHC longline fishery and the State of Alaska shrimp fishery are identified as non-contributing factors to the change in genetic structure and reproductive success of GOA shortraker/rougheye rockfish since bycatch in these fisheries is unlikely to occur.

- **Cumulative Effects.** A cumulative effect of the spatial/temporal characteristics of the GOA shortraker/rougheye rockfish complex is identified and is rated as insignificant. The combined effect of internal and external removals is unlikely to occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA shortraker/rougheye rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability are insignificant due to the significant reduction in the groundfish fishery effort under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on shortraker/rougheye rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The IPHC longline fishery is identified as a non-contributing factor to shortraker/rougheye rockfish prey availability since bycatch of shortraker/rougheye rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since shrimp is a main prey item of rougheye rockfish.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability of the GOA shortraker/rougheye rockfish and is rated as insignificant. The combined effect of internal and external removals of GOA shortraker/rougheye rockfish prey species is unlikely to jeopardize the ability of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in habitat suitability are insignificant due to the significant reduction in the groundfish fishery effort under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Past foreign, JV, domestic groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA shortraker/rougheye rockfish habitat due to the impacts caused by fishering gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA shortraker/rougheye rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to shortraker/rougheye rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. The IPHC longline fishery has been identified as a potential adverse contributor to shortraker/rougheye rockfish habitat suitability due to impacts from fishing gear. The State of Alaska shrimp fishery is a non-contributing factor since habitat degradation from shrimp fishing gear is not expected to occur. See Section 3.6 for more information on the impacts of fishery gear on essential fish habitat.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability of GOA shortraker/rougheye rockfish and is rated as insignificant. The combination of internal and external habitat disturbances is unlikely to lead to a detectable change in the spawning or rearing success such that it jeopardizes the ability of the stock to maintain current population levels.

GOA Slope Rockfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

No projections are possible for these two parameters, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Fishing Mortality

This bookend is much more precautionary in its approach than the baseline situation or any of the other FMPs, with the exception of FMP 4.2. FMP 4.1 primarily affects catch of slope rockfish in two ways: 1) it retains the eastern GOA trawl closure and also includes various areas located throughout the GOA as "no-take" reserves, in which no fishing of any gear type can take place; and 2) it includes a measure that changes the biological reference point for determining rockfish ABCs from the $F_{40\%}$ baseline to a much more conservative value, $F_{75\%}$. Both of these effects from FMP 4.1 would result in a decreased catch for slope rockfish and greatly reduce any risk of overfishing these species. As in FMP 1, FMP 2.2, FMP 3.1, and FMP 3.2, the eastern GOA trawl closure protects most of the GOA biomass of slope rockfish from any significant fishing pressure. The no-take reserves cover substantial areas of the GOA and would serve to increase this protection even further. At present, changing the biological reference point for slope rockfish species to $F_{75\%}$ would affect just sharpchin rockfish, because the latter is the only slope rockfish species that is in Tier 4 and has the age data required to calculate $F_{75\%}$. Sharpchin rockfish; however, comprise almost 40 percent of the current exploitable biomass for slope rockfish; therefore, using $F_{75\%}$ for sharpchin rockfish would still result in a considerably lower overall ABC for slope rockfish. The model projections for FMP 4.1 show very low slope rockfish catches of only 200 mt per year, which seem plausible given the very stringent precautionary measures of this bookend (Table H.4-31 of Appendix H).

FMP 4.2 sets ABC equal to zero for all species in the GOA, so catch projections for slope rockfish also become zero for all years (Table H.4-31 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The main spatial effect of FMP 4.1 on slope rockfish would be caused by the bookend's retention of the eastern GOA trawl closure, which would mean most of the GOA population of slope rockfish, which is found primarily in the eastern GOA, would not be vulnerable to fishing. No-take reserves located throughout the GOA, in which no fishing of any kind would be permitted, are also part of this bookend and would serve to increase protection of slope rockfish even further. For example, the bookend includes a large no-take reserve off Cape Ommaney in southeast Alaska, and this would prevent any catch of slope rockfish by longlines in this productive fishing area. There have been no studies to determine stock structure for any species of slope rockfish, and it is unknown if subpopulations exist. However, because most of the biomass of slope rockfish occurs in the eastern GOA, and much of the biomass outside this region is found within the no-take reserves, localized depletion is unlikely under this FMP.

Another important aspect of FMP 4.1 is that overcapacity problems in all fisheries would be addressed by adopting measures such as trip limits and LLPs. Such measures would especially affect trawl fisheries, and these fisheries would become less intense and more spread out in time. This would allow better management oversight of trawl fisheries and reduce of the risk of over-harvesting slope rockfish.

Fishing mortality for FMP 4.2 is zero, so there is no spatial or temporal concentration of fishing.

Status Determination

No projections are possible for the fishing mortality rate or MSST, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. There is no information on the sex ratio of slope rockfish, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 4.1 or FMP 4.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, FMP 4.1 impacts habitat for slope rockfish mainly because it closes the eastern GOA to trawling. This creates a de facto no-take zone or refuge for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species. Nearly all the biomass of slope rockfish is found in the eastern GOA, which means the trawl closure in this region protects most of the GOA population from any fishing pressure. FMP 4.1 also creates a series of no-take reserves across the GOA, which establishes daily refuge for all species, including slope rockfish.

FMP 4.2 changes the entire GOA into one large no-take reserve. Such a large closed area would allow increased survival of larger and older fish that may produce significantly more eggs and larvae to replenish the stocks. Damage to the benthic environment by fishing gear would be prevented throughout the GOA.

Given the low level of exploitation by the groundfish fisheries under these FMPs, the effects of FMP 4.1 and FMP 4.2 on GOA slope rockfish species through habitat suitability are considered insignificant.

Predation-Mediated Impacts

No studies have been done in Alaska to determine the food habits for any of the slope rockfish species. Many of the abundant species, such as sharpchin, harlequin, and redstripe rockfish, are relatively small in size and may be plankton-feeders, but this is conjecture. There is also no documentation of predation on slope rockfish, although larger fishes such as Pacific halibut that are known to prey on other rockfish presumably also prey on slope rockfish. Because of this lack of information, the effect of FMP 4.1 and FMP 4.2 on predator-prey relationships for slope rockfish is unknown.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Slope Rockfish

Internal effects on mortality, spatial/temporal characteristics, change in biomass, and change in habitat suitability are identified as insignificant. Change in prey availability are identified as unknown (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of GOA slope rockfish are summarized in Table 4.5-28.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA other slope rockfish is rated as insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, domestic fisheries, and State of Alaska groundfish fisheries have been identified as having had a adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of other slope rockfish. The State of Alaska groundfish fisheries is identified as a non-contributing factor since catch and bycatch of slope rockfish species is already accounted for by the domestic groundfish fishery model projections. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA other slope rockfish and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of changes in biomass level is determined to be insignificant due to the substantial reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a adverse persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass are indicated due to potential adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts have also been identified as having potential beneficial or adverse effects on the other slope rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.24 and 3.10). The State of Alaska groundfish fisheries are identified as non-contributing factors to GOA slope rockfish biomass level. Although catch and bycatch do occur in these fisheries, the removals are already accounted for by the domestic groundfish fishery model projections.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA other slope rockfish and is rated as insignificant. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA slope rockfish under FMP 4.1 and FMP 4.2 is insignificant.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA slope rockfish; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on slope rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to GOA slope rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, they could affect reproductive success by driving changes in prey availability and habitat suitability. The State of Alaska groundfish fishery is identified as a non-contributing factor to the change in genetic structure and reproductive success of GOA slope rockfish. Although catch and bycatch of slope rockfish species occurs in these fisheries, they are not expected to contribute to localized depletion such that it leads to a detectable reduction in genetic diversity or reproductive success. The IPHC longline fishery is also identified as a non-contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect for the spatial/temporal characteristics of the GOA slope rockfish complex is identified as insignificant. The combined effect of internal and external removals is unlikely to occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA slope rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under FMP 4.1 and FMP 4.2 is identified as unknown due to the limited scientific information.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on slope rockfish prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potential adverse contributor to slope rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regime shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10). The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to slope rockfish prey availability since bycatch of slope rockfish prey species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability of the GOA slope rockfish but is unknown. It is unknown whether future harvest levels are would lead to a change in prey availability such that it jeopardizes the ability of the stock to sustain itself at or above current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the effect of the fisheries on the change in habitat suitability is insignificant due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past foreign, JV, domestic groundfish fisheries, State of Alaska groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent adverse effects on GOA slope rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA slope rockfish habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to slope rockfish habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts. The State of Alaska groundfish fishery and the IPHC longline fishery have been identified as potential adverse contributors to slope rockfish habitat suitability due to impacts from fishery gear. See Section 3.6 for more information on the impacts of fishery gear on essential fish habitat.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability of GOA slope rockfish and is rated as insignificant. The combined effect of internal and external habitat disturbances are unlikely to lead to a detectable change in spawning or rearing success such that it jeopardizes the ability of the stock to sustain itself at or above current population levels.

GOA Pelagic Shelf Rockfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish. Until recently, an age-structured model had not been finalized for dusky rockfish. Beginning in 2004, dusky rockfish will be managed under Tier 3; however, for the purposes of this analysis, dusky rockfish have been modeled under Tier 4.

Fishing Mortality

This bookend is much more precautionary in its approach than the baseline situation or any of the other FMPs, with the exception of FMP 4.2. FMP 4.1 would have a substantial impact on catch of PSR because it includes a measure that changes the biological reference point for determining rockfish ABCs from the $F_{40\%}$ baseline to the much more conservative value of $F_{75\%}$. Using $F_{75\%}$ would substantially reduce the ABC value for PSR, which in turn would result in a large decrease in catch. Therefore, FMP 4.1 would greatly minimize the risk of overfishing PSR. The model projections for FMP 4.1 show PSR catch reductions of about 80 percent compared to FMP 1 (the present management regime), and the projected catches are around 90 percent less than has been taken by the fishery in recent years. The projections appear reasonable given the stringent precautionary measures of this bookend (Table H.4-32 of Appendix H).

FMP 4.2 sets ABC equal to zero for all species in the GOA, so catch projections for PSR also become zero for all years (Table H.4-32 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 4.1 would have a large effect on the spatial/temporal concentration of PSR catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, FMP 3.1, and FMP 3.2. The spatial distribution of the catch would change substantially because FMP 4.1 sets aside between 20 percent and 50 percent of the GOA as no-take reserves or as MPAs. No-take reserves in the proposed area cover large portions of Portlock, Albatross, and Shumagin Banks and the "W" grounds west of Yakutat, all of which are major fishing grounds for dusky rockfish (Reuter 1999). Much of the past fishing effort for dusky rockfish has been concentrated on these banks, so FMP 4.1 would likely displace this effort to other localities. Whether this displacement would result in spreading out the fishing effort over a wider area, or would merely concentrate the effort in new localities, is unknown. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource.

Another important aspect of FMP 4.1 is that overcapacity problems in all fisheries would be addressed by adopting measures such as trip limits and LLPs. Such measures would especially affect trawl fisheries, and these fisheries would become less intense and more spread out in time. This would allow better management oversight of trawl fisheries and reduce of the risk of over-harvesting PSR.

Fishing mortality for FMP 4.2 is zero, so there is no spatial or temporal concentration of fishing.

Status Determination

The catch rates are below the ABC and OFL values. The MSST cannot be determined for these stocks.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish. There is no information on the sex ratio of PSR, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by FMP 4.1 or FMP 4.2 is unknown.

Habitat-Mediated Impacts

Because FMP 4.1 creates a series of large no-take reserves across the GOA, it may provide substantial habitat benefits to PSR. At present, the only de facto no-take reserve affecting PSR is the eastern GOA region that has been closed to trawling for the past several years. FMP 4.1 retains the eastern GOA trawl closure, and it also adds many no-take reserves elsewhere in the GOA.

FMP 4.2 changes the entire GOA into one large no-take reserve. Such a large closed area would allow increased survival of larger and older fish that may produce significantly more eggs and larvae to replenish the stocks. Damage to the benthic environment by fishing gear would be prevented throughout the GOA.

Given the low level of exploitation by the groundfish fisheries under these FMPs, the effects of FMP 4.1 and FMP 4.2 on GOA PSR species through habitat suitability are considered insignificant.

Predation-Mediated Impacts

The major prey of dusky rockfish appears to be euphausiids, based on the limited food information available for this species (Yang 1993). Euphausiids are also the major prey of walleye pollock, which means dusky rockfish and walleye pollock may be competing for the same food resource. Thus, any measures in FMP 4.1 that affect the commercial catch of walleye pollock could have a subsequent indirect effect on dusky rockfish by increasing or decreasing the amount of euphausiids available to dusky rockfish. FMP 4.1 would change the biological reference point for determining ABC of walleye pollock to the highly precautionary value of $F_{75\%}$, which results in greatly reduced catch projections for walleye pollock in this bookend compared to the baseline and FMP 1, FMP 2.1, FMP 2.2, FMP 3.1, and FMP 3.2. This would lead to an obvious increase in abundance of walleye pollock and possibly have an adverse effect on the food supply for dusky rockfish. FMP 4.2 would prevent any fishing for walleye pollock, but the model projections show that these zero catches translate into only a modest increase in abundance (i.e., biomass) of walleye pollock compared to the baseline situation and FMP 1. How adverse this effect would really be, however, is unknown, as there is little or no quantitative information on trophic interactions between dusky rockfish and walleye pollock or data on whether they even feed on the same spatial aggregations of euphausiids.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Pelagic Shelf Rockfish

The effects of FMP 4.1 and FMP 4.2 on PSR in the GOA are summarized in Table 4.8-1.

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of the GOA PSR complex are summarized in Table 4.5-29.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA PSR complex is insignificant under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA PSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR mortality since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA PSR, and is rated as insignificant. PSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** Under FMP 4.1 and FMP 4.2, the groundfish fishery would have no significant effect on the GOA PSR biomass levels due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR biomass levels since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass and is rated as insignificant. The combined effect of internal and external removals is unlikely to push biomass towards levels that jeopardize the ability of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the change in genetic structure and reproductive success is insignificant under FMP 4.1 and FMP 4.2 due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA PSR; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on PSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR genetic structure and reproductive success since bycatch in this fishery is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA PSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, they could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** The cumulative effect is identified for the spatial/temporal concentration of catch as insignificant. The combined effect of internal and external removals is not expected to be of a localized manner such that it leads to changes in the genetic diversity or reproductive success of GOA PSR and jeopardizes the ability of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability is unknown under FMP 4.1 and FMP 4.2 due to limited scientific information.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on PSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a potential adverse contributor to GOA PSR prey availability. The catch of shrimp in the shrimp fishery is expected to continue in the future. Marine pollution is identified as a potential adverse contributor to PSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability of the GOA PSR, but is unknown. It is unknown whether the combination of internal and external removals of prey species is likely to jeopardize the ability of the GOA PSR stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in habitat suitability is insignificant under FMP 4.1 and FMP 4.2 due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries have been identified as having past persisting adverse effects on GOA PSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA PSR habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a non-contributing factor to GOA PSR habitat suitability since the gear associated with this fishery is not expected to cause a significant impact to the benthic habitat (see Sections 3.5.1.24 and 3.6 for more information on the effects of fishing gear on EFH. Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability of GOA PSR, and is rated as insignificant. The combination of internal and external habitat disturbances is unlikely to lead to detectable change in spawning or rearing success such that it jeopardizes the ability of the stock to maintain current population levels.

GOA Demersal Shelf Rockfish – Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Total and Spawning Biomass

Reliable total and spawning biomass statistics are not available for demersal shelf rockfish species.

Fishing Mortality

The projected TAC of DSR species would be reduced to 100 mt or less, under FMP 4.1. Where currently DSR species are managed as a discrete assemblage, based on their strong association with particular rock habitat, this FMP would require that these species be split out if possible and assigned species-specific ABCs. Until then the DSR TAC would be based on the least abundant member of the assemblage. In addition, this FMP would require that a $F_{75\%}$ exploitation rate be used in determining ABCs. Reduced mortality of DSR would likely benefit the population over time but determining such benefits cannot be made at this time due to insufficient information. However, FMP 4.1 would not result in any significantly adverse effects on the ability of DSR to sustain itself at current population levels. A reduced TAC would eliminate the directed fishery for DSR in the eastern GOA. All DSR would be placed on "bycatch-only" status and could significantly constrain the halibut fishery if managers were to strictly limit the bycatch of DSR (Table H.4-33 of Appendix H).

Under FMP 4.2, the projected TAC would be temporarily set to zero for all DSR species unless the harvesting of a species can be shown to have no adverse effect on the environment. DSR species are long lived, slow growing fishes. Temporary suspension of fishing would provide only marginal benefits to DSR assuming the suspension is within two years. In addition, since the GOA FMP controls only groundfish fishing, some mortality is predicted regardless due to bycatch of DSR in the halibut fishery. For this analysis, we presume that the current bycatch limit for DSR species would remain in the halibut fishery to prevent unlimited mortality. Mortality levels will remain at current levels. Therefore, unless the halibut fishery were restricted further, (a scenario not contemplated now) there would be no significant effect (benefit) of a zero TAC on DSR species (Table H.4-33 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

FMP 4.1 would significantly reduce DSR TAC from present levels. DSR species would be taken only as bycatch in the halibut fishery. As such, the catch of DSR would be associated with areas where halibut fishing is best. Therefore, we conclude that the spatial/temporal effects of fishing DSR under FMP 4.1 will be insignificant to the current DSR stock condition.

Under FMP 4.2, there is no projected fishing mortality, so there would be no concentration of harvest and no significant impact to DSR stocks.

Status Determination

The MSST cannot be determined for this stock complex.

Age and Size Composition and Sex Ratio

Age and size composition data is not available for GOA DSR species. The sex ratio of GOA DSR species is unknown.

Habitat-Mediated Impacts

Any habitat suitability impacts of FMP 4.1 and FMP 4.2, such as spawning habitat, nursery grounds, benthic structures, etc.) would be governed by a complex web of direct and indirect interactions which are difficult to quantify at the present time. The example FMP 4.1 includes establishing a network of MPAs along the continental shelf and slope of Alaska. It is unclear what benefits DSR species may receive from the illustrated closures since they only pertain to groundfish fisheries and not the halibut fishery. Regardless, at the low level of harvest authorized by these FMPs, it can be concluded that there would be no significant effects on DSR habitat suitability indexes as a result of FMP 4.1 or FMP 4.2.

Predation-Mediated Impacts

As with habitat impacts, any effects on predator-prey interactions as a result of fishing under FMP 4.1 and FMP 4.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify at the present time. Information is insufficient to conclude that existing trophic interactions would undergo any significant change under FMP 4.1 or FMP 4.2. However, due to the significant reduction of the groundfish fishery effort, we conclude that the effects on prey availability would be insignificant.

Summary of Effects of FMP 4.1 and FMP 4.2 – GOA Demersal Shelf Rockfish

A significant feature of FMP 4.1 is the lowering of ABC levels for DSR. For DSR species, the eastern GOA ABC and TAC would be less than 100 mt. Because DSR would now be fished at, or below, this low ABC level, the direct and indirect effects of FMP 4.1 on DSR stocks and their habitat are considered either insignificant. Under these considerations, the spatial/temporal distribution of catch should have no significant direct impact on stock productivity.

With the temporary suspension of all direct fishing of DSR species, the direct and indirect effects under FMP 4.2 are considered insignificant (Table 4.8-1).

Cumulative Effects of FMP 4.1 and FMP 4.2

Cumulative effects of the GOA DSR complex are summarized in Table 4.5-30.

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA DSR complex is insignificant under FMP 4.1 and FMP 4.2. The TAC and reported landings are expected to remain well below the OFL.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR mortality since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA DSR and is rated as insignificant. DSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effect of the fisheries on the change in biomass levels is insignificant under FMP 4.1 and FMP 4.2 due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering adverse effect on the GOA DSR population (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery have been identified as non-contributing factors to GOA DSR biomass levels since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potential adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not identified as being contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified and is rated as insignificant. The combined internal and external removals are not expected to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA DSR is insignificant under FMP 4.1 and FMP 4.2 due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA DSR; however, climate changes and regime shifts have been identified as having had potential beneficial or adverse effects on DSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and IPHC longline fisheries have been identified as non-contributing factors to GOA DSR genetic structure and reproductive success. Catch/bycatch of these fisheries is already accounted for by the domestic groundfish management or is not expected to occur (as in the case of the State of Alaska herring and shrimp fisheries). Marine pollution is identified as a potential adverse contributor to GOA DSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are identified as non-contributing factors to genetic structure; however, they could effect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect for the spatial/temporal characteristics of the GOA DSR complex is identified and is rated as insignificant. The combined internal and external removals are not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability is insignificant under FMP 4.1 and FMP 4.2 due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had beneficial or adverse effects on DSR prey availability (see Sections 3.5.1.24 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as potential adverse contributors to GOA DSR prey availability. Catch of herring in the herring fishery and the catch of shrimp in the shrimp fishery are expected to continue in the future. The State of Alaska groundfish fishery and the IPHC longline fishery are identified as non-contributing factors to GOA DSR prey availability since bycatch of DSR prey species is not expected to occur. Marine pollution is identified as a potential adverse contributor to DSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potential beneficial or adverse contributors to prey availability (see Sections 3.5.1.24 and 3.10).

- **Cumulative Effects.** The cumulative effect for the change in prey availability of the GOA DSR is identified and is rated as insignificant. The combined external and internal factors effecting prey availability are not expected to jeopardize the populations ability to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in habitat suitability is insignificant under FMP 4.1 and FMP 4.2 due to the significant reduction in the groundfish fishery effort.

- **Persistent Past Effects.** Past foreign, JV, domestic groundfish fisheries, and the IPHC longline fisheries have been identified as having past persisting adverse effects on GOA DSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past beneficial or adverse effects on GOA DSR habitat suitability (see Section 3.5.1.24).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as non-contributing factors to GOA DSR habitat suitability since the gear associated with these fisheries are not expected to cause a significant impact to the benthic habitat. The State of Alaska groundfish fisheries and the IPHC longline fisheries are identified as potential adverse contributors to DSR habitat suitability. See Sections 3.5.1.24 and 3.6 for more information on the effects of fishery gear on EFH. Marine pollution has been identified as a potential adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potential beneficial or adverse contribution to DSR habitat suitability. See Sections 3.5.1.24 and 3.10 for more information on climate changes and regime shifts.

- **Cumulative Effects.** The cumulative effect for habitat suitability of GOA DSR is identified and is rated as insignificant. The combined internal and external factors are not expected to lead to a detectable change in spawning or rearing success such that the ability of the DSR complex to maintain current population levels is jeopardized.

4.8.2 Prohibited Species Alternative 4 Analysis

4.8.2.1 Pacific Halibut

Pacific halibut are managed by the IPHC. Halibut bycatch in federal groundfish fisheries is controlled by the use of PSC limits. IPHC provides for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery.

FMP 4.1 and 4.2 – Direct/Indirect Effects

Direct and indirect effects for Pacific halibut include mortality, changes in reproductive success, and prey availability. These effects, which are associated with changes in catch, are considered insignificant because annual quota setting processes implemented by IPHC account for all removals of halibut, including bycatch in other fisheries. Thus, if changes to the baseline condition of the stock occur, they are reflected in the quotas set for the directed fishery. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. Halibut are opportunistic predators with a wide range of prey species, and no significant change to prey structure is expected as a result of these FMPs. No evidence of fishery impact to habitat of halibut has been shown, so this effect will not be considered in the cumulative effects analysis that follows.

Under FMP 4.1, halibut PSC caps would be reduced by 50 percent. Halibut bycatch mortality attributed to the combined BSAI and GOA groundfish fisheries would decrease from 6,800 mt to 3,400 mt. This would allow a corresponding increase in halibut catches by the directed fishery. Total removals would continue to be limited by IPHC to protect the halibut resource.

As proposed in FMP 4.2, every groundfish fishery in the U.S. EEZ would be suspended until the fisheries are shown to have no adverse effect on the resource or its environment. For this FMP scenario, it is presumed that all other fisheries not governed by the BSAI or GOA groundfish FMPs would be authorized to fish in the EEZ under their respective FMPs or international treaties. Therefore, the Alaska halibut fishery would continue under its current management framework.

In the short-term, no directed groundfish fishery would exist, resulting in no incidental take of halibut. This mortality could be transferred by the IPHC to increase quotas for the commercial halibut fishery. However, once fishing recommences in the groundfish fisheries, it is presumed that these fisheries would be managed under strict regulations and that a halibut PSC limit would again be assigned to each groundfish fishery. The IPHC would estimate the mortality for these groundfish fisheries and would follow the current policy of withdrawing this amount from the level available for harvest. The recreational and subsistence fisheries would most likely continue under any scenario in state waters, as would the small Metlakatla treaty fishery in southeast Alaska. In the long-term, total removals would depend on the definition of adverse effects that emerged for the groundfish fisheries.

FMP 4.1 – Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with FMP 4.1 is shown in Table 4.5-31. For further information on persistent past effects included in this analysis, see Section 3.5.2.1 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects**. The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 4.1 because current management of halibut by IPHC accounts for all removals of halibut including bycatch in other fisheries when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects**. No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects**. The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, increases or decreases in halibut bycatch are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events, both human controlled and natural, are considered insignificant for FMP 4.1.

Change in Reproductive Success

- **Direct/Indirect Effects**. The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 4.1. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 4.1.

- **Persistent Past Effects**. No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects**. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut, since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events, both human controlled and natural, are considered insignificant for FMP 4.1.

Change in Prey Availability

- **Direct/Indirect Effects**. The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 4.1. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of FMP 4.1.

- **Persistent Past Effects**. No persistent past effects impacting prey availability of halibut have been identified.

- **Reasonably Foreseeable Future External Effects**. Halibut are opportunistic predators with a wide range of prey species. Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events, both human controlled and natural, are considered insignificant for FMP 4.1.

Cumulative Effects Analysis FMP 4.2

A summary of the cumulative effects analysis associated with FMP 4.2 is shown in Table 4.5-31. For further information on persistent past effects included in this analysis, see Section 3.5.2.1 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects**. The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under FMP 4.2 because current management of halibut by IPHC accounts for all removals of halibut including bycatch in other fisheries when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects**. No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in the past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects**. The directed longline fishery for Pacific halibut remains in effect, but is closely managed by IPHC. Although state-managed fisheries may incidentally catch halibut, IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, increases or decreases in halibut bycatch are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events, both human controlled and natural, are considered insignificant for FMP 4.2.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects**. The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under FMP 4.2. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of FMP 4.2.

- **Persistent Past Effects**. No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects**. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut, since there is no significant spatial/temporal overlap between these fisheries and halibut spawning areas. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events, both human controlled and natural, are considered insignificant for FMP 4.2.

Change in Prey Availability

- **Direct/Indirect Effects**. The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under FMP 4.2. Halibut are opportunistic predators with a wide range of prey species, and no significant change to prey structure is expected as a result of FMP 4.2.

- **Persistent Past Effects**. No persistent past effects impacting prey availability of halibut have been identified.

- **Reasonably Foreseeable Future External Effects**. Halibut are opportunistic predators with a wide range of prey species. Increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability on Pacific halibut resulting from direct catch, bycatch, and reasonably foreseeable future external events, both human controlled and natural, are considered insignificant for FMP 4.2.

4.8.2.2 Pacific Salmon or Steelhead Trout

Pacific salmon are managed by the ADF&G, which also manages the salmon sport fisheries and permitted subsistence harvesting, to ensure that escapement goals are met for the spawning population in order to maintain sustained yields from the stock as a whole. Annual harvest levels are responsive to fluctuations in run sizes.

For reasons discussed in Section 4.5.2.2, ESA-listed Pacific Northwest chinook salmon and steelhead trout were not specifically considered in this cumulative effects analysis.

Management of Alaskan salmon stocks is challenging due to the lack of precise information on total return and the inability to predict future returns to most rivers or tributaries with any degree of certainty. In most cases, total return and escapement are not known. Due to this lack of information, estimates of significant impacts of bycatch on various runs are unreliable. Another factor to consider in salmon management is the Alaska Subsistence Preference Law. This law requires that commercial, recreational, and personal use fisheries be restricted prior to the restriction of subsistence fisheries. Therefore, management of all fisheries for these stocks in state waters incorporates conservative measures.

A summary of assumptions included in the impact analysis of the FMPs is presented in Section 4.5.2.2.

The cumulative effects analyses were based on two groupings of Alaska salmon in BSAI and GOA: chinook salmon and other salmon.

Direct/Indirect Effects FMP 4.1 and 4.2

Direct and indirect effects for chinook salmon and other salmon in BSAI and GOA include mortality along with changes in prey availability, genetic structure of population, and reproductive success.

<u>BSAI – Chinook Salmon</u>

Under FMP 4.1, chinook salmon bycatch in the BSAI varies from approximately 7,000 in 2008 to 6,000 in 2003. Assuming that 58 to 70 percent of BSAI chinook salmon bycatch is of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 3,000 to 5,000 fish during the next six years. This harvest represents approximately 1.0 to 1.7 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This FMP results in a significant reduction (>25 percent) in western Alaska chinook salmon catches of approximately 10,000 to 13,000 fish per year. These bycatch levels are not detectable in natal streams and would have no detectable effects on commercial or subsistence harvests or escapement. However, given the recent stock status, this FMP could have a conditionally significant beneficial impact due to uncertainty regarding a gain in population sustainability resulting from this FMP.

Under FMP 4.2, chinook salmon bycatch in the BSAI would be eliminated in the years 2003 through 2008, eliminating all western Alaska chinook salmon bycatch during those years. This FMP results in a significant reduction (>25 percent) in western Alaska chum salmon catches of approximately 13,000 to 18,000 fish per year resulting in a bycatch of zero. When considered across all chinook salmon runs in western Alaska, the reduction in bycatch levels are probably not detectable in natal streams, and would have no detectable effect on commercial or subsistence harvests or escapement. Therefore, no significant impacts on the sustainability of the stock are expected. However, if combined with FMP 4.2 for the GOA, the result would be a significant reduction (>25 percent) in western Alaska chinook salmon bycatch of 21,000 to 34,000 fish. When considered across all chum salmon runs in western Alaska, the combined reduction in bycatch levels is probably not detectable in natal streams, but could have beneficial effects on commercial and subsistence harvests and escapement. Given the recent stock status, this FMP could have a conditionally significant beneficial impact resulting in a gain in population sustainability especially to depressed stocks, although the magnitude of this change in population is not known.

<u>BSAI – Other Salmon</u>

Under FMP 4.1, bycatch of other salmon in BSAI varies from approximately 22,000 in 2008 to 17,000 in 2003. Assuming 96 percent of this other salmon bycatch is chum salmon and 19 percent may be of western Alaska origin, the bycatch of western Alaska chum salmon stocks could range from 3,000 to 4,000 fish during the next six years. This harvest represents approximately 0.3 to 0.4 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This FMP results in a significant reduction (>25 percent) in western Alaska chum salmon catches of approximately 8,000 to 9,000 fish per year. These bycatch levels are not likely to be detectable in natal streams, would have no detectable effects on commercial or subsistence harvests or escapement, and are not expected to significantly impact sustainability of the stock. The combined decrease in bycatch for BSAI and GOA may provide a conditionally significant beneficial effect on mortality of certain salmon stocks that have been depressed in this region.

Under FMP 4.2, other salmon bycatch in BSAI would be eliminated in the years 2003 through 2008, eliminating all western Alaska chum salmon bycatch during those years. This FMP results in a significant reduction (>25 percent) in western Alaska chum salmon catches of approximately 11,000 to 13,000 fish per year. When considered across all chum salmon runs in western Alaska, the reduction in bycatch levels are not detectable in natal streams and would have no detectable effect on commercial or subsistence harvests or escapement. However, given the recent stock status, this FMP could have a conditionally significant beneficial impact resulting in a gain in population sustainability especially to depressed stocks, although the magnitude of this change in population is not known.

<u>GOA – Chinook Salmon</u>

Under FMP 4.1, chinook salmon bycatch in the BSAI varies from approximately 2,000 in 2003 to 7,000 in 2008. Assuming 58 percent of GOA chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 1,000 to 4,000 fish during the next six years. This harvest represents approximately 0.3 to 1.3 percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. This FMP results in a significant reduction (>25 percent) in western Alaska chinook salmon catches of approximately 7,000 to 12,000 fish per year. These bycatch levels are not detectable in natal streams, nor would they have any detectable effect on commercial or subsistence harvests or escapement. Given the recent stock status, this FMP would have a conditionally significant beneficial impact resulting in a gain in population sustainability due to uncertainty in the population's response to less catch.

Under FMP 4.2, chinook salmon bycatch in GOA would be eliminated in the years 2003 through 2008, eliminating all western Alaska chinook salmon bycatch during those years. This FMP results in a significant reduction (>25 percent) in western Alaska chinook salmon catches of approximately 8,000 to 16,000 fish per year. These bycatch savings are not detectable in natal streams, but could have beneficial effects on commercial or subsistence harvests or escapement. If combined with FMP 4.2 for the BSAI, the result would be a significant reduction (>25 percent) in western Alaska chinook salmon bycatch of 21,000 to 34,000 fish. When considered across all chum salmon runs in western Alaska, the combined reduction in bycatch levels would not be detectable in natal streams, but could have a beneficial effect on commercial and subsistence harvests and escapement. Given the recent stock status, this FMP could have a conditionally significant beneficial impact resulting in a gain in population sustainability especially to depressed stocks, although the magnitude of this change in population is not known.

<u>GOA – Other Salmon</u>

Under FMP 4.1, bycatch of other salmon in the BSAI varies from approximately 1,000 in 2003 up to 3,000 in 2008. Assuming 56 percent of this other salmon bycatch is chum salmon, the bycatch could range from 1,000 to 2,000 fish during the next six years. The proportion of these fish that are of western Alaska origin is unknown. Assuming that all of these fish originate in western Alaska, this harvest represents approximately 0.1 to 0.2 percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. This FMP results in a significant reduction (>25 percent) in western Alaska chum salmon catches of approximately 2,000 to 4,000 fish per year when compared to FMP 1. Although these bycatch levels are not likely to be detectable in natal streams, would have no detectable effects on commercial or subsistence harvests or escapement, and are not expected to significantly impact sustainability of the stock, the combined decrease in bycatch for BSAI and GOA may provide a conditionally significant beneficial effect on mortality of certain salmon stocks that have been depressed in this region.

Under FMP 4.2, other salmon bycatch in the GOA would be eliminated in the years 2003 through 2008, eliminating all western Alaska chum salmon bycatch during those years. This FMP results in a significant reduction (>25 percent) in western Alaska chum salmon catches of approximately 3,000 to 6,000 fish per year. These levels of bycatch are not detectable in natal streams, and would have no detectable effect on commercial or subsistence harvests or escapement. However, given the recent stock status, this FMP could have a conditionally significant beneficial impact resulting in a gain in population sustainability especially to depressed stocks, although the magnitude of this change in population is not known.

Cumulative Effects Analysis FMP 4.1

A summary of the cumulative effects analysis associated with FMP 4.1 is shown in Table 4.8-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of FMP 4.1 on fishing mortality of BSAI and GOA chinook and other salmon is considered conditionally significant beneficial. When considered across all salmon runs in western Alaska, the combined reduction in bycatch levels is probably not detectable in natal streams, but could have beneficial effects on commercial and subsistence harvests and escapement. Given the depressed western Alaska stock status, this FMP could have a conditionally significant beneficial impact resulting in a gain in population sustainability

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the following years and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** External effects on Alaskan salmon populations differ between BSAI and GOA and will be discussed independently for each region.

  In BSAI, state commercial and subsistence fisheries exert effects on mortality of chinook and other salmon populations. The magnitude of this effect cannot be determined; however, the current stock status indicates that salmon runs in western Alaska are depressed. In considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. State commercial, subsistence, and sport fisheries are not considered contributing factors in the mortality of GOA other salmon stocks, since these stocks are considered stable. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in the direct mortality of salmon. State of Alaska hatchery enhancement programs were initiated in GOA and have a potential beneficial contribution to the effect of mortality on salmon stocks. In addition, long-term climate change and regime shift are not expected to result in the direct mortality of salmon.

In GOA, state commercial, subsistence, and sport fisheries exert effects on mortality of chinook and other salmon populations, but they are not considered contributing factors in the mortality of salmon stocks as a whole. As mentioned in BSAI above, land management practices are an important factor influencing spawning habitat of salmon, but are not considered contributing factors in direct mortality of salmon in GOA. State of Alaska hatchery enhancement programs were initiated in GOA and have a potential beneficial contribution to the effect of mortality on salmon stocks. Long-term climate change and regime shifts are not expected to result in the direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, decreasing bycatch in BSAI and GOA may help to restore stock and improve recovery of salmon. Bycatch of chinook salmon originating in the Pacific Northwest may be reduced as well. The combined effects of mortality on BSAI and GOA chinook and other salmon resulting from direct catch, bycatch, internal catch, and reasonably foreseeable future external events both human controlled and natural are considered conditionally significant beneficial for FMP 4.1. A combined decrease in bycatch potential of BSAI and GOA bycatch potential in the BSAI fisheries under this FMP could support continued recovery of depressed stocks in BSAI and improve sustainability of the Alaskan salmon stock as a whole.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The potential effects of FMP 4.1 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of prey and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In BSAI and GOA, a relationship between state commercial and subsistence fisheries bycatch of prey and salmon prey availability has not been defined and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. State of Alaska hatchery enhancement programs occur in GOA, but do not include prey species of salmon. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct internal catch, bycatch, and reasonably foreseeable future external events both human controlled and natural are unknown under FMP 4.1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 4.1 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In BSAI and GOA, salmon bycatch composition has not been determined. Potential effects of state commercial and subsistence fisheries, along with sport fisheries in the GOA, on genetic structure of salmon populations are unknown. Potential effects of state commercial and subsistence fisheries on genetic structure of salmon populations are unknown. Significant impacts to genetic structure of salmon populations by land management practices are not expected and are not considered contributing factors to a possible change in the baseline condition. State of Alaska hatchery enhancement programs focus on building certain salmon stocks. Because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in GOA are not known. Long-term climate change and regime shifts are not expected to result in direct mortality which would potentially affect genetic structure of BSAI and GOA chinook and other salmon stocks.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from direct internal catch, bycatch, and reasonably foreseeable future external events both human controlled and natural are unknown under FMP 4.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 4.1 on reproductive success for BSAI and GOA chinook and BSAI other salmon are considered conditionally significant beneficial. Potential effects on GOA other stocks are unknown.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska, it may be inferred that reproductive success has been impacted in certain populations of BSAI region. Successful reproduction of salmon depends on the spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may play a role in the reproductive success of certain salmon populations. Stocks in GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** External effects on Alaskan salmon populations differ between BSAI and GOA and will be discussed independently for each region.

  In BSAI, state commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. Degradation of watersheds used by spawning salmon caused by poor land management practices could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potential adverse contributions to possible changes in reproductive success of this population.

  Salmon stocks in GOA are considered stable, so potential effects of state commercial, subsistence, and sport fisheries on reproductive success of this stock are considered insignificant for this population. For reasons stated above, land management practices are considered as potential adverse contributions to the reproductive success of GOA salmon stocks. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska and are considered potentially beneficial to the reproductive success of salmon.

  Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska combined with decreases in bycatch potential for BSAI and GOA predicted under FMP 4.1 may result in beneficial impacts to the BSAI chinook and other salmon stocks. Decreasing bycatch in BSAI and GOA may enable more spawners to reach the destined spawning grounds. The potential combined effects from internal and external events could result in conditionally significant benefits to the reproductive success of BSAI salmon. Although current stock status of GOA chinook and other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from decreased internal catch and reasonably foreseeable future external events both human controlled and natural cannot be determined for GOA other salmon stocks under FMP 4.1.

Cumulative Effects Analysis FMP 4.2

Summaries of the cumulative effects analysis associated with FMP 4.2 are shown in Table 4.8-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effects of FMP 4.2 on fishing mortality of BSAI and GOA chinook and other salmon are considered conditionally significant beneficial.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in BSAI and GOA. U.S. bilateral agreements with these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries while allocating salmon resources to the state fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The state took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow and by the 1970's, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** External effects on Alaskan salmon populations differ between BSAI and GOA and will be discussed independently for each region.

  In BSAI, state commercial and subsistence fisheries exert effects on mortality of western Alaska chinook and other salmon populations. The magnitude of this effect cannot be determined; however, the current stock status indicates that salmon runs in western Alaska are depressed. Considering this stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. In addition, long-term climate change and regime shift are not expected to result in direct mortality of salmon.

  In GOA, state commercial, subsistence, and sport fisheries exert effects on mortality of chinook and other salmon populations, but they are not considered contributing factors in mortality of salmon stocks as a whole. As mentioned in BSAI above, land management practices are an important factor influencing spawning habitat of salmon but are not considered contributing factors in direct mortality of salmon in GOA. State of Alaska hatchery enhancement programs were initiated in GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. Long-term climate change and regime shifts are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, eliminating bycatch in BSAI and GOA may help to restore stock and improve recovery of salmon. Bycatch of chinook salmon originating in the Pacific Northwest may be reduced as well. The combined effects of mortality on BSAI and GOA chinook and other salmon resulting from direct internal catch, bycatch, and reasonably foreseeable future external events both human controlled and natural are considered conditionally significant beneficial for FMP 4.2. A combined decrease in bycatch potential in the BSAI and GOA fisheries under this FMP could support continued recovery of depressed stocks in the BSAI and GOA and improve sustainability of the Alaskan salmon stock as a whole.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effects of FMP 4.2 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of salmon prey items and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In BSAI and GOA, a relationship between state commercial and subsistence fisheries bycatch of prey and salmon prey availability has not been defined and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. State of Alaska hatchery enhancement programs occur in GOA, but do not include prey species of salmon. Long-term climate change and regime shifts could have impacts on certain prey species of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on the prey structure of salmon cannot be determined.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from direct internal catch, bycatch, and reasonably foreseeable future external events both human controlled and natural are unknown under FMP 4.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of FMP 4.2 on genetic structure of salmon populations in BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In BSAI and GOA, salmon bycatch composition has not been determined so potential effects of state commercial and subsistence fisheries on genetic structure of salmon populations are unknown. Significant impacts to genetic structure of salmon populations by land management practices are not expected and are not considered contributing factors to a possible change in baseline condition. State of Alaska hatchery enhancement programs focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in GOA are not known. Long-term climate change and regime shifts are not expected to result in direct mortality which would potentially affect genetic structure of BSAI chinook and other salmon stocks.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from direct internal catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are unknown under FMP 4.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of FMP 4.2 on reproductive success for BSAI chinook and other salmon are considered conditionally significant beneficial. Potential effects on GOA other salmon stocks are unknown.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska it may be inferred that reproductive success has been impacted in certain populations of BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Other past effects tied to freshwater life stages of salmon may play a role in the reproductive success of certain salmon populations. Stocks in GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** External effects on Alaskan salmon populations differ between BSAI and GOA and will be discussed independently for each region.

  In BSAI, state commercial and subsistence fisheries catch of chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. Considering this depressed stock condition, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. Degradation of watersheds used by spawning salmon caused by poor land management practices could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potential adverse contributions to possible changes in reproductive success of this population.

  Salmon stocks in GOA are considered stable. Potential effects of state commercial, subsistence, and sport fisheries on reproductive success of this stock are considered insignificant for this population. For reasons stated above, land management practices are considered as potential adverse contributions to the reproductive success of GOA salmon stocks. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska and are considered potentially beneficial to the reproductive success of salmon.

Long-term climate change and regime shifts could have impacts on the reproductive success of Pacific salmon in BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, elimination of bycatch for BSAI and GOA under FMP 4.2 may result in beneficial impacts to the BSAI chinook and other salmon stocks. Thus, eliminating bycatch in BSAI and GOA may enable more spawners to reach the destined spawning grounds and potential combined effects from internal and external events could result in conditionally significant benefits to the reproductive success of BSAI chinook salmon and other salmon. Although current stock status of GOA chinook and other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from decreased internal bycatch and reasonably foreseeable future external events (both human controlled and natural) cannot be determined for GOA stocks under FMP 4.2.

4.8.2.3 Pacific Herring

Pacific herring are managed by the ADF&G. Harvest policy and allocations among gear user groups is established by the Alaska Board of Fisheries. Annual harvest quotas are set by ADF&G under an exploitation rate harvest policy; herring exploitation rates are capped at a maximum level of 20 percent statewide. All directed herring fisheries occur in state waters and are managed by regulatory stocks.

A detailed discussion of the modeling approach used in this analysis is included in Section 4.5.2.3. Given the low herring bycatch levels that are predicted across all FMPs, bycatch removals would not be expected to have significantly different impacts on herring abundance estimates between FMPs.

Direct/Indirect Effects FMP 4.1 and 4.2

Direct and indirect effects for Pacific herring include mortality along with changes in reproductive success, prey availability, and habitat. These effects, which are associated with changes in catch, are considered insignificant for the following reasons: bycatch of herring in the groundfish fisheries is low, the fisheries do not target herring prey, and spatial/temporal overlap between the groundfish fisheries and herring habitat is minimal. In addition, annual quota setting processes implemented by ADF&G are responsive to fluctuations in herring biomass.

Cumulative Effects Analysis FMP 4.1 and 4.2

A summary of the cumulative effects analysis associated with FMP 4.1 and FMP 4.2 is shown in Table 4.5-34. For further information on persistent past effects included in this analysis, see Section 3.5.2.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA herring is insignificant under FMP 4.1 and 4.2 given the low amounts predicted for herring bycatch, and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. The herring savings areas reduce herring bycatch potential by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Domestic herring fisheries became prominent in the early 1900s with peak catches occurring in the 1920s and 1930s. Foreign herring harvests became prominent in the BSAI in the late 1950s, with highs in the late 1960s and early 1970s. Overexploitation of herring likely resulted during these years of high catch. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have impacted herring populations long-term. In addition, past federal groundfish fisheries bycatch combined with the directed state fisheries have exceeded the state's herring harvest policy in the past and may still exert lingering effects on current herring populations in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur, but are closely managed by the state (ADF&G). Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. State of Alaska subsistence catch is accounted for in ADF&G herring management plans. These fisheries are not considered contributing factors to changes in herring mortality. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring mortality, especially for those populations that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass, and fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. Thus, although some persistent past effects may still be present on certain herring populations in the BSAI and GOA, the combined effects of mortality on Pacific herring resulting from direct internal catch, bycatch, and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for FMP 4.1 and 4.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on reproductive success of BSAI and GOA herring is insignificant under FMP 4.1 and 4.2 due to the low amounts of estimated herring bycatch and because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in reproductive success occurs, it would most likely be reflected in corresponding changes to biomass, which are incorporated into ADF&G management plans of Pacific herring.

- **Persistent Past Effects.** Herring spawning habitat in the GOA, specifically PWS, was contaminated with oil resulting from the EVOS in 1989. It has been found that this type of contamination exposure to adult and larval herring can result in many adverse effects such as increased rates of egg mortality, larval deformities, and immune system deficiencies. It is presumed that the effects of EVOS still exist and subsets of herring populations in the GOA are still recovering (see foregoing discussion of cumulative effects on Pacific herring mortality).

- **Reasonably Foreseeable Future External Effects.** Directed state herring fisheries still occur, but are closely managed by the state (ADF&G). Fishing quotas are based on variable exploitation rates that account for declines in stock. State of Alaska subsistence catch is accounted for in ADF&G herring management plans. Thus, these fisheries are not considered contributing factors to changes in herring reproductive success. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring reproductive success, especially for those populations that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific herring depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass and fishing quotas are based on variable exploitation rates that account for declines in stock. Although certain herring populations in the GOA have been impacted by EVOS, the stock as a whole is considered to be recovering. Thus, some persistent past effects may still be present on certain herring populations in the BSAI and GOA, but the combined effects on Pacific herring reproductive success resulting from direct internal catch, bycatch, and reasonably foreseeable future external events both human controlled and natural are considered insignificant for FMP 4.1 and FMP 4.2.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on prey availability for BSAI and GOA herring is insignificant under FMP 4.1 and FMP 4.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass and spatial/temporal overlap between the fisheries and herring habitat is minimal. However, if the groundfish fisheries were to somehow impact herring habitat it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring. In addition, the herring savings areas reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects**. No persistent past effects impacting prey availability of herring have been identified.

- **Reasonably Foreseeable Future External Effects.** Pacific herring prey primarily on zooplankton which are not affected by state directed herring fisheries or state subsistence fisheries. Thus, these fisheries are not considered contributing factors to changes in prey availability for herring. Future acute and chronic marine pollution could occur, but effects on prey such as zooplankton are unknown. Long-term climate change and regime shifts could have impacts to many species that contribute to the prey structure of Pacific herring. The nature of these impacts depends on the direction of the climatic shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** Potential effects of future natural events such as marine pollution and climatic shifts on prey availability for Pacific herring are unknown for FMP 4.1 and FMP 4.2.

Change in Habitat

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on habitat of BSAI and GOA herring is insignificant under FMP 4.1 and FMP 4.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Spatial/temporal overlap between the fisheries and herring habitat is minimal. Thus, if a change in important habitat occurs, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans of Pacific herring. The herring savings areas reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Herring spawning habitat in the GOA, specifically PWS, was contaminated with oil resulting from the EVOS in 1989. The long-term effects of this event to herring habitat are unknown. It is presumed that the effects of EVOS still exist, and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** No evidence of fishery impact on habitat of herring exists. Thus, fisheries are not considered contributing factors to changes in herring habitat at this time. Future acute and chronic marine pollution could occur and is considered potentially adverse to some herring habitat, especially those that are still recovering from EVOS in the GOA. Long-term climate change and regime shifts are not expected to significantly change physical habitat of Pacific herring.

- **Cumulative Effects.** Potential impacts of future natural events, such as marine pollution and climatic shifts, in addition to lingering contamination from EVOS on certain habitat of herring in the GOA exist, but effects are not known for FMP 4.1 and FMP 4.2.

4.8.2.4 Crab

Alaska king, bairdi Tanner, and opilio Tanner (snow crab) crab fisheries are managed by the State of Alaska with federal oversight and the following guidelines established in the BSAI king and Tanner crab FMP (NPFMC 1989). Section 4.5.2.4 contains further information on current stock status and management of crab in Alaska.

For the cumulative effects analysis, crab stocks in BSAI and GOA will be placed in the following groups: bairdi Tanner, opilio Tanner (only BSAI), red king, blue king, and golden king.

Direct/Indirect Effects FMP 4.1 and 4.2

Direct and indirect effects for all species of crab in BSAI and GOA include mortality along with changes in biomass, reproductive success, prey availability, and habitat. These effects may be attributed to fishing activities both directed and undirected, but may be linked to natural events such as long-term climatic change and decadal regime shifts. Significance of these effects is based on the likelihood that population-level changes will result from internal events within the groundfish fishery. An effect that is considered insignificant corresponds to a change that is not likely to result in population-level effects on crab or that lies within the range of natural variability for the species.

Cumulative Effects Analysis FMP 4.1 and 4.2

Summaries of the cumulative effects analyses associated with FMP 4.1 and 4.2 are shown in Table 4.8-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.4 of this Programmatic SEIS.

The foundation of the cumulative effects analysis is the baseline description for each species that includes population status and trends, if known, and the major human and natural influences that have affected the population in the past and that continue up to the present.

For each species, the predicted direct and indirect effects of the groundfish fishery are then analyzed for their contribution to the overall impacts from all sources, including reasonably foreseeable future events resulting from human and natural events external to the fishery. The reasonably foreseeable future events include other U.S. and foreign fisheries, acute and chronic environmental pollution, and natural events such as climatic and oceanographic fluctuations. Cumulative effects are each rated according to the same significance criteria as the direct/indirect effects of the fishery and are based on the potential for population-level effects.

Mortality

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Under FMP 4.1, predicted catch of these crab species both decreases and increases from the current baseline condition in FMP 4.1 and is completely eliminated in FMP 4.2. Under FMP 4.1, trawl closure areas and protection areas are more extensive than other proposed FMPs, concentrating red king crab bycatch to a small area on the western edge of their distribution. Most bycatch of opilio and bairdi Tanner crab would come from the open areas east of the Pribilof Islands. In addition, bairdi Tanner crab catch would be shifted to the north as a result of closures in Bristol Bay and areas north of Unimak Island. Predicted crab bycatch varies by fishery. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. Under these proposed FMPs, it is possible that bycatch of crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks. Thus, FMP 4.1 and 4.2 are considered to have conditionally significant beneficial effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. The conditional rating is based on the lack of recovery for these stocks under current management plans.

- **Persistent Past Effects.** Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). The U.S. initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between State of Alaska crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur and are managed by ADF&G in cooperation with NOAA Fisheries. These fisheries are considered to have a potential adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. Under these proposed FMPs, it is possible that bycatch of crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks. Persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. It is unclear if additional protection measures and a decrease or elimination of crab bycatch will mitigate the combined effects of mortality resulting from past events, direct internal catch, bycatch, and reasonably foreseeable future external events on depressed stocks. Thus, cumulative effects of FMP 4.1 and FMP 4.2 on BSAI crab stocks cannot be determined.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Under FMP 4.1, predicted catch of golden king crab in BSAI and GOA were combined with those predictions for blue king crab. The BSAI predictions showed increases in catch for FMP 4.1 when compared to current catch rates, while FMP 4.2 eliminates bycatch over the next five years. Model projections for GOA catch showed decreases in catch for FMP 4.1 compared to current catch in this region, while FMP 4.2 eliminates bycatch. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status of golden king crab. Thus, effects of FMP 4.1 and FMP 4.2 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects.** See foregoing discussion for crab bycatch in yellowfin sole and Pacific ocean perch fisheries. Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA are currently unknown. Thus, the potential effects of these fisheries on mortality are not known. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. Under these proposed FMPs, it is possible that bycatch of golden king crab could decrease or be eliminated and additional protection measures could enhance habitat and possible recovery of depressed stocks. However, persistent past effects on these crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in BSAI and GOA is unknown. Thus, potential combined effects of mortality resulting from past events, direct internal catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 4.1 and FMP 4.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under FMP 4.1, predicted catch of bairdi Tanner, red king, and blue king crab in GOA showed decreases from current catch levels baseline for the next five years while FMP 4.2 eliminates crab bycatch. However, significance of these predicted changes in catch on mortality is unknown for bairdi Tanner and blue king crab due to lack of survey information for determining current stock status as a whole. Thus, effects of FMP 4.1 and FMP 4.2 on mortality of GOA bairdi Tanner and blue king crab are unknown. GOA red king crab stocks are considered severely depressed according to ADF&G survey information. It is unclear if possible decreases in catch or elimination of crab bycatch proposed under these FMPs will mitigate driving factors of mortality in these stocks. Potential effects of FMP 4.1 and FMP 4.2 on mortality in GOA red king crab populations are unknown due to the lack of recovery that has been observed in these stocks under current management plans. Under these proposed FMPs, it is possible that bycatch of crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks. Thus, FMP 4.1 and 4.2 are considered to have conditionally significant beneficial effects on GOA red king crab. The rating is conditional based on the lack of recovery for these stocks under current management plans.

- **Persistent Past Effects.** See previous discussion of past GOA crab bycatch. Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state directed, subsistence, and scallop fisheries could adversely impact recovery and sustainability of red king crab stocks in GOA. Long-term climate change and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status is unknown. Thus, potential combined effects of mortality resulting from past, present, and future events, internal catch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 4.1 and FMP 4.2. It is unclear if additional protection measures and decreases or elimination of crab bycatch put forth under these FMPs will mitigate the combined effects of mortality, resulting from past events, internal catch, and reasonably foreseeable future external events on severely depressed red king crab stocks. Therefore, cumulative effects of FMP 4.1 and FMP 4.2 on GOA red king crab cannot be determined at this time.

<u>Change in Biomass</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** Under FMP 4.1, predicted catch of these crab species decreases and increases from the current baseline condition in FMP 4.1 and is completely eliminated in FMP 4.2. Under FMP 4.1, trawl closure areas and protection areas are more extensive than other proposed FMPs, concentrating red king crab bycatch to a small area on the western edge of their distribution. Most bycatch of opilio and bairdi Tanner crab would come from the open areas east of the Pribilof Islands. In addition, bairdi Tanner crab catch would be shifted to the north as a result of closures in Bristol Bay and areas north of Unimak Island. Predicted crab bycatch varies by fishery. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed and in some instances, overfished. Under these proposed FMPs, it is possible that bycatch of crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks. Thus, FMP 4.1 and FMP 4.2 are considered to have conditionally significant beneficial effects on changes in biomass of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. The conditional rating is based on the lack of recovery these stocks have been shown under current management plans.

- **Persistent Past Effects.** See previous discussion of crab bycatch in yellowfin sole and Pacific ocean perch fisheries. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur and are considered to have a potential adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Potential effects of long-term climate change and regime shifts on crab biomass have not be determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. Under these proposed FMPs, it is possible that bycatch of crab could decrease or be eliminated and additional protection measures could enhance habitat and possible recovery of depressed stocks. Persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. It is unclear if additional protection measures and a decrease or elimination of crab bycatch will mitigate the combined effects of mortality and subsequent changes in biomass, resulting from past events, internal catch, and reasonably foreseeable future external events on depressed stocks. Thus, cumulative effects of FMP 4.1 and FMP 4.2 on BSAI crab stocks cannot be determined at this time.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current biomass of golden king crab in BSAI and GOA, potential effects of FMP 4.1 and FMP 4.2 on changes to biomass cannot be determined.

- **Persistent Past Effects.** See previous discussion of crab bycatch in yellowfin sole and Pacific ocean perch fisheries. The potential effects of past fishing mortality on biomass of golden king crab stocks in BSAI and GOA cannot be determined because catch composition is unknown, and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in BSAI and GOA is unknown, and biomass estimates have not been determined. Thus, the potential effects of these fisheries on biomass are not known. Effects of long-term climate change and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. Under these proposed FMPs, it is possible that bycatch of golden king crab could decrease or be eliminated and additional protection measures could enhance habitat and possible recovery of depressed stocks. However, persistent past effects on these crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status and biomass estimates of golden king crab in BSAI and GOA are unknown. Thus, potential combined effects of changes in biomass, resulting from past events, direct internal catch, bycatch, and reasonably foreseeable future external events cannot be determined at this time for FMP 4.1 and FMP 4.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under FMP 4.1, predicted catch of bairdi Tanner, red king, and blue king crab in GOA showed decreases from current baseline for the next five years while FMP 4.2 eliminates crab bycatch. However, significance of these predicted changes in catch on mortality is unknown for bairdi Tanner and blue king crab due to lack of survey information for determining current stock status as a whole. Thus, effects of FMP 4.1 and FMP 4.2 on mortality and subsequent changes in biomass of GOA bairdi Tanner and blue king crab are unknown. GOA red king crab stocks are considered severely depressed according to ADF&G survey information. It is unclear if possible decreases in catch or elimination of crab bycatch proposed under these FMPs will mitigate driving factors of mortality in these stocks. Potential effects of FMP 4.1 and FMP 4.2 on changes in biomass of GOA red king crab populations are unknown due to the lack of recovery that has been observed in these stocks under current management plans. Under these proposed FMPs, it is possible that bycatch of crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks. Thus, FMP 4.1 and FMP 4.2 are considered to have conditionally significant beneficial effects on changes in biomass of red king crab stocks in the GOA. The conditional rating is based on the lack of recovery observed for these stocks under current management plans.

- **Persistent Past Effects.** Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries (see previous discussion of persistent past effects on mortality). Adverse effects of past fishing mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in GOA may still exist as recovery of depressed stocks has not been observed.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on biomass of bairdi Tanner and blue king crab stocks cannot be determined. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with state directed, subsistence, and scallop fisheries could adversely impact recovery and sustainability of red king crab stocks in GOA. Effects of long-term climate change and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status and biomass estimates are unknown. Thus, potential combined effects of changes in biomass, resulting from past events, direct internal catch, bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time for FMP 4.1 and FMP 4.2. It is unclear if additional protection measures and decreased or elimination of crab bycatch put forth under these FMPs will mitigate the combined effects of mortality and subsequent changes to biomass, resulting from past events, internal catch, and reasonably foreseeable future external events on severely depressed red king crab stocks. Cumulative effects of FMP 4.1 and FMP 4.2 on GOA red king crab cannot be determined at this time.

Change in Reproductive Success

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects**. These stocks are currently considered depressed and in some instances, overfished. Changes in reproductive success within BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causation between spawning-recruitment reproductive success and depressed stock status cannot be concluded at this time. Therefore, the potential effects of FMP 4.1 and FMP 4.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** See previous discussion of persistent past effects on mortality. Past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations Dew and McConnaughey In review). Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Directed crab fishing seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at the time of this writing. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. A relationship between spawning-recruitment success and other factors impeding on reproductive potential to depressed stock status cannot be drawn at this time. Thus, potential effects on reproductive success resulting from past, present, and future events, internal catch, and reasonably foreseeable future external events are unknown for FMP 4.1 and FMP 4.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, potential effects of FMP 4.1 and FMP 4.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects.** See previous discussion of crab bycatch in yellowfin sole and Pacific ocean perch fisheries on mortality. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on reproductive success are unknown.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA are not known. Potential effects on reproductive success resulting from past events, direct internal catch, bycatch, and reasonably foreseeable future external events are unknown for FMP 4.1 and FMP 4.2.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in GOA, potential effects of FMP 4.1 and FMP 4.2 on changes to reproductive success cannot be determined. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery while other GOA stocks are still considered depressed. Red king crab populations in GOA are at historic lows according to ADF&G survey information. Changes in reproductive success within GOA crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causation between reproductive success and depressed stock status cannot be concluded at this time. Therefore, the potential effects of FMP 4.1 and FMP 4.2 on changes to reproductive success cannot be determined for bairdi Tanner and red king crab populations in GOA.

- **Persistent Past Effects.** See previous discussion of persistent past effects on mortality. Past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set to avoid mating and molting periods, so these fisheries are not considered contributing factors to changes in reproductive success of these stocks. The potential effects of long-term climate change and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the GOA may still exist, and some stocks are considered depressed with no signs of recovery to date. Thus, potential effects on reproductive success resulting from past events, direct internal catch, bycatch, and reasonably foreseeable future external events are unknown for FMP 4.1 and FMP 4.2.

Change in Prey Availability

Bairdi Tanner, Opilio Tanner, Red King, Blue King, and Golden King Crab in BSAI and GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, only BSAI opilio Tanner crab is included in this analysis.

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries catch has not been shown, and it is unclear if FMP 4.1 and FMP 4.2 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of FMP 4.1 and FMP 4.2 on changes in prey availability cannot be determined.

- **Persistent Past Effects.** Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past groundfish fisheries is minimal. Thus, past effects on crab prey structure and availability in BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Competition for prey species of crab resulting from groundfish fisheries catch has not been shown, and these fisheries are not considered contributing factors to changes in prey availability. Rebuilding plans currently in effect in BSAI do not address crab prey structure and availability and are not considered contributing factors to potential changes in prey availability. Long-term climate change and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the possible effects that these changes may have on crab populations throughout BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined and potential changes to prey structure resulting from Direct/Indirect Effects and reasonable foreseeable future events cannot be determined for all species of crab in BSAI and GOA for FMP 4.1 and FMP 4.2.

<u>Change in Habitat</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. However, a direct link between changes to habitat and the depressed stock status of these crab species in the BSAI cannot be concluded at this time. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks, but recovery has not been shown. Under these proposed FMPs, protection areas are more extensive than other FMPs, and it is likely that the elimination or severe restriction of trawling in BSAI would enhance recovery of crab habitat. However, it is impossible to predict the potential population-level effects that may result. Thus, FMP 4.1 and FMP 4.2 are considered to have conditionally significant beneficial effects on changes in habitat of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in BSAI. The conditional rating is based on the lack of recovery for these stocks under current management plans.

- **Persistent Past Effects.** See previous discussion of persistent past effects on mortality. Past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. The Japanese pot sanctuary area was established as a no-trawl zone in the early 1960s, but was eliminated in 1976 with the implementation of the MSA. This area coincided with the distribution of mature female red king crab brood stocks in the Bering Sea, and the removal of this protection has been suggested as having long-term detrimental effects on red king crab populations (Dew and McConnaughey In review). Thus, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of trawling and using other types of fishing gear that interact with bottom habitat. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Although much of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures. These fisheries are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Formal stock rebuilding plans are in place for BSAI bairdi and opilio

Tanner crab stocks. St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time and offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect. The population is currently considered depressed, and possible habitat-related effects have not been determined. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. Although much of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, recovery has not been shown. Under these proposed FMPs, protection areas are more extensive than other FMPs, and it is likely that the elimination or severe restriction of trawling in BSAI would enhance recovery of crab habitat. However, it is impossible to estimate the potential population-level effects that may result. Thus, potential cumulative effects on changes to crab habitat resulting from internal effects and reasonable foreseeable future events cannot be determined for FMP 4.1 and FMP 4.2.

Golden King Crab in BSAI and GOA

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of golden king crab in BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout BSAI and GOA. Potential effects of FMP 4.1 and FMP 4.2 to crab habitat are unknown.

- **Persistent Past Effects.** See previous discussion of persistent past effects on mortality. Past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as many of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur and are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for many of the crab stocks under current management plans and the depressed nature of some golden king crab stocks in GOA currently. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** Some GOA golden king crab stocks are considered depressed, and past effects may still exist as many of these stocks have not shown signs of recovery to date. Although much of the known habitat areas of BSAI and GOA crab are currently protected by no trawl zones and conservation zones, recovery of depressed stocks has not been shown. Under these proposed FMPs, protection areas are more extensive than other FMPs, and it is likely that the elimination or severe restriction of trawling in BSAI and GOA would enhance recovery of crab habitat. However, it is impossible to predict the potential population-level effects that may result. Thus, potential effects on golden king crab habitat resulting from past events, internal catch, and reasonably foreseeable future external events cannot be determined for FMP 4.1 and FMP 4.2 without first establishing the overall population and essential habitat status of this species.

Bairdi Tanner, Red King, and Blue King Crab in GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Red king and bairdi Tanner stocks in the GOA are currently considered depressed while blue king crab stock status is unknown, but presumed to be depressed based on limited survey data. Population data is limited for both bairdi Tanner and blue king crab stocks, thus the cumulative effects of FMP 4. 1 and FMP 4.2 on the habitat suitability of these stocks are unknown. Red king crab stocks in the GOA are severely depressed., However, a relationship between changes to habitat and depressed stock status cannot be drawn at this time. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks, but recovery of stocks has not been shown. Under these proposed FMPs, protection areas are more extensive than other FMPs, and it is likely that the elimination or severe restriction of trawling in GOA would enhance recovery of crab habitat. However, it is impossible to predict the potential population-level effects that may result. Thus, the potential effects of FMP 4.1 and FMP 4.2 on changes to bairdi Tanner, red king, and blue king crab habitat in GOA are unknown. Thus, FMP 4.1 and FMP 4.2 are considered to have conditionally significant beneficial effects on changes in habitat of red king crab stocks in BSAI. The conditional rating is based on the lack of recovery observed for these stocks under current management plans.

- **Persistent Past Effects.** See previous discussion of persistent past effects on mortality. Past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as some of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. These fisheries are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for some of these stocks under current management plans. Long-term climate change and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist and stocks are considered depressed with no signs of recovery to date. Although much of the known habitat areas of GOA crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included. Under these proposed FMPs, protection areas are more extensive than other FMPs, and it is likely that the elimination or severe restriction of trawling in GOA would enhance recovery of crab habitat. However, it is impossible to predict the potential population-level effects that may result. Thus, potential cumulative effects on GOA bairdi Tanner, red king, and blue king crab habitat resulting from past events, direct internal catch, bycatch, and reasonably foreseeable future external events cannot be determined for FMP 4.1 and FMP 4.2.

4.8.3 Other Species Alternative 4 Analysis

The other species category consists of the following species:

- Squid (order Teuthoidea).
- Sculpin (family Cottidae).
- Shark (Somniosus pacificus, Squalus acanthias, Lamna ditropis).
- Skate (genera Bathyraja and Raja).
- Octopi (Octopus dofleini, Opistholeutis california, and Octopus leioderma).

An aggregate TAC limits the catch of species in this category. Within the other species category, only shark are identified to the species level by fishery observers. Furthermore, accuracy of catch estimates depends on the level of coverage in each fishery. Estimates of observer coverage in the BSAI is 70 to 80 percent, whereas the GOA has only approximately 30 percent observer coverage. Coverage can vary for certain target fisheries and vessel sizes (Gaichas 2002). Further description of this management is described in detail in Section 3.5.3.

Formal stock assessments for other species are not currently conducted in the BSAI and GOA, and biomass estimates for the species included in this category are limited and often unreliable. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition . While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact the other species populations, or whether these impacts might be adverse, beneficial, or neutral. There are numerous direct and indirect effects that may impact the current and future status of individual species within this group and/or this group as a whole. These effects are presented in detail in the section that follows.

Direct/Indirect Effects FMP 4.1 – Other Species

Direct and indirect effects for other species include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups is unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch. Although the differences in catch between the comparative baseline and FMP 4.1 are relatively large in some cases, we still predict similar (unknown) effects on each stock.

The following component of FMP 4.1 was not implemented in the projection model used to generate these results: "For species managed as members of a stock complex, rather than setting TAC as the aggregate of the individual members' ABCs, the max ABC value for each component stock would be determined and the TAC set equal to the lowest value." If this component of FMP 4.1 were implemented along with all of the other management measures in this FMP, it is likely that catches of other species would be considerably lower than those reported here. This is because setting the TAC of all complexes to the lowest single species ABC would result in very low TACs for all rockfish and flatfish complexes as well as the other species complex, which would be quite constraining to target fisheries that encountered any members of the species complex. Therefore, the catch estimates reported here are the maximum likely to be taken under this alternative if it were fully implemented in reality.

Under FMP 4.1, total catch of BSAI squid and other species and GOA other species is predicted to drop to approximately one-third to one-half of the currently observed levels. This is due to predicted decreases in catches of the target species. Most of this decrease in both areas is predicted in the catch of skates. Species-specific catch projections are presented below.

Squid

In the BSAI, squid catch is predicted to be cut to one third of the current level over the five projection years, likely following trends in the pollock fishery. Squid catch is predicted to remain at or below the currently low levels over the five-year projection period in the GOA, likely reflecting stable catches in the pollock fishery.

Sculpin

Catches of BSAI sculpins are predicted to be cut in half relative to current catches. GOA sculpin catch is predicted to decrease by 200 mt relative to current levels.

Shark

BSAI shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of all of these species are predicted to remain relatively low and stable throughout the projection period. It is somewhat surprising that catch of Pacific sleeper shark is predicted to increase slightly under FMP 4.1, reversing the trend of nearly every other group under this alternative. As in the BSAI, shark catches are partitioned into Pacific sleeper shark, salmon shark, dogfish, and other shark in the GOA. While all shark catch in the GOA is predicted to be relatively low, catches of other shark are predicted to remain stable and catches of Pacific sleeper shark, salmon shark, and dogfish are predicted to decrease relative to current levels.

Skate

Catches of skate are predicted to decrease relative to current levels. Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the Target Species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined big and longnose skates in the central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway and improved collection of data is expected under this amendment.

Octopi

Octopus catch in the BSAI is predicted to remain stable at 300 to 400 mt per year. The trace amounts of octopus catch reported in the GOA are predicted to decrease slightly over the projection period, with no discernable differences in the currently unknown population impacts.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 4, FMP 4.1 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA other species is unknown under Alternative 4, FMP 4.1. The current baseline condition is unknown since species-specific catch information is deficient for this complex because species identification does not occur in the fisheries.

- **Persistent Past Effects.** Under current other species management in the BSAI and GOA, a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on other species resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA other species are unknown under Alternative 4, FMP 4.1. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm climatic trends favor recruitment while cool climatic trends weaken recruitment, but it is currently undetermined how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species within this complex are unknown and persistent past effects have not been identified. The combined effects of changes to reproductive success on other species resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in BSAI and GOA are unknown, under Alternative 4, FMP 4.1. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex have not been determined.

- **Persistent Past Effects.** The current genetic composition of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. This possible overexploitation could impact the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the other species complex, life history, and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the other species complex resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are unknown.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA other species is unknown under Alternative 4, FMP 4.1. The current baseline condition is unknown, and species-specific catch information is lacking for this complex since species identification does not occur in the fisheries. Formal stock assessments are not conducted for other species, and most biomass estimates for BSAI and GOA other species are unreliable or unknown.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and Non-specified Species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects**. In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm regimes favor recruitment while cool regimes weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on other species resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species are unknown under Alternative 4, FMP 4.1. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the other species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Persistent past effects potentially impacting habitat for some or all of these species could exist, but without a baseline condition established, those effects remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the other species complex, life history, and distribution information are minimal in both the BSAI and the GOA. These species have diverse habitat preferences and persistent past effects potentially impacting habitat could exist, but without a baseline condition established, those effects remain unknown. The combined effects of changes to habitat on other species resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are unknown.

Direct/Indirect Effects FMP 4.2 – Other Species

Direct and indirect effects for other species include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking in order to determine how these stocks respond to changes in catch.

Federal groundfish catch of all groups within the other species category in both the BSAI and GOA are reduced to zero under FMP 4.2. While this eliminates all effects of federal fishing on all species in this group, we still cannot determine what impact this has on populations within the other species category since so little is known about the effects of fishing on these populations.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 4, FMP 4.2 is shown in Table 4.5-43. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of eliminating federal fishing mortality on BSAI and GOA other species is unknown under Alternative 4, FMP 4.2. The current baseline condition is unknown, and species-specific catch information is lacking for this complex since species identification does not occur in the fisheries.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and Non-specified Species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown since current baseline conditions has not been determined. Long-term climate change and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects.** For all members of the other species complex, life history, and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on other Species resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA other species are unknown under Alternative 4, FMP 4.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm regimes favor recruitment while cool regimes weaken recruitment, but it is currently unknown how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history, and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on other species resulting from elimination of internal catch and occurrence of reasonably foreseeable future external events both human controlled and natural are unknown.

<u>Change in Genetic Structure of Population</u>

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in BSAI and GOA are unknown under Alternative 4, FMP 4.2. The current baseline condition is unknown, and genetic structure of species-specific populations within this complex have not been determined.

- **Persistent Past Effects.** The current genetic composition of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. This possible overexploitation could have impact on the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the other species complex resulting from elimination of internal catch and occurrence of reasonably foreseeable future external events both human controlled and natural are unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of eliminating federal fishing on change in biomass in BSAI and GOA other species is unknown under Alternative 4, FMP 4.2. The current baseline condition is unknown, and species-specific catch information is lacking for this complex since species identification does not occur in the fisheries. Formal stock assessments are not conducted for Other species, and most biomass estimates for BSAI and GOA other species are unreliable or not known.

- **Persistent Past Effects.** It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and Non-specified Species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continues to take other species as bycatch. However, potential impacts to specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm regimes favor recruitment while cool regimes weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations

- **Cumulative Effects.** For all members of the other species complex, life history, and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on other species resulting from elimination of internal catch and occurrence of reasonably foreseeable future external events both human controlled and natural are unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species are unknown under Alternative 4, FMP 4.2. A current baseline condition has not been determined.

- **Persistent Past Effects.** Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the other species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, those effects remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fishery, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to habitat of the specific species within this complex are unknown. Long-term climate change and regime shifts are not expected to result in significant change to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on other species resulting from elimination of internal catch and occurrence of reasonably foreseeable future external events both human controlled and natural are unknown.

4.8.4 Forage Fish Alternative 4 Analysis

The BSAI and GOA FMPs were amended in 1998 to establish a forage species category to prevent the development of directed fisheries on these ecologically important non-target species. Forage fish are described in more detail under Section 3.5.4.

Direct/Indirect Effects of FMP 4.1 – BSAI and GOA Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. The level of forage fish bycatch under FMP 4.1 is not expected to affect biomass because the level of incidental catch is already low.

Catch/Fishing Mortality

A directed fishery on forage species is prohibited by Amendments 36 and 39 in the BSAI and GOA FMP. However, forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (>90 percent most years) of the forage fish bycatch is made up of smelt species (Osmeridae) from the pollock fishery. In the BSAI region, model projections for FMP 4.1 indicate incidental catch of forage fish would drop sharply (Table H.4-22 in Appendix H). Over the next five years the incidental catch of forage fish in the GOA is projected to remain at similar levels to the baseline under FMP 4.1 (Table H.4-41 in Appendix H).

Fishing mortality of BSAI and GOA forage fish is unknown at this time. As described above, forage fish bycatch and hence fishing mortality, in the BSAI would drop under FMP 4.1. In the GOA the fishing mortality is predicted to continue at current levels.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality for forage species. It is unknown how the spatial or temporal concentration of fishing effort is expected to change under FMP 4.1.

Status Determination

The MSST of forage fish species is unknown at this time, but it is highly unlikely that management practices under FMP 4.1 would lead to stocks dropping below a sustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of the species in the forage fish group is unknown. However, it is assumed that the age and size composition of forage fish would not change under FMP 4.1. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest this would change under FMP 4.1.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to quantify. With the given data it would be extremely difficult to accurately assess the predator-prey impacts of FMP 4.1.

Cumulative Effects Analysis of FMP 4.1 – BSAI and GOA Forage Fish

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 4.1.

- **Persistent Past Effects** have not been identified for fishing mortality in the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects.** Possible impacts on mortality are indicated due to potential adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts are considered non-contributing factors, since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of forage fish (see Sections 3.5.4 and 3.10). Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish mortality; however, the removal of these species is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. Removals at projected levels are small and not expected to have a population level impact. The combined effect of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.

- **Persistent Past Effects** have not been identified for the change in biomass in the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects.** Changes in biomass are indicated due to the potential adverse contributions of marine pollution, since acute and/or chronic pollution events could cause forage fish mortality. Climate changes and regime shifts have been identified as having potential beneficial or adverse contributions on the forage fish biomass level. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Sections 3.5.4 and 3.10. The Alaska subsistence and personal use fisheries have been identified as a potential adverse contributor to the change in biomass level of BSAI and GOA forage fish. Subsistence and personal use fisheries concentrate mostly on the smelt species, and it is unlikely that these fisheries would have a population level effect.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 4.1, the effect of the spatial/temporal concentration of catch is unknown.

- **Persistent Past Effects.** The genetic structure of the BSAI and GOA forage fish are not identified. Climate changes and regime shifts are identified as influencing the reproductive success of BSAI and GOA forage fish. For example, some Osmeridae species have shown a decline in recruitment since the late 1970s coinciding with the increase water temperature.

- **Reasonably Foreseeable Future External Effects.** The reproductive success of forage fish due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has been identified as a potential adverse contribution, since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI and GOA forage fish. The Alaska subsistence and personal use fisheries are identified as having potential adverse contributors to the genetic structure and reproductive success of BSAI and GOA forage species. As stated above, these fisheries mainly target smelt species. It is unlikely the removals in these fisheries would be large enough and taken in a localized manner such that it would jeopardize the capacity of the stocks to maintain current population levels.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect is unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently insufficient.

Change in Prey Availability

- **Direct/Indirect Effects.** Under FMP 4.1, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** are identified for the change in prey availability of the BSAI and GOA forage fish stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.4 and 3.10 for more information on climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** The climate changes and regime shifts on the BSAI and GOA forage fish stock are potential beneficial or adverse. Marine pollution has been identified as a potential adverse contribution, since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to the prey availability of BSAI and GOA forage fish. However, the catch/bycatch of these species is expected to be minimal and unlikely to have a population level impact.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability; however, this effect is unknown. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under FMP 4.1, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for BSAI and GOA forage fish include climate changes and regime shifts. For more information, see Sections 3.5.4 and 3.10.

- **Reasonably Foreseeable Future External Effects.** The climate changes and regime shifts on the BSAI and GOA forage fish stock are potential beneficial or adverse. Marine pollution has been identified as a potential adverse contribution since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish habitat suitability. For more information on the effects of fishery gear on essential fish habitat see Section 3.6.

- **Cumulative Effects.** A cumulative effect is identified for BSAI and GOA forage fish habitat suitability; however, this effect is unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

Direct/Indirect Effects of FMP 4.2 – BSAI and GOA Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. Due to complex ecosystem interactions the effect of FMP 4.2 on the biomass of forage fish is difficult to predict.

Catch/Fishing Mortality

Under FMP 4.2, no fishing would be allowed unless it could be proven that the fishery did not have an adverse effect on the environment. With the cessation of all fishing, there would be no bycatch of forage species. Until a fishery that takes forage fish as bycatch was allowed to open, there would be no fishing mortality for forage fish under FMP 4.2.

Spatial/Temporal Concentration of Fishing Mortality

As stated above, there would be no fishing mortality under FMP 4.2.

Status Determination

Assuming no fishing pressure, it would be highly unlikely that forage fish species would drop below a hypothetical MSST.

Age and Size Composition

The age and size composition of the species in the forage fish group is unknown. The age and size composition of forage fish would most likely not change under FMP 4.2.

Sex Ratio

The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest this would change under FMP 4.2.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the suitability of the habitat occupied by forage fish.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the given data it would be extremely difficult to accurately assess the predator-prey impacts of FMP 4.2.

Cumulative Effects Analysis of FMP 4.2 – BSAI and GOA Forage Fish

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI and GOA forage fish is rated as insignificant under FMP 4.2.
- **Persistent Past Effects** have not been identified for fishing mortality in the BSAI or GOA forage fish stock.
- **Reasonably Foreseeable Future External Effects** on mortality the same as those indicated under FMP 4.1.
- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish and is rated as insignificant. The effect of external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.
- **Persistent Past Effects** have not been identified for the change in biomass in the BSAI or GOA forage fish stock.
- **Reasonably Foreseeable Future External Effects** on the change in biomass are the same as those described under FMP 4.1.
- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but the effect is unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under FMP 4.2, the effect of the spatial/temporal concentration of catch is unknown.
- **Persistent Past Effects** identified for the change in genetic structure and reproductive success of the BSAI and GOA forage fish are the same as those indicated under FMP 4.1.
- **Reasonably Foreseeable Future External Effects** identified for the change in genetic structure and reproductive success of the BSAI and GOA forage fish are the same as those indicated under FMP 4.1.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the forage fish catch; however, this effect is unknown. Information on the spatial/temporal concentration of the BSAI and GOA forage fish bycatch is currently insufficient.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under FMP 4.2, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for the change in prey availability are the same as those indicated under FMP 4.1.

- **Reasonably Foreseeable Future External Effects** identified for the change in prey availability are the same as those indicated under FMP 4.1.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown. Information on forage fish prey interactions is insufficient.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under FMP 4.2, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for the change in habitat suitability are the same as those described under FMP 4.1.

- **Reasonably Foreseeable Future External Effects** identified for the change in habitat suitability are the same as those described under FMP 4.1.

- **Cumulative Effects.** A cumulative effect is possible for BSAI and GOA forage fish habitat suitability; however, this effect is unknown. Information of forage fish habitat and the distribution of the fisheries on these habitats is insufficient at this time.

4.8.5 Non-Specified Species Alternative 4 Analysis

Grenadiers have been chosen to illustrate potential effects to non-specified species because they are currently the major catch in the non-specified FMP category. Non-specified species refers to a huge and diverse category encompassing every species not listed in the current FMP as a target, prohibited, forage, or other species. Considering a single species group from this category, such as grenadier, does not represent the diverse effects to all species in the category. However, because information is lacking for nearly all of these groups, and they are caught in small or unknown amounts (due to a lack of reporting requirements in this category), only potential effects to grenadier are discussed.

Formal stock assessments are not conducted for grenadiers. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to lack of a baseline condition. Changes in bycatch of grenadiers were predicted based on modeled changes in target species catches and population trajectories. Sablefish target fisheries have the most grenadier bycatch. While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact grenadier populations or whether these impacts might be adverse, beneficial, or neutral.

Direct/Indirect Effects FMP 4.1 – BSAI and GOA Non-Specified Species

Direct and indirect effects for grenadier include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown because information on stock status is lacking with regard to how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 4.1 are relatively small, such that diverse alternatives may have similar unknown effects on each stock.

The following component of FMP 4.1 was not implemented in the projection model used to generate these results: "For species managed as members of a stock complex, rather than setting TAC as the aggregate of the individual members' ABCs, the max ABC value for each component stock would be determined and the TAC set equal to the lowest value." If this component of FMP 4.1 were implemented along with all of the other management measures in this FMP, it is likely that catches of grenadiers would be considerably lower than those reported here. Setting the TAC of all complexes to the lowest single species ABC would result in very low TACs for all rockfish and flatfish complexes as well as the other species complex, which would be quite constraining to target fisheries that encounter any members of the species complex. Therefore, the catch estimates reported here are considered maximum amounts likely to be taken under this alternative if it were fully implemented.

Under FMP 4.1, catch of grenadiers in both the BSAI is predicted to remain within the currently observed range. In the GOA, grenadier catch is predicted to decrease slightly to just under 8,000 mt per year.

Cumulative Effects Analysis

A summary of the cumulative effects analysis associated with Alternative 4, FMP 4.1 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis, see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA grenadier is unknown under FMP 4.1. The current baseline condition is unknown. Catch information is lacking for all members of the non-specified category, since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier, and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited as stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA, and mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** For grenadiers and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on grenadiers, and other species with the non-specified complex, resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are unknown for FMP 4.1.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier, and presumably all other species within the non-specified complex, are unknown under FMP 4.1. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier, and all other species included in the non-specified category, in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. This possible over exploitation could have impacts to reproductive success if sex ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts on the reproductive success of grenadiers and other non-specified species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadiers, and all other members of the non-specified category, will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadiers and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on grenadiers and other non-specified species resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are unknown for FMP 4.1.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier and other species within the non-specified complex, populations in BSAI and GOA are unknown under FMP 4.1. The current baseline condition is unknown and genetic structure of species-specific populations within this complex have not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts on the genetic structure of the population if genetic composition within these species groups have been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, their potential impacts to genetic structure of the specific species populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For grenadiers and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are unknown for FMP 4.1.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadiers is unknown under FMP 4.1. The current baseline condition is unknown for all members of the non-specified complex, and species-specific catch information is lacking, since species identification does not occur in the fisheries. Formal stock assessments are not conducted. Biomass estimates in the BSAI and GOA for grenadiers, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. The current non-management of grenadiers could mask declines in individual grenadier species and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to the specific species within this complex are unknown, since current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadiers, and all other members of the non-specified group, depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment, while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadiers and all other species in the non-specified group, resulting from internal catch and reasonably foreseeable future external events both human controlled and natural are therefore unknown for FMP 4.1.

Direct/Indirect Effects FMP 4.2 – BSAI and GOA Non-Specified Species

Direct and indirect effects for grenadier include mortality along with changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown because information on stock status is lacking with regard to how these stocks respond to changes in catch. For many non-target species, the differences in catch between the comparative baseline and FMP 4.2 are relatively small, such that diverse alternatives may have similar unknown effects on each stock.

Federal groundfish fisheries catches of grenadiers and all groups within the non-specified species category in both the BSAI and GOA are reduced to zero under FMP 4.2. While this eliminates all effects of federal fishing on all species in this group, impacts on grenadiers or other populations within the non-specified species category cannot be determined, since little is known about the effects of fishing on these populations.

Cumulative Effects Analysis

A Summary of the cumulative effects analysis associated with Alternative 4, FMP 4.2 is shown in Table 4.5-46. For further information on persistent past effects included in this analysis, see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of eliminating federal fishing mortality on BSAI and GOA grenadier is unknown under FMP 4.2. The current baseline condition is unknown, and catch information is lacking for all members of the non-specified category since species identification does not occur in the fisheries.

- **Persistent Past Effects.** No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA, and mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown since current baseline condition has not been determined. Long-term climate change and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** For grenadiers and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on grenadiers and other species with the non-specified complex, resulting from elimination of internal catch and occurrence of reasonably foreseeable future external events both human controlled and natural are unknown for FMP 4.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier and presumably all other species within the non-specified complex are unknown under FMP 4.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** Current reproductive status of grenadier is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown since current baseline condition and species-specific reproductive status have not been determined. Long-term climate change and regime shifts could have impacts to the reproductive success of grenadiers and other non-specified species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadiers, and all other members of the non-specified category, will respond to climatic fluctuations.

- **Cumulative Effects.** For grenadiers and all other species within the non-specified category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to reproductive success on grenadiers and other non-specified species resulting from elimination of internal catch and occurrence of reasonably foreseeable future external events both human controlled and natural are unknown for FMP 4.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of grenadier, and other species within the non-specified complex populations in BSAI and GOA are unknown under FMP 4.2. The current baseline condition is unknown and genetic structure of species-specific populations within this complex have not been determined.

- **Persistent Past Effects.** The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to the genetic structure of the population if genetic composition within these species groups have been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, their potential impacts to genetic structure of the specific species' populations within this complex are unknown. Long-term climate change and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects.** For grenadiers and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from elimination of internal catch and occurrence of reasonably foreseeable future external events both human controlled and natural are unknown for FMP 4.2.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadiers is unknown under FMP 4.2. The current baseline condition is unknown for all members of the non-specified complex, and species-specific catch information is lacking, since species identification does not occur in the fisheries. Formal stock assessments are not conducted. Biomass estimates in the BSAI and GOA for grenadiers, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier and all other species included in the non-specified category in the BSAI and GOA could be disproportionately exploited; however, stock status remains unknown. The current non-management of grenadiers could mask declines in individual grenadier species and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries specifically sablefish and Greenland turbot longline, and IPHC halibut longline fishery continue to take grenadier and other non-specified species as bycatch. However, potential impacts to the specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate change and regime shifts could have impacts on the biomass of grenadiers, and all other members of the non-specified group, depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries, and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadiers and all other species in the non-specified group resulting from elimination of internal catch and occurrence of reasonably foreseeable future external events both human controlled and natural are unknown for FMP 4.2.

4.8.6 Habitat Alternative 4 Analysis

This policy represents an extremely precautionary approach to managing fisheries under scientific uncertainty. It shifts the burden of proof from demonstration of adverse impacts to prohibit or proscribe a fishery, to demonstration of no-adverse impact for authorization of a fishery. It would involve a strict interpretation of the precautionary principle. This policy assumes that fishing does produce adverse impacts on the environment. The initial restrictive and precautionary conservation and management measures would be modified or relaxed when additional, reliable scientific information becomes available.

Direct/Indirect Effects FMP 4.1 – Habitat

Alternative 4 represents a fundamental change in the management of the fisheries by presuming that the current groundfish fisheries are producing large-scale adverse effects on the marine ecosystem. Figure 4.2-6 illustrates the suite of year-round closures in the BSAI and GOA management areas. Under this FMP bookend, current levels of fishing are reduced and 20 to 50 percent of the management area would be designated as no-take marine reserves (i.e., no commercial fishing) within the 1,000-m bathymetric line. A special management area would be established in the Aleutian Islands to protect coral habitat. Trawling itself would be restricted to those fisheries that cannot be prosecuted with other gear types (i.e, the flatfish fisheries). Given these changes, management impacts to habitat are expected to be significantly reduced relative to baseline levels.

Direct and indirect effects of the FMP on habitat are discussed for changes to living habitat through direct mortality of benthic organisms and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to their habitat type differences, the Bering Sea, Aleutian Islands, and GOA are rated and discussed separately.

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Bering Sea**. Bottom trawling restrictions and major reductions in target species catches should reduce damage and mortality to living substrate. These restrictions should over-ride any shifts in fishing effort related to location of closure areas. For these reasons, the predicted impact of FMP 4.1 on mortality and damage to living habitat is significantly beneficial.

- **Aleutian Islands**. Bottom trawling restrictions and major reductions in target species catch should reduce damage and mortality to living substrate. For short-lived biota with fast recovery rates, recovery may occur quickly. For other species of living substrates such as long-lived corals and perhaps some sponges, increases over baseline levels may not occur or may occur after many years. For these reasons, the predicted impact of FMP 4.1 on mortality and damage to living habitat is significantly beneficial.

- **GOA**. Closures illustrated by FMP 4.1 encompass most of the heavily fished areas in the GOA suggesting areas with high target species density will be closed and catch may have to come from areas of less density. However, major reductions in target species catches that are a component of this FMP scenario should over-ride any negative impacts due to geographic shifts in fishing effort and should result in less overall impacts. For these reasons, the impact of FMP 4.1 on mortality and damage to living habitat is predicted to be significantly beneficial.

<u>Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection</u>

- **Bering Sea**. Table 4.5-49 shows that of the Bering Sea fishable area, 33.5 percent is closed to bottom trawling under FMP 4.1. Figure 4.8-1 shows areas closed to trawling at various times of the year under this FMP, while Figure 4.8-2 depicts those areas closed to fixed gear. Figure 4.8-3 overlays the closures over fishing intensity and shows that closure boundaries along 56° 30'N latitude and 165°W longitude and 57° 30'N between 165° and 166°W longitude bisect two clusters of heavily fished habitat, providing a diversity of fishing impact for habitat in the vicinity of the boundary. Other large expanses of high fishing intensity are either untouched by any closure (along 56° 30'N from 165° to 167°W longitude and further north at about 57° 10'N, from 56° 50'N to 57° 30'N latitude and 165° to 166° 40'W longitude) or totally encompassed by the closure (the cod corridor, along the north side of the Alaska Peninsula), resulting in no diversity of impact for the habitat in those areas. Still, given the size and location of the closed areas, the predicted overall effects of FMP 4.1 on benthic community diversity and on geographic diversity of impacts are significantly beneficial to habitat.

- **Aleutian Islands**. Figures 4.8-1 and 4.8-2 show the closure areas under FMP 4.1 broken down by gear type, bottom trawl and fixed gear. No closure boundaries illustrated under FMP 4.1 appear to bisect any existing cluster of high fishing intensity. However, increased levels of reallocated effort will likely result in some large scale improvements as a result of the suite of closures (see Figure 4.8-3). As shown on Table 4.5-49, about 85 percent of the fishable area in the Aleutians is closed to bottom trawling at one time or another during the year under this FMP, with about 70 percent of these closures being year-round no-take protected areas. Sufficient area would be closed as no-take reserves, with very little fishable area left open. The redistributed effort could produce areas of high fishing intensity with contrasting closed area boundaries. This would result in an increase in the geographic diversity of impacts. Based on these observations, the change of FMP 4.1 on benthic community diversity and geographic diversity of impacts is predicted to be significantly beneficial relative to the baseline.

- **GOA.** As shown on Figures 4.8-1 and 4.8-2, closures illustrated by FMP 4.1 are well distributed among geographical habitat types. The closure areas are large compared to the GOA spatial habitat or bathymetric resolution, and thus tend to encompass much of a bathymetric feature. Table 4.5-49 shows that FMP 4.1 closes nearly 81 percent of the fishable area in the GOA to trawling at one time or another during the year. About 38 percent of the fishable area is designated as no-take marine reserves. However, Figure 4.8-4 shows that the closures encompass clusters of historically high fishing intensity, leaving little diversity or contrast of fishing intensity within a bathymetric feature or habitat type. Therefore, little to no improvement in geographic diversity of impact would result. An overall improvement to geographic diversity of impacts could have been realized with smaller closure areas strategically placed so as not to encompass entire habitat types or clusters of fishing intensity. For example, the 13 closure areas on the upper slope should include some portion of areas where high fishing intensity has occurred, but need not be as large as illustrated in this FMP 4.1 bookend. Increased levels of reallocated effort may provide some large scale contrasts in fishing intensity. Effectiveness and evaluation may be confounded due to variable distribution of habitat in the GOA. Based on these observations, the predicted effects of FMP 4.1 on benthic community diversity is significantly beneficial. However, the predicted effects of FMP 4.1 on geographic diversity of impacts are insignificant compared to the baseline.

Cumulative Effects FMP 4.1

Cumulative effects on habitat for FMP 4.1 are summarized on Table 4.5-50. The following discussion is broken down by geographic area.

Bering Sea

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects**. As described in earlier sections, this effect is predicted to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Bering Sea. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing, described in Section 3.6, may have recovered or may be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts which include mortality due to smothering and/or reduced oxygen are expected to be more prevalent in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use are possible at several locations in the Bering Sea area, including Port Moller, Port Heiden, Dillingham, St. Paul and St. George. Again the impacts include mortality due to smothering, and/or burying and would only affect nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potentially adverse contribution because if large enough in scale, acute and/or chronic pollution events could cause mortality to benthic organisms. Again, areas more likely to be impacted are nearer to shore. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, are expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects** are identified for mortality of Bering Sea benthic organisms, and the effect is judged to be conditionally significant adverse. While benefits accrue due to the extensive reductions in TAC and establishment of MPAs, the cumulative rating is conditionally adverse due to the fact that the baseline is already considered to be impacted, and additional impacts, both internal from the FMP and external as shown on the table, cannot be eliminated. Neither the location of future closures nor their designation as no-take reserves or as gear-specific/species specific MPAs is certain. Therefore, the cumulative effect of the FMP on mortality could be conditionally significant adverse.

  However, if the closures proposed under FMP 4.1 were to be further defined based on additional information regarding important habitats in need of protection, and were properly designed and located to protect the sensitive habitats, future closures could provide successful mitigation of the effects of fishing. Over time, valued habitat that has been adversely affected by fishing could recover. Therefore, under that condition, cumulative effects may have more of a conditionally significant beneficial rating rather than conditionally significant adverse.

Changes to Benthic Community Structure

- **Direct/Indirect Effects**. As described earlier in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Bering Sea. Changes to benthic community structure, including a reduction in species diversity, have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing, described in Section 3.6, may be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, and marine pollution have the potential to cause changes to benthic communities. If long-term, as in the case of a change in a weather pattern, wind-induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with ENSO and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific. These changes could have either beneficial or adverse effects on the benthic community (see Sections 3.6 and 3.10).

- **Cumulative Effects** are identified for changes in benthic community structure of the Bering Sea, and the effect is judged to be conditionally significant adverse. However, as described above for mortality, while the reduction in bottom trawling and major reductions in target species catches prescribed in the FMP could provide benefits to community structure (see previous discussion for mortality), the baseline is already considered to be impacted, and additional impacts both internal from the FMP and external, as shown on the table, cannot be eliminated.

  As described previously for mortality, if the closures proposed under FMP 4.1 were to be further defined based on additional information regarding important habitats in need of protection, cumulative effects may have a conditionally significant beneficial rating rather than conditionally significant adverse.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects**. As described previously in this section, the effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected because fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 illustrate the spatial measures that were in effect before 1980 or were later established by regulations following the publication of the Final Groundfish Programmatic SEIS in November of 1980. As discussed in Section 3.6, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most of the restricted areas were implemented to spatially and temporally restrict the foreign fishery to prevent conflicts with domestic fisheries through bycatch of species important to U.S. fishermen, or grounds preemption and gear conflicts. Most domestic fishing efforts focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. This was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 almost nine percent of the fishable area in the Bering Sea was closed to trawling, with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time.

- **Reasonably Foreseeable Future External Effects** include port expansion and the potential resultant changes to offal discharge and marine pollution episodes. As ports in the Bering Sea are expanded and new ports are created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, the opening of new ports may allow vessels of all sizes to access new or relatively unfished areas. On the other hand depending on distribution, fishing pressure in heavily fished areas may be eased as access to other areas becomes available. Of course, closed areas that are proposed to continue under this FMP would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects** are identified for changes in distribution of fishing effort, and the effect is judged conditionally significant adverse. The maps and statistics discussed above show that FMP 4.1 would protect more benthic habitat from trawl gear (34 percent) than was protected in 1980 (8.6 percent). Several closure areas under this FMP cover a portion of high fishing intensity, thereby providing improvement in the geographic diversity of impacts. However, fishing will still occur, and the baseline is considered to be already adversely impacted. Therefore, the combination of the past external effects, along with the continuation of fishing effort in areas potentially already impacted, leads to the conditionally adverse rating in the cumulative case. However, as described for mortality, better definition and focus of the closures could lead to a conditionally significant beneficial rating.

Aleutian Islands

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutians. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. However, mobile epibenthic predators are not likely to exhibit lingering effects, since they can move into areas that are not fished (see Section 3.6). The areas historically and recently closed to fishing described in Section 3.6 may have recovered or may be recovering, with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution have the potential to cause direct mortality of benthic organisms and changes to living habitat. Dredging due to scallop fisheries and/or navigation can occur in localized areas (often in conjunction with port development) and can cause burial or smothering of benthic fauna. Damage to living substrates by longline and pot fisheries (see Section 3.6) has been documented and is expected to continue in the heavily fished areas. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts including mortality due to smothering and/or reduced oxygen are expected to be more prevalent in inshore, protected bay locations. However, improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and have potentially improved conditions. Port expansion and increased use are possible at several locations in the Aleutian Islands including Atkutan, Adak, Unalaska, Cold Bay, Dutch Harbor, and King Cove. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution because large enough acute and/or chronic pollution events could cause mortality to benthic organisms. Again, areas more likely to be impacted are located nearer to shore. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, are expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects** are identified for mortality of Aleutian Islands benthic organisms, and the effect is judged to be conditionally significant adverse. As described above for the Bering Sea, the rating is conditionally significant adverse in the cumulative case because fishing is still occurring, and the baseline is considered to be adversely impacted. However, also as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Aleutians. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or may be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline, and pot fisheries, offal discharge, port expansion and use, and marine pollution have the potential to cause changes to benthic communities. If long-term, as in the case of a change to a weather pattern, wind induced waves and surges could also cause sufficient changes to the substrate such that the benthic community is impacted. As discussed previously for mortality, all of these impacts are more likely to be observed in nearshore areas. Regime shifts and large-scale environmental fluctuations associated with ENSO and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific (see Sections 3.6 and 3.10). These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects** are identified for changes in benthic community structure of the Aleutians, but the effect is judged to be conditionally significant adverse. As described previously for morality, the baseline is considered to be adversely affected. It is not certain whether the closures under this FMP would be effective. Due to the fact that impacts are not eliminated, the cumulative effect is rated conditionally significant adverse.

  However, as described previously for mortality, if the closures proposed under FMP 4.1 were to be further defined and designed to protect important habitats, mitigation of fishing-related impacts could occur and cumulative effects may have more of a conditionally significant beneficial rating rather than conditionally significant adverse.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected because fishing effort and distribution has changed as areas have been closed and remain closed. As discussed previously for the Bering Sea, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 about 31 percent of the fishable area in the Aleutians was closed to trawling, with about six percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time.

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion, and the potential resultant changes to offal discharge and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be further impacted or allowed to recover. As with the Bering Sea, ports in the Aleutians will be expanded and new ports created, and additional dock space for harboring the fishing fleet will be made available. While the fleet might not necessarily expand, the distribution of fishing effort is likely to change and previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects** are identified for changes in distribution of fishing effort, and the effect is judged conditionally significant adverse. The maps and statistics discussed previously show that FMP 4.1 would protect more benthic habitat from trawl gear (85 percent) than was protected in 1980 (31 percent). Sufficient area would be closed as no-take reserves (70 percent of fishable area).The redistributed effort would result in an increase in the geographic diversity of impacts. Since the baseline is considered to be adversely impacted and the impacts are not eliminated in either external or internal fisheries, the cumulative effect is rated as conditionally significant adverse. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

GOA

Changes to Living Habitat –Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. However, mobile epibenthic predators are not likely to exhibit lingering effects because they can move into areas that are not fished (see Section 3.6). The areas historically and recently closed to fishing described in Section 3.6 may be recovered or may be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects**. As described for the Bering Sea and Aleutian Islands, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events have the potential to cause direct mortality of benthic organisms and changes to living habitat. Port expansion and increased use are possible at several locations in the GOA including Kodiak, Sand Point, Chignik, Port Lions, Ouzinkie, Valdez, and Seward. The impacts include mortality due to smothering and/or burying and would likely only affect nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution because large enough acute and/or chronic pollution events could cause mortality to benthic organisms. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organism.

- **Cumulative Effects** are identified for mortality of GOA benthic organisms, but the effect is judged to be conditionally significant adverse. While reductions in bottom trawling and major reductions in target species catches are prescribed in the FMP, the baseline is considered to be impacted and additional impacts, both external and internal are not eliminated. However, as described for the Bering Sea and Aleutian Islands, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

Changes to Benthic Community Structure

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the GOA. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may be recovered or may be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects**. As described for the other regions, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects** are identified for changes in benthic community structure of the GOA, and the effect is judged to be conditionally significant adverse. As described previously for mortality, while reductions in bottom trawling and major reductions in target species catches are prescribed in the FMP, the baseline is considered to be impacted and both external and internal additional impacts are not eliminated. However, as described previously further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

<u>Geographic Diversity of Impacts and Protection</u>

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a an insignificant change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected because fishing effort and distribution has changed over time as areas have been closed and remain closed. As discussed for the other regions, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring, and there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about five percent of the fishable area in the GOA was closed to trawling, with about seven percent closed to all fishing. The largest closures in the GOA concerned longline fishing where almost 61 percent of the fishable area was closed to longlining. Therefore, in 1980 about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at some time.

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and the potential resultant changes to offal discharge and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As ports in the GOA are expanded and new ports created, additional dock space for harboring the fishing fleet will be made available, and changes in the distribution of fishing effort could result. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects** are identified for changes in distribution of fishing effort, but the effect is judged conditionally significant adverse. The maps and statistics discussed above show that FMP

4.1 would protect much more benthic habitat from trawl gear (81 percent) than was protected in 1980 (16 percent). However, the closures encompass clusters of historically high fishing intensity, leaving little diversity or contrast of fishing intensity within a bathymetric feature or habitat type. Therefore, little to no improvement in geographic diversity of impact would result. Also, in 1980 more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under FMP 4.1 (38 percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. Therefore, because the baseline is considered to be adversely impacted and the impacts are not eliminated in either external or internal fisheries, the cumulative effect is rated as conditionally significant adverse.

However, as described previously for mortality, if the closures proposed under FMP 4.1 were to be further defined and designed to protect important habitats, mitigation of fishing-related impacts could occur and cumulative effects may have more of a conditionally significant beneficial rating rather than conditionally significant adverse.

Direct and Indirect Effects FMP 4.2 – Habitat

All fishing is suspended under this FMP until the fisheries can be reviewed and certified by the agency as having no significantly adverse effects on the resource and its environment. Figure 4.2-7 illustrates the year-round suspension of fishing in the BSAI and GOA management areas. Significantly adverse effects identified for each fishery would have to be mitigated through improved fishery practices or management measures before the fishery could be authorized in the EEZ. Such a scenario may result in a 2-year suspension with some fisheries being quickly certified (i.e., those with little or no bycatch) and others taking longer. Some fisheries may never be certified, or could only be certified following a period of scientific research.

Direct and indirect effects of the FMP on habitat are discussed for changes to living habitat through direct mortality or benthic organisms, and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to their habitat type differences the Bering Sea, Aleutian Islands, and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Bering Sea**. Protection of living habitat will increase from baseline levels. When $F = 0$, the estimate of equilibrium impact level is zero, which is less than estimates for under-baseline F levels. Benthic organisms will begin to increase in abundance toward the equilibrium from original baseline levels. For these reasons, it is predicted that FMP 4.2 would result in significantly beneficial change to mortality and damage to living habitat. However, for species like tree corals, returning to equilibrium levels may take an extremely long time.

- **Aleutian Islands**. When impact rates are zero, soft coral, tunicate, and other fast to intermediate recovering living habitats will increase from baseline levels, and gorgonian coral will cease to decrease from baseline levels. For these reasons, changes to mortality and damage to living habitat are predicted to be significantly beneficial due to FMP 4.2. However, for species like tree corals, returning to equilibrium levels may take an extremely long time.

- **GOA**. Living habitat will increase from baseline levels. When *F* = 0, the estimate of equilibrium impact level is zero, which is less than estimates for under-baseline *F* levels. Benthic organisms will begin to increase in abundance toward the equilibrium from original baseline levels. For these reasons, it is predicted that FMP 4.2 would result in significantly beneficial change to mortality and damage to living habitat. However, returning to equilibrium levels may take an extremely long time for species like tree corals.

<u>Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection</u>

- **Bering Sea, Aleutian Islands, and GOA**. With *F* = 0, there will be no fishing impacts to induce geographic diversity of impacts, and the benthic community may progress towards its unfished level over the short-term. Some species may recover extremely slowly or not at all depending on life history requirements and the length of the fishery suspension. Based on these results, the predicted change of FMP 4.2 on benthic community diversity and geographic diversity of impacts is predicted to be significantly beneficial relative to the baseline.

Cumulative Effects FMP 4.2

Cumulative effects of habitat for FMP 4.2 are summarized on Table 4.8-3. The following discussion is broken down by geographic area.

Bering Sea

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Bering Sea. These effects include persistent mortality of long-lived species such as tree corals and other sessile epifauna. See the cumulative effects write-up for FMP 4.1 for additional discussion.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events have the potential to cause direct mortality of benthic organisms and changes to living habitat (see the cumulative effects discussion for FMP 4.1 in the Bering Sea).

- **Cumulative Effects** are identified for mortality of Bering Sea benthic organisms, and the effect is judged to be conditionally significant adverse. As described for FMP 4.1, while beneficial effects of no fishing under the FMP accrue, the baseline is considered to be adversely impacted. Over the period of analysis for the FMP (out to five years), it is considered that the lingering past effects, particularly on long-lived species, will not be mitigated, especially since fishing in some form will likely occur within two years of cessation. However, careful definition and refinement of the areas open to fishing will occur under the new management regime because all fishing must be done in an environmentally safe manner. Therefore, as with FMP 4.1, the combination of external and internal effects lead to the cumulative rating of conditionally significant beneficial to conditionally significant adverse depending on the location of fishing when it resumes and recovery times of habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Bering Sea. Persistent changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see Section 4.8.6).

- **Reasonably Foreseeable Future External Effects**. As described for FMP 4.1, offal discharge, port expansion and use, marine pollution, and natural events have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects** are identified for changes in benthic community structure of the Bering Sea, and the effect is judged to be conditionally significant adverse for reasons described above under mortality. Over the period of analysis for the FMP (out to five years), it is considered that the lingering past effects, particularly on long-lived species, will not be mitigated, especially because fishing in some form will likely occur within two years of cessation. The combination of external and internal effects lead to the cumulative rating of conditionally significant adverse. However, as described above for mortality, once fishing is allowed it must occur in an environmentally safe manner and effects would be similar to those described for FMP 4.1. Therefore, cumulative effects could range from conditionally significant beneficial to conditionally significant adverse.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects**. As described above in this section, the effects of FMP 4.2 on geographic diversity of impacts is significantly beneficial .

- **Persistent Past Effects** are expected because fishing effort and distribution has changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 almost nine percent of the fishable area in the Bering Sea was closed to trawling, with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time. The cumulative effects section for FMP 4.1 provides additional details regarding past effects.

- **Reasonably Foreseeable Future External Effects** include port expansion and the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes (see the discussion for FMP 4.1). Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects**. Once fishing commences, the predicted change to geographic diversity of impacts is expected to be similar as that described for the FMP 4.1 bookend.

Aleutian Islands

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutians. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see the FMP 4.1 cumulative effects write-up).

- **Reasonably Foreseeable Future External Effects**. As described for FMP 4.1, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events have the potential to cause direct mortality of benthic organisms and changes to living habitat.

- **Cumulative Effects** are identified for mortality of Aleutian Islands benthic organisms, and the effect is judged to be conditionally significant adverse. As described for FMP 4.1, benefits will accrue due to the cessation of fishing; however, the baseline is considered to be adversely impacted and impacts are not eliminated under this FMP. Over the period of analysis for the FMP (out to five years), it is considered that the lingering past effects, particularly on long-lived species, will not be mitigated, especially because fishing in some form will likely occur within two years of cessation. Therefore, the combination of external and internal effects lead to the cumulative rating of conditionally significant adverse. However, as described above for mortality, once fishing is allowed it must occur in an environmentally safe manner and effects would be similar to those described for FMP 4.1. Therefore, cumulative effects could range from conditionally significant beneficial to conditionally significant adverse.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the Aleutians. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see the FMP 4.1 cumulative effects discussion for the Aleutian Islands).

- **Reasonably Foreseeable Future External Effects**. As described for FMP 4.1, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects** are identified for changes in benthic community structure of the Aleutians, and the effect is judged to range from conditionally significant adverse to conditionally significant beneficial for reasons described above under mortality.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects**. As described previously in this section, this effect is significantly beneficial.

- **Persistent Past Effects** are expected because fishing effort and distribution has changed as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 31 percent of the fishable area in the Aleutians was closed to trawling, with about six percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time (see Section 4.8.6).

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case (see the FMP 4.1 discussion).

- **Cumulative Effects**. Once fishing commences, the predicted change to geographic diversity of impacts is expected to be similar as that described for the FMP 4.1 bookend.

GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see the FMP 4.1 discussion).

- **Reasonably Foreseeable Future External Effects**. As described for FMP 4.1, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events have the potential to cause direct mortality of benthic organisms and changes to living habitat in the GOA.

- **Cumulative Effects** are identified for mortality of GOA benthic organisms, and the effect is judged to be conditionally significant adverse. As described for FMP 4.1, benefits will accrue due to the cessation of fishing; however, the baseline is considered to be adversely impacted and impacts are not eliminated under this FMP. Over the period of analysis for the FMP (out to five years), it is considered that the lingering past effects, particularly on long-lived species, will not be mitigated, especially because fishing in some form will likely occur within two years of cessation. Therefore, the combination of external and internal effects lead to the cumulative rating of conditionally significant adverse. However, as described previously for mortality, once fishing is allowed it must occur in an environmentally safe manner and effects would be similar to those described for FMP 4.1. Therefore, cumulative effects could range from conditionally significant beneficial to conditionally significant adverse.

Changes to Benthic Community Structure

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to result in a significantly beneficial change to the baseline, but as described in Section 3.6 the baseline is considered to be already adversely impacted.

- **Persistent Past Effects** are expected in heavily fished areas of the GOA. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see the FMP 4.1 discussion).

- **Reasonably Foreseeable Future External Effects**. As described for FMP 4.1 in the GOA, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects** are identified for changes in benthic community structure of the GOA, and the effect is judged to range from conditionally significant adverse to conditionally significant beneficial for reasons described previously for mortality.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects**. As described previously in this section, this effect is judged to be significantly beneficial.

- **Persistent Past Effects** are expected because fishing effort and distribution has changed as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about five percent of the fishable area in the GOA was closed to trawling, with about seven percent closed to all fishing. The largest closures in the GOA concerned longline fishing where almost 61 percent of the fishable area was closed to longlining. Therefore, in 1980 about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at some time (see the FMP 4.1 cumulative effect discussion).

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion and the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects**. Once fishing resumes, The predicted change to geographic diversity of impacts is expected to be similar as that described for the FMP 4.1 bookend.

4.8.7 Seabirds Alternative 4 Analysis

4.8.7.1 Short-Tailed Albatross

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Incidental Take

Under FMP 4.1, seabird protection measures would be established for all species with the goal of reducing incidental take of ESA-listed species and species of management concern to levels approaching zero. For short-tailed albatross, reducing take to levels approaching zero has been the goal of NOAA Fisheries and USFWS for at least ten years, so there is no change in intent from the baseline condition. From a practical standpoint, this policy will lead to essentially the same development and implementation of regulations for the longline and trawl fleets as are described for FMP 3.2 in Section 4.7.7.1. Since the seabird avoidance techniques are likely to be the same, the difference between FMP 3.2 and FMP 4.1 will be the greatly reduced fishing effort under FMP 4.1. Longline effort under FMP 4.1 is predicted to be only about six percent of the baseline effort in the BSAI and 30 percent of the baseline effort in the GOA. Combined with highly effective deterrence techniques, this major reduction in fishing effort will essentially eliminate the chances of incidentally taking short-tailed albatross on longline gear. Trawl effort would be reduced under FMP 4.1 to approximately 60 percent of the baseline effort in the BSAI and 30 percent of the baseline in the GOA. Combined with mitigation measures, this reduction in trawl effort should substantially reduce the chances of taking short-tailed albatross in trawl gear or third wire collisions.

Under FMP 4.2, all fishing efforts would cease until particular fisheries were certified as having minimal environmental effects. The process of certification has not been defined, so which fisheries are likely to pass such certification tests are unknown. When the management policy is first enacted; however, no commercial groundfish fishing would be allowed except under special experimental permits for certification purposes. This is the situation that will be analyzed for the effects of FMP 4.2 on seabirds. With the virtual elimination of fishing effort, the incidental take of short-tailed albatross will be reduced to zero. The expected take of short-tailed albatross under FMP 4.1 and FMP 4.2 would therefore approach zero and be considered insignificant at the population level.

Changes in Food Availability

Short-tailed albatross forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under FMP 4.1 or FMP 4.2. The fisheries are considered to have insignificant effects on short-tailed albatross through availability of food.

Benthic Habitat

Short-tailed albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under FMP 4.1 or FMP 4.2. The fisheries are therefore considered to have no effects on short-tailed albatross through benthic habitat.

Cumulative Effects of FMP 4.1 and FMP 4.2

The past/present effects on short-tailed albatross are described in Section 3.7.4 (Table 3.7-12). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for this species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.1 (Table 4.5-52) and summarized below.

Mortality

- **Direct/Indirect Effects**. Under FMP 4.1, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be installed and then improved through further research. In addition, effective seabird protection measures for the trawl fleet would be developed through collaborative research and would lead to a reduced likelihood of taking short-tailed albatross in the longline and trawl groundfish fleets. Combined with a greatly reduced level of fishing effort under FMP 4.1, these measures are expected to reduce incidental take of short-tailed albatross to a level approaching zero, which is considered insignificant at the population level. Under FMP 4.2, the groundfish fisheries would be suspended; therefore, there would be insignificant effects on short-tailed albatross through mortality.

- **Persistent Past Effects**. The most important persistent influence on the short-tailed albatross population is their near extinction due to commercial feather hunting. Conservation efforts have allowed the population to recover at or near to its biologically maximum rate. The total fishery-related mortality of short-tailed albatross is unknown, but it does not appear to be having an overriding effect on the population growth rate.

- **Reasonably Foreseeable Future External Effects**. The short-tailed albatross population may be substantially affected by several natural and human-caused mortality factors that may or may not occur in the future, including volcanic eruptions on their main breeding site, Torishima Island, and increased rates of incidental take in fisheries throughout their range. If the species experiences a substantial increase in mortality that threatens its recovery, it may lead to further efforts to protect the species from fishery interactions.

- **Cumulative Effects**. The population of short-tailed albatross is susceptible to several natural and human-caused mortality factors that may or may not occur in the future, including an extremely small chance of incidental take in the groundfish fisheries under FMP 4.1, and zero chance of incidental take under FMP 4.2. Therefore, the cumulative effect on short-tailed albatross is considered to be conditionally adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch. This effect is considered insignificant at the population level for short-tailed albatross.

- **Persistent Past Effects**. Short-tailed albatross primarily prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to natural fluctuations in primary productivity and oceanographic factors. Pollution from a variety of land and marine sources has potentially affected short-tailed albatross prey in the past, but specific toxicological effects are unknown.

- **Reasonably Foreseeable Future External Effects**. There are no foreseeable fisheries that will likely have more than a negligible effect on short-tailed albatross prey availability. Pollution is likely to affect short-tailed albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to short-tailed albatross, can not be made at this time.

- **Cumulative Effects**. The cumulative effect of all fisheries on the abundance and distribution of short-tailed albatross prey is considered to be insignificant at the population level under FMP 4.1 and FMP 4.2.

Benthic Habitat

Short-tailed albatross feed at the surface, and their prey live in the upper and middle levels of the water column. Therefore, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for short-tailed albatross.

4.8.7.2 Laysan Albatross and Black-Footed Albatross

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Incidental Take

New seabird protection measures for the longline and trawl sectors, in addition to greatly reduced fishing effort would reduce incidental take of albatross to levels approaching zero. The overall effect of FMP 4.1 and FMP 4.2 on the incidental take of these albatross species is considered insignificant.

Changes in Food Availability

Albatross forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the groundfish fishery. FMP 4.1 and FMP 4.2 are therefore considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery. FMP 4.1 and FMP 4.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 4.1 and FMP 4.2

The past/present effects on Laysan and black-footed albatross are described in Sections 3.7.2 and 3.7.3 (Tables 3.7-6 and 3.7-7). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Tables 4.5-53 and 4.8-4) and summarized below.

Mortality

- **Direct/Indirect Effects**. Under FMP 4.1, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be installed and then improved through further research. In addition, effective seabird protection measures for the trawl fleet would be developed through collaborative research and would thus lead to reduced incidental take of albatross in the longline and trawl groundfish fleets. Combined with a greatly reduced level of fishing effort under FMP 4.1, these measures are expected to reduce incidental take of albatross substantially below the baseline level of incidental take, which is considered insignificant at the population level for both albatross species. Under FMP 4.2, the groundfish fisheries would be suspended, thus there would be no effect on Laysan and black-footed albatross through mortality.

- **Persistent Past Effects**. For black-footed and Laysan albatross, past mortality factors include large contributions from foreign longline fisheries and Hawaiian pelagic longline fisheries, a smaller contribution from the BSAI and GOA longline fisheries, and an unknown contribution from other longline fisheries (IPHC), trawl fisheries, and vessel collisions throughout their range. Both species have been experiencing population declines over the past decade. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown for both albatross species.

- **Reasonably Foreseeable Future External Effects**. New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets that are expected to reduce take of albatross in those fisheries. It is expected that incidental take of black-footed and Laysan albatross in foreign longline fisheries will remain high and will continue to exceed the threshold for population level effects.

- **Cumulative Effects**. The populations of black-footed and Laysan albatross are undergoing measurable declines and several human-caused mortality factors have been identified and are expected to continue in the future, including minimal contributions from the groundfish fisheries under FMP 4.1, and zero contribution from the groundfish fisheries under FMP 4.2. Therefore, the cumulative effects on black-footed and Laysan albatross are considered to be significantly adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects**. The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch. This effect is considered insignificant at the population level for both albatross species. While groundfish vessels contribute to overall marine pollution through spills and vessel accidents, the effects of this pollution on albatross prey populations can not be assessed at this time.

- **Persistent Past Effects**. Albatross primarily prey on squid species and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since albatross can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected albatross prey in the past. However, very little is known about the specific toxicological effects on prey species important to albatross or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects**. There are no foreseeable fisheries that are likely to have more than a negligible effect on albatross prey availability. Pollution is likely to affect albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to albatross, can not be made at this time.

- **Cumulative Effects**. The cumulative effect of all fisheries on the abundance and distribution of albatross prey is considered to be insignificant at the population level for all species.

Benthic Habitat

Since albatross feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.8.7.3 Shearwaters

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Incidental Take

New seabird protection measures for the longline and trawl sectors and greatly reduced fishing effort would greatly reduce incidental take of shearwaters, which is currently considered insignificant at the population-level. The overall effect of FMP 4.1 and FMP 4.2 on the incidental take of these shearwater species is considered insignificant.

Changes in Food Availability

Shearwaters forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the groundfish fishery. FMP 4.1 and FMP 4.2 are considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Shearwaters are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery. FMP 4.1 and FMP 4.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 4.1 and FMP 4.2

The past/present effects on sooty and short-tailed shearwaters are described in Section 3.7.6 (Table 3.7-14). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.3 (Table 4.5-54 and 4.8-4) and summarized below.

Mortality

- **Direct/Indirect Effects**. Under FMP 4.1, effective seabird protection measures would be developed for the longline and trawl fleets through collaborative research and would lead to reduced incidental take of shearwaters in both sectors. Combined with a greatly reduced level of fishing effort under FMP 4.1, these measures are expected to reduce incidental take of shearwaters substantially below the baseline level of incidental take, which is considered insignificant at the population level for both shearwater species. Under FMP 4.2, the groundfish fisheries will be suspended; therefore, there would be no effects on shearwaters through mortality.

- **Persistent Past Effects**. For sooty and short-tailed shearwaters, mortality factors include large contributions from subsistence and commercial harvest of chicks on the nesting grounds, as well as climatic and oceanic fluctuations that cause periodic mass starvation, substantial contributions from foreign, Hawaiian, and BSAI and GOA groundfish longline and trawl fisheries, and a smaller contribution from vessel collisions throughout their range. It is difficult to assess the population trends in these abundant and widespread species, but there are some indications that both species may be declining. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment is unknown for both species.

- **Reasonably Foreseeable Future External Effects**. Incidental take of shearwaters will likely continue in external longline and trawl fisheries as in the past unless longline and trawl deterrence techniques that are effective for diving species are developed and applied.

- **Cumulative Effects**. The populations of shearwaters may be undergoing declines and several human-caused mortality factors have been identified and are expected to continue in the future, including small contributions from the groundfish fisheries under FMP 4.1, and no contributions from the groundfish fishery under FMP 4.2. Therefore, the cumulative effects on sooty and short-tailed shearwaters are considered to be conditionally adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects**. The groundfish fisheries would continue to take a very small amount of squid as bycatch. This effect is considered insignificant at the population level for both shearwater species. While groundfish vessels contribute to overall marine pollution through spills and vessel accidents, the effects of this pollution on shearwater prey populations can not be assessed at this time.

- **Persistent Past Effects**. Short-tailed and sooty shearwaters are susceptible to periodic widespread food shortages that have caused massive die-offs in Alaskan waters. Natural fluctuations in primary productivity and oceanographic factors are considered to be the driving forces that determine the abundance of their main prey (euphausiids) rather than competitive interactions with other predators. Since shearwaters can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected shearwater prey in the past. However, very little is known about the specific toxicological effects on species important to these seabirds or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects**. There are no foreseeable fisheries that are likely to have more than a negligible effect on shearwater prey availability. Pollution is likely to affect shearwater prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to shearwaters, can not be made at this time.

- **Cumulative Effects**. The cumulative effect of all fisheries on the abundance and distribution of shearwater prey is considered to be insignificant at the population level for both shearwater species.

Benthic Habitat

Since shearwaters feed at the surface or with shallow dives, and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for these species.

4.8.7.4 Northern Fulmar

Direct/Indirect Effects FMP 4.1 and FMP 4.2

Incidental Take

New seabird protection measures for the longline and trawl sectors, in addition to greatly reduced fishing effort would reduce incidental take of fulmars to hundreds of birds or less under FMP 4.1, rather than over 15,000 per year under baseline conditions. Incidental take under FMP 4.2 would approach zero. For such an abundant species, this level of take would be considered negligible on a population level. This reduced level of take would eliminate concerns over possible colony level effects. The overall effect on the incidental take of fulmars is considered insignificant.

Changes in Food Availability

Fulmars forage over vast areas of ocean and are unlikely to be affected by any potential localized disturbance or depletion of prey from the groundfish fishery. FMP 4.1 and FMP 4.2 are therefore considered to have insignificant effects on fulmars through availability of food.

Benthic Habitat

Fulmars are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery. FMP 4.1 and FMP 4.2 are considered to have no effects on fulmars through benthic habitat.

Cumulative Effects of FMP 4.1 and FMP 4.2

The past/present effects on northern fulmars are described in Section 3.7.5 (Table 3.7-13) and the predicted direct and indirect effects of the groundfish fishery are described in Section 4.5.7.4 (Table 4.5-55). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Tables 4.5-55 and 4.8-4 and summarized below.

Mortality

- **Direct/Indirect Effects**. Under FMP 4.1, the new seabird protection measures for the longline fleet that are described in Section 3.7.1 would be installed and then improved through further research. In addition, effective seabird protection measures for the trawl fleet would be developed through collaborative research and would lead to reduced incidental take of fulmars in the longline and trawl groundfish fleets. Combined with a greatly reduced level of fishing effort under FMP 4.1, these measures are expected to reduce incidental take of fulmars substantially below the baseline level of incidental take, which is considered insignificant at the population level.

- **Persistent Past Effects**. For northern fulmars, past mortality factors include large contributions from the BSAI and GOA groundfish fisheries and other net and longline fisheries in the North Pacific and

Bering Sea. There is no indication of an area-wide population decline, but there is some concern that particular colonies may be experiencing declines related to the groundfish fisheries. Other potential mortality factors that have been identified include acute and chronic effects of pollution, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation) due climatic and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects**. Incidental take of fulmars is expected to continue in all offshore fisheries in the BSAI and GOA. The IPHC fisheries will be subject to new seabird avoidance measures, so incidental take from the halibut and sablefish fleet is expected to decline substantially. Future oil spills and other incidents of pollution are likely, but their effects on fulmars will depend on many factors that can not be predicted.

- **Cumulative Effects**. The population of northern fulmars appears to be stable and the primary human-caused mortality factors, including contributions from the groundfish fisheries under FMP 4.1 are expected to decline in the future, and no contribution under FMP 4.2. Therefore, the cumulative effects on fulmars are considered to be insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects**. The groundfish fisheries would continue to take a very small amount of forage fish and pelagic invertebrates as bycatch. This effect is considered insignificant at the population level for northern fulmars. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on fulmar prey populations can not be assessed at this time.

- **Persistent Past Effects**. Fulmars prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since fulmars can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected fulmar prey in the past. However, very little is known about the specific toxicological effects on species important to fulmars or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects**. There are no foreseeable fisheries that will likely have more than a negligible effect on fulmar prey availability. Pollution is likely to affect fulmar prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to fulmars, can not be made at this time.

- **Cumulative Effects**. The cumulative effect of all fisheries on the abundance and distribution of fulmar prey is considered to be insignificant at the population level.

Benthic Habitat

Since fulmars feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernible effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for this species.

4.8.7.5 Species of Management Concern (Red-Legged Kittiwakes, Marbled and Kittlitz's Murrelets)

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Incidental Take

Since incidental take of these species approaches zero under the baseline conditions, the major reduction of fishing effort plus new seabird protection measures under FMP 4.1 would essentially eliminate the chances of taking these species in any groundfish fishery. Incidental take under FMP 4.2 would approach zero. The effect of the groundfish fishery on incidental take of these species is considered insignificant at the population level.

Changes in Food Availability

The effects of the groundfish fishery on prey availability for these species is considered insignificant under the baseline conditions (Section 4.5.7.5). Since overall TAC is greatly reduced under FMP 4.1 and eliminated in the short-term under FMP 4.2, and many areas potentially important to foraging seabirds may be placed in MPAs, the potential effect of the fisheries is substantially reduced from the baseline conditions. The effect of FMP 4.1 and FMP 4.2 on the prey availability of these species is considered insignificant at the population level.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of groundfish management. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles. However, benthic habitats in their nearshore foraging areas would not be affected directly by groundfish trawls as these take place further offshore. FMP 4.1 and FMP 4.2 are considered to have insignificant effects on the murrelet species through benthic habitat.

Cumulative Effects of FMP 4.1 and FMP 4.2

The past/present effects on red-legged kittiwakes, marbled murrelets, and Kittlitz's murrelets are described in Sections 3.7.13 and 3.7.17 (Table 3.7-22 and 3.7-26) and the predicted direct and indirect effects of the groundfish fishery are described (Table 4.5-56). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.5 (Tables 4.5-56 and 4.8-4) and summarized below.

Mortality

- **Direct/Indirect Effects**. Under FMP 4.1, new seabird protection measures for the longline and trawl fleets would be implemented and fishing effort would be much less than under baseline conditions. The incidental takes of red-legged kittiwakes and both murrelets are expected to be very rare, if they occur at all, and are insignificant at the population level under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects**. Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging (red-legged kittiwakes), incidental take in coastal salmon gillnet and other net fisheries (murrelets), oil spills (murrelets), and logging of nest trees (marbled murrelets). Incidental take in the BSAI and GOA groundfish fisheries appears to have contributed very little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects**. All of the mortality factors listed above in persistent past effects are likely to continue in the future. For red-legged kittiwakes, the introduction of nest predators or a large oil spill around the Pribilof Islands in nesting season could have significant effects on mortality. For the murrelet species, oil spills in nearshore habitats and incidental take in salmon and other net fisheries are likely to remain the largest factors in the future. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may contribute to future mortality. If the Kittlitz's murrelet population continues to decline and the species is listed under the ESA, new regulations may be placed on the various nearshore net fisheries to monitor and reduce incidental take of the species. These measures would also benefit marbled murrelets.

- **Cumulative Effects**. The three species in this group have all experienced substantial population declines in the recent past and are all susceptible to future human-caused mortality factors, including potentially minimal contributions from the groundfish fishery. The decline of red-legged kittiwakes on the Pribilofs may have been reversed recently, but it is not clear if their recovery will continue in the future. The cumulative effect for red-legged kittiwake is considered conditionally significant adverse at the population level through mortality. Both murrelet species continue to decline in their core areas and are considered to have significantly adverse cumulative effects at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects**. The groundfish fisheries would continue to take a very small amount of forage fish and pelagic invertebrates as bycatch. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all three species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects**. All three species prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources, including the EVOS, has likely affected the prey of these species in the past. Since murrelets are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded murrelets from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects**. Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects**. While the groundfish fisheries are considered to have an insignificant effect on prey availability on their own, the dynamic interaction of natural and human-caused events, including fisheries and pollution, on the availability of forage fish and invertebrate prey to seabirds is beginning to be explored with directed research. Since this dynamic could conceivably be adverse or beneficial depending on different circumstances, the cumulative effect on prey availability is considered to be unknown for these three species.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery; therefore, there are no cumulative effects on red-legged kittiwakes under FMP 4.1 and FMP 4.2. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles, but they forage in shallow waters that are inshore of the groundfish fishery. Since the groundfish fishery would contribute minimally to potential effects on benthic habitats important to murrelets, an insignificant cumulative effect is identified for these species.

4.8.7.6 Other Piscivorous Species (Most Alcids, Gulls, and Cormorants)

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Incidental Take

The surface-feeding gulls in this piscivore group would benefit the most from protection measures and reductions in fishing effort for the longline fleet, while the diving alcids and cormorants would benefit the most from mitigation and reductions in effort for the trawl fleet. All species would be expected to have substantially reduced levels of mortality relative to baseline conditions. Since the baseline level of take is already considered insignificant at the population level for these species (Section 4.5.7.6), reduced levels of take would also be considered insignificant.

Changes in Food Availability

As described in Section 4.5.7.6, the potential effects of the groundfish fishery on piscivore prey availability are considered to be insignificant on the population level under the baseline conditions. Under FMP 4.1, total TAC and fishing effort in the trawl and longline fleets would be substantially reduced. This would reduce the potential impact of the fishery on forage fish even more than the baseline condition. In addition, under FMP 4.1, 20 to 50 percent of the BSAI and GOA would be designated as no-fishing marine reserves. To the extent that these reserves were established in areas important to seabirds, these no-fishing areas could serve as refugia from potential fishery-induced disturbance or localized depletions of seabird prey. The contribution of the fishery to the food supply of gulls in the form of fishery discards would be reduced in proportion to the reductions in TAC. If this supplemental food supply is important to the survival or reproductive rates of particular species (i.e. the large gulls), an assumption that has not been tested in Alaska, the reduction in offal under FMP 4.1 could have population level effects for some species. However, other species like kittiwakes and murres would likely benefit from reduced rates of predation if the large gull populations were reduced. These predator/prey relationships exist independent of the fishery, and there is no reason to consider shifts in the balance one way or the other as adverse or beneficial. The overall effect of FMP 4.1 on the availability of food for piscivorous species is considered to be insignificant on the population level. Since FMP 4.2 would reduce the potential effects on piscivores even more, those effects are also considered insignificant at the population level.

Benthic Habitat

Specific effects of trawling on seabird prey species in the BSAI and GOA (through habitat change rather than by direct take) are poorly known. However, none of the species in this group appears to have experienced consistent or widespread population declines, so there is no indication that the carrying capacity of the environment has been decreased through changes to benthic habitat (or any other mechanism). Overall trawl effort in the BSAI and GOA under FMP 4.1 is predicted to be substantially less than the baseline conditions and eliminated under FMP 4.2. The effects on piscivorous seabirds through potential changes in benthic habitat are considered insignificant at the population level.

Cumulative Effects of FMP 4.1 and FMP 4.2

The past/present effects on the species in this group, including most alcids, gulls, and cormorants, are described in the species accounts of Section 3.7 (Tables 3.7-16 through 3.7-28). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Tables 4.5-57 and 4.8-4 and summarized below.

Mortality

- **Direct/Indirect Effects**. Under FMP 4.1, new seabird protection measures for the longline and trawl fleets would be implemented and fishing effort would be much less than under baseline conditions. Under FMP 4.2, the groundfish fisheries would be suspended. The incidental takes of all species in this group are expected to be insignificant at the population level under FMP 4.1 and FMP 4.2.

- **Persistent Past Effects**. Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging, incidental take in a variety of foreign and U.S. coastal and pelagic fisheries, oil spills and other pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI and GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects**. All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. Conservation concerns focus on preventing potential impacts around breeding colonies during the nesting season, since populations are concentrated in time and space. For some species, human impacts in nearshore habitats will likely have a much greater effect on their populations than offshore fisheries. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality.

- **Cumulative Effects**. Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are considered insignificant at the population level through mortality.

<u>Changes in Food Availability</u>

- **Direct/Indirect Effects**. The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects**. All species in this group prey on small schooling fish and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources has likely affected the prey of these species in the past. Since some of the alcids are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded them from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects**. Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects**. The groundfish fisheries contribute to the dynamic interaction of natural and human-caused events that affect the availability of forage fish and invertebrate prey to seabirds. While this dynamic is beginning to be explored with directed research, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under FMP 4.1 or FMP 4.2, the cumulative effect on prey availability is considered insignificant at the population level for these species.

Benthic Habitat

- **Direct/Indirect Effects**. Bottom trawls, and to a lesser extent pelagic trawls and pot gear, have the potential to modify benthic habitats and have indirect effects on the food web of diving piscivorous species. The overall effects of FMP 4.1 on piscivorous seabirds through potential changes in benthic habitat are considered insignificant. Under FMP 4.2, the groundfish fisheries would be suspended, therefore, their effects on piscivorous seabirds through benthic habitat is insignificant.

- **Persistent Past Effects**. Benthic habitats important to the diving species in this group have been affected by various foreign and U.S. fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated, so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to seabirds. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus may have persistent effects in certain areas.

- **Reasonably Foreseeable Future External Effects**. All future fisheries in the BSAI and GOA that use bottom contact fishing gear are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will also continue.

- **Cumulative Effects**. The groundfish fisheries contribute to the many human-caused and natural factors that alter benthic habitats important to the food web of piscivorous seabirds. While there has been limited research on specific effects of benthic habitat disturbance on seabirds, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under FMP 4.1 or FMP 4.2, the cumulative effect on benthic habitat is considered insignificant at the population level for these species.

4.8.7.7 Other Planktivorous Species (Storm-Petrels and Most Auklets)

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Incidental Take

Since incidental take of these species approaches zero under the baseline conditions, the major reduction of fishing effort plus new seabird protection measures would essentially eliminate the chances of taking these species in any groundfish fishery. The effects of incidental take on these species are considered insignificant at the population level.

Food Availability

As described in Section 4.5.7.7, the effect of the groundfish harvest on planktonic prey is considered insignificant to the populations of planktivorous species under the baseline conditions. Since the intensity of the fishery would be greatly reduced from the baseline effort, the effect of FMP 4.1 or FMP 4.2 on prey availability for planktivores would also be considered insignificant at the population level.

Benthic Habitat

Storm-petrel and auklets are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of groundfish management. FMP 4.1 and FMP 4.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of FMP 4.1 and FMP 4.2

The past/present effects on the species in this group, including storm-petrels and most auklets, are described in Sections 3.7.7 and 3.7.18 (Table 3.7-15 and 3.7-27). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Tables 4.5-58 and 4.8-4 and summarized below.

Mortality

- **Direct/Indirect Effects**. Incidental take of all seabirds is expected to decrease under FMP 4.1 due to new seabird protection measures for the longline and trawl fleets. Under FMP 4.2, the groundfish fisheries would be suspended. The incidental take of all species in this group is expected to be insignificant at the population level.

- **Persistent Past Effects**. Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in foreign and U.S. coastal and pelagic fisheries, oil spills and other marine pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI and GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects**. All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e. rats) to seabird colonies. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may contribute to future mortality.

- **Cumulative Effects**. Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are considered insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects**. The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch. Indirect effects on zooplankton and juvenile fish abundance through changes in the abundance of target fish predators is considered minor compared to seasonal changes in primary productivity and oceanographic factors. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazards on seabird prey populations cannot be assessed at this time.

- **Persistent Past Effects**. Factors that have affected the abundance and distribution of zooplankton and juvenile fish include bycatch in squid and forage fish fisheries, marine pollution, and the decimation of planktivorous whales by commercial whaling. These effects are considered minor compared to seasonal and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects**. Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have minimal effects on prey availability for these species. Pollution is likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects**. The groundfish fisheries contribute in an indirect way to human influences on planktonic prey availability, which are considered minimal compared to natural fluctuations. These cumulative effects are considered insignificant on the population level for all species in this group.

Benthic Habitat

Since these planktivorous seabirds feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for these species.

4.8.7.8 Spectacled Eiders and Steller's Eiders

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Incidental Take

Under FMP 4.1 and FMP 4.2, the potential of the fisheries to cause incidental take of Steller's eider would be even less than the baseline condition, which already approaches zero. The fisheries are considered to have insignificant effects on the populations of these species through incidental take under FMP 4.1. There is a possibility of expansion into spectacled eider critical habitat under FMP 4.1; however, the effects from this expansion are considered insignificant. There would continue to be no overlap between spectacled eider critical habitat and the groundfish fishery FMP 4.2; therefore, there would be no direct/indirect effect on spectacled eiders through mortality.

Changes in Food Availability

There is a possibility of expansion into spectacled eider critical habitat under FMP 4.1, however the effects from this expansion are considered insignificant. Because there would continue to be no overlap between spectacled eider critical habitat and the groundfish fishery under FMP 4.2, there would be no direct/indirect effect on spectacled eiders through food availability. Under FMP 4.1, there would be little overlap between the groundfish fisheries and foraging habitats for Steller's eider. The effects of FMP 4.1 on the prey abundance and availability for Steller's eiders are considered insignificant at the population level. FMP 4.2 would have no overlap with Steller's eider foraging areas and would have no effects on Steller's eider prey.

Benthic Habitat

Under FMP 4.1, two management programs designed to conserve fish populations may actually lead to increased fishing in some eider habitats in spite of greatly reduced overall fishing effort. First, the establishment of MPAs and no-fishing zones in many areas that were fished under the baseline conditions would force the groundfish fleet to look for new areas to fish. Second, increased rationalization of the fishery would tend to give fishermen more time and opportunity to explore for new fishing grounds. It is not known whether the fishery would have the economic incentive to start fishing more heavily in the Steller's eider critical habitat in Kuskokwim Bay or to expand northward to spectacled eider critical habitat north of St. Matthew Island. It is not known whether disturbance of benthic habitat by fishing gear in these areas would have enough impact on benthic invertebrate populations to decrease eider foraging success. Although FMP 4.1 creates conditions under which these areas may be affected by benthic habitat disturbance, the level and type of disturbance needed to create population level effects on eiders are unknown. The effects of FMP 4.1 on the benthic habitat of spectacled and Steller's eider are considered unknown. Under FMP 4.2, the fishery would be halted, so there would be no direct/indirect effects on either eider species through benthic habitat.

Cumulative Effects of FMP 4.1 and FMP 4.2

The past/present effects on spectacled and Steller's eiders are described in Sections 3.7.9 and 3.7.10 (Table 3.7-17 and 3.7-18). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Tables 4.5-59 and 4.8-1and summarized below.

Mortality

- **Direct/Indirect Effects**. Under FMP 4.1, incidental take of eiders is expected to be less than the baseline condition, which already approaches zero, and is considered to be insignificant at the population level for Steller's and spectacled eiders. FMP 4.2 would suspend the groundfish fisheries and would have no effect on eiders through mortality.

- **Persistent Past Effects**. Past sources of mortality that may continue to have an effect on these species include sport hunting and subsistence harvest in Russia and Alaska, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution that causes physiological stress and reduces survival rates, lead shot poisoning on the nesting grounds, and collisions with vessels and other structures. Incidental take in the BSAI and GOA groundfish fisheries appears to have been very rare for Steller's eider. Both species have been afforded protection through the ESA.

- **Reasonably Foreseeable Future External Effects**. All of the mortality factors listed above in persistent past effects are likely to continue in the future. Conservation concerns focus on preventing potential impacts in critical habitat areas.

- **Cumulative Effects**. The groundfish fisheries are not likely to contribute to direct mortality of spectacled eiders, so no cumulative effect is identified for that species under FMP 4.2. However, there is potential for expansion of the groundfish fishery into spectacled eider critical habitat under FMP 4.1. The effects from this expansion are considered insignificant. Decreased adult survival rates appear to have driven the past population decline of Steller's eiders. Known sources of direct human-caused mortality of Steller's eider, including very rare incidental take in the groundfish fisheries, do not appear to account for the past population decline in Alaska. However, several indirect factors may be contributing to decreased adult survival rates, including climate-induced changes in habitat, concentration of predators around nesting areas due to nearby human habitation, and pollution of nearshore waters from chronic and periodic sources of petroleum products (USFWS 2003a). Since the Alaska breeding population of Steller's eiders has declined dramatically in the past and has not recovered, and because several human-induced sources of mortality have been identified as potential contributing factors to this decline, including the potential for contributions to pollution and vessel collisions from the groundfish fisheries as managed under FMP 4.1, the cumulative effects of mortality on Steller's eiders are considered significant adverse at the population level.

Changes in Food Availability

The abundance of marine invertebrate species important to the spectacled and Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. Although other factors external to the fisheries may influence the abundance and distribution of eider prey, the groundfish fisheries contribute minimally to these potential effects under FMP 4.1. The cumulative effects on eider prey availability from bycatch of all fisheries is considered insignificant. Under FMP 4.2, the groundfish fishery would be suspended, and there would be no effects on eider prey. Therefore, no cumulative effects on prey availability are identified for eiders.

<u>Benthic Habitat</u>

- **Direct/Indirect Effects**. Bottom trawls, and to a lesser extent pelagic trawls and pot gear, disrupt benthic habitats that support the prey of eiders. Under FMP 4.1, the groundfish fishery has the potential to be displaced into eider critical habitat areas. The overall effects of FMP 4.1 on eiders through potential changes in benthic habitat are considered unknown. The groundfish fishery would be suspended under FMP 4.2, and there would be no effects on eiders through benthic habitat.

- **Persistent Past Effects**. Benthic habitats important to spectacled and Steller's eiders have been affected by various trawl and pot fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated, so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to eiders. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may have persistent effects in certain areas. Climate change and ocean temperature fluctuations may also play a role in altering the benthic environment.

- **Reasonably Foreseeable Future External Effects**. All future fisheries that use bottom contact fishing gear in areas used by eiders are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will continue.

- **Cumulative Effects**. While the groundfish fisheries are predicted to have little spatial overlap with spectacled and Steller's eider habitat under FMP 4.1, the interaction of all human-caused and natural disturbances on benthic habitat important to eiders has not been examined with respect to their population declines in the past. The cumulative effects of benthic habitat disruptions and changes over the years as they relate to the food web important to eiders are therefore considered to be unknown. Under FMP 4.2, the groundfish fishery would be suspended, so there would be no cumulative effects on eiders through benthic habitat.

4.8.8 Marine Mammals Alternative 4 Analysis

4.8.8.1 Western Distinct Population Segment of Steller Sea Lions

FMP 4.1 – Direct/Indirect Effects

<u>Incidental Take/Entanglement in Marine Debris</u>

Catch levels are reduced to extremely low levels relative to the baseline under FMP 4.1. Incidental takes of all marine mammals would decrease under FMP 4.1. Even under the baseline level of groundfish fisheries, takes and entanglements incidental to fishing activities are much less than PBR and are thus considered to be insignificant at the population level to the western distinct population segment (western population) of the Steller sea lion. Substantially reduced levels of incidental take under FMP 4.1 would not affect the rate of population recovery and are therefore considered insignificant.

Fisheries Harvest of Prey Species

Changes in the fishing mortality rate for Steller sea lion prey species were calculated using output from the multi-species management model which projected catch rates for the various FMPs. The estimated fishing mortality rates expected to occur under each FMP management regime were compared to the baseline fishing mortality rate in order to apply the significance criteria established in Table 4.1-6 for determining the effects on marine mammal populations. The baseline fishing mortality rates for the individual BSAI and GOA groundfish fisheries, the fishing mortality rates projected to occur under each FMP, and the relative difference between the baseline and FMP fishing mortality rates are shown in Table 4.5-61.

Under FMP 4.1, (F) of EBS pollock is expected to decrease by an average of 76 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in the harvest of this key Steller sea lion prey species is rated significant. The harvest of EBS pollock under the FMP 4.1 management regime meets the criteria of a significantly beneficial effect to Steller sea lions relative to the baseline condition.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 78 percent relative to the comparative baseline over the next five years under FMP 4.1. This change in F is significantly beneficial under the FMP 4.1 scenario at the population level for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline condition. There is no change in the projected catch of Aleutian Islands pollock between the baseline and FMP 4.1; therefore, effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level for this FMP.

Under FMP 4.1, the BSAI Pacific cod fishing mortality rate is expected to decrease by 71 percent. This change is determined to be significantly beneficial to Steller sea lions according to the criteria established in Table 4.1-6. Under FMP 4.1, the GOA Pacific cod fishing mortality rate is expected to decrease by 73 percent. This change is determined to be significantly beneficial to Steller sea lions. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly beneficial to Steller sea lions with decreases in F of 81 percent under FMP 4.1 relative to the baseline.

Little difference is expected relative to the baseline and among the FMPs for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMPs were determined to be insignificant to Steller sea lions. The reduced combined harvest of Steller sea lion prey species under FMP 4.1 is expected to result in significantly beneficial population-level effects for the western population of Steller sea lions (Table 4.8-5).

Spatial/Temporal Concentration of the Fishery

Relative to the baseline, FMP 4.1 offers substantially more temporal and spatial protection from the effects of groundfish fisheries on Steller sea lions. FMP 4.1 was determined to have significantly beneficial effects for the western population of Steller sea lions in regards to the spatial/temporal concentration of the fishery.

Disturbance

FMP 4.1 is expected to result in decreased disturbance to the western population of Steller sea lions relative to the baseline. Since the effects of disturbance are insignificant under the baseline condition, they would also be insignificant at the population level under FMP 4.1 management scenarios.

Cumulative Effects

The past/present effects on the western population of Steller sea lion are described in Section 3.8.1 (Table 3.8-1). The effects considered in this analysis are listed in Table 4.8-5. Representative direct effects used in this analysis include mortality and disturbance. Major indirect effects are availability of prey and spatial/temporal concentration of the fisheries.

Mortality

- **Direct/Indirect Effects**. With regard to incidental take, FMP 4.1 is not likely to result in significant changes to the population trajectory of the western population of Steller sea lions, so it is considered insignificant.

- **Persistent Past Effects.** Substantial mortality of Steller sea lions did not occur in the fisheries until after the 1950s. The take of Steller sea lions was substantial after this time with over 20,000 animals believed to have been incidentally killed in the foreign and JV groundfish fisheries from 1966 to 1988, although data from this period are not complete (Perez and Loughlin 1991). In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 per year in the early 1990s to an average of 7.8 sea lions per year from 1996 to 2000. Steller sea lions are also taken incidentally in state-managed nearshore salmon gillnet fisheries and halibut longline fisheries with an estimated 14.5 sea lion takes per year in the PWS drift gillnet fisheries (Wynne *et al*. 1992). Two cases of illegal shooting were prosecuted in the Kodiak area in 1998 involving two Steller sea lions from the western population (Angliss *et al*. 2001). It is thought that shooting used to be a significant source of mortality prior to ESA listing. The subsistence harvest in the western population has decreased over the last ten years from 547 to 171 animals per year (1992 to 1998) (Angliss *et al*. 2001). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). Predation by transient killer whales and sharks has always contributed to the natural mortality of Steller sea lions but the numbers of sea lions taken and the relative contribution of this factor to the recent population decline and lack of recovery is currently under investigation (Matkin *et al.* 2001, Matkin *et al.* 2003, Springer *et al.* 2003).

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries, such as salmon gillnet fisheries, will continue in the foreseeable future, but the numbers of Steller sea lions will likely be relatively low (less than ten per year). Entanglement in fishing gear and intentional shootings would be expected to continue at a level similar to the baseline condition. Predation will continue to contribute to natural mortality but climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** Cumulative effects of mortality are based on the contribution of internal effect of the groundfish fishery and external effects. These cumulative effects are considered significantly adverse, since the overall human-caused mortality approaches or exceeds the PBR for this population, and the species is listed as endangered under the ESA due to the severe decline of the species. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and, under the baseline conditions, is not considered to cause jeopardy to this population under the ESA (NMFS 2001b).

<u>Prey Availability</u>

- **Direct/Indirect Effects**. The reduced combined harvest of Steller sea lion prey species under FMP 4.1 is expected to result in significantly beneficial population-level effects to Steller sea lions.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in State of Alaska waters, partially overlapping with other state-managed fisheries. These species were targeted in the past foreign and JV groundfish fisheries. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s and one hypothesis is that the combined fisheries, perhaps in conjunction with climate and oceanographic fluctuations, greatly reduced the availability of forage fish to Steller sea lions. NMFS issued a number of BiOps since 1991 that analyzed the key issue as to whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat but most of the focus was on the western population. A recent Steller sea lion BiOp and EIS explore this subject in great depth (NMFS 2001b).

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a generally similar manner to the baseline conditions. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having effects on availability of prey, but the direction or magnitude of these changes is difficult to predict. Climate-induced change has been a suspected cause in the decline of the western population of Steller sea lions.

- **Cumulative Effects.** Cumulative effects of prey availability were based on both internal and external effects. The significantly beneficial rating of the internal effects on prey availability in the groundfish fisheries results from extensive area closures under MPAs for sea lion prey species and the no-take reserves under this FMP. When added to the external factors, the cumulative effects were determined to result in a population-level effect to the western population of the Steller sea lion and are considered significantly beneficial.

<u>Spatial/Temporal Concentration of Prey</u>

- **Direct/Indirect Effects.** Relative to the baseline, FMP 4.1 offers substantially more temporal and spatial protection from the effects of groundfish fisheries on Steller sea lions. FMP 4.1 was determined to have significantly beneficial effects on Steller sea lions with regard to the spatial/temporal concentration of the fishery.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal, and domestic groundfish fisheries and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of sea lion protective measures, which are expanded under FMP 4.1.

- **Reasonably Foreseeable Future External Effects.** The reasonably foreseeable future factors, external to the groundfish fisheries, that could affect the spatial/temporal harvest of Steller sea lion prey would be state-managed salmon and herring fisheries which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to be managed in a similar manner to recent years. No new state or federal fisheries are anticipated at this time.

- **Cumulative Effects.** Cumulative effects of the spatial/temporal harvest of prey on Steller sea lions were considered conditionally significant beneficial based on the significant beneficial effects of the groundfish fisheries under FMP 4.1. This rating is conditional on whether the actual decrease in concentration of the groundfish fisheries would result in improvements to prey fields to the extent that beneficial population-level effects occur and also whether the location of MPAs and no take reserves are in areas critical to Steller sea lion foraging success.

<u>Disturbance</u>

- **Direct/Indirect Effects.** FMP 4.1 is expected to result in decreased disturbance to Steller sea lions relative to the baseline. However, because the effects of disturbance are insignificant under the baseline condition they would be insignificant at the population level under FMP 4.1.

- **Persistent Past Effects.** Past effects of disturbance were identified from foreign, JV, and domestic groundfish fisheries in the BSAI and GOA and state-managed fisheries. Past disturbances from commercial harvest, intentional shooting, and subsistence harvest were identified. General vessel traffic and disturbance of prey fields from fishing gear have regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects.** Future sources of disturbance were identified as state-managed salmon and herring fisheries and general fishing and non-fishing vessel traffic in Steller Sea lion foraging areas. Subsistence harvest was identified as a continuing source of disturbance to Steller sea lions. Levels of disturbance from external sources are expected to be similar to baseline conditions.

- **Cumulative Effects.** Cumulative effects of disturbance on Steller sea lions are considered insignificant because they are either decreased from or similar to the baseline condition and population-level effects are unlikely.

Direct/Indirect Effects FMP 4.2

Under FMP 4.2, the groundfish fisheries would be essentially closed until specific fisheries were certified to have no adverse effects on the environment. The potential impacts to marine mammals would therefore be even less than described under FMP 4.1 but the conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 4.2 are the same as described under FMP 4.1.

Cumulative Effects

Since the groundfish fisheries would be essentially closed under FMP 4.2, the cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance would all be dominated by the same persistent past and external factors discussed under FMP 4.1. Since the contribution of the groundfish fisheries to all of these effects is also greatly reduced relative to the baseline condition under FMP 4.1, the cumulative effects conclusions are the same as discussed under FMP 4.1.

4.8.8.2 Eastern Distinct Population Segment of Steller Sea Lions

Direct/Indirect Effects FMP 4.1

Incidental Take/Entanglement in Marine Debris

Catch levels are reduced to extremely low levels relative to the baseline under FMP 4.1. Incidental take of all marine mammals, including the eastern distinct population segment (eastern population) of Steller sea lions, would decrease under FMP 4.1. Even under the baseline conditions, takes and entanglements incidental to fishing activities are considered insignificant to the eastern population of Steller sea lions at the population level. Reducing these takes to even further would also be considered insignificant to the population.

Fisheries Harvest of Prey Species

The fishing mortality rate of GOA pollock is expected to decrease by an average of 78 percent relative to the comparative baseline over the next five years under FMP 4.1. This change in F is significantly beneficial under the FMP 4.1 scenario at the population level of Steller sea lions. Under FMP 4.1, the GOA Pacific cod fishing mortality rate is expected to decrease by 73 percent. This change is determined to be significantly beneficial to Steller sea lions. The combined harvest of prey species from the eastern population of Steller sea lions under FMP 4.1 is therefore expected to be substantially less than the baseline condition and is considered to be significantly beneficial.

Spatial/Temporal Concentration of the Fishery

Relative to the baseline, FMP 4.1 offers substantially more temporal and spatial protection from the effects of groundfish fisheries on Steller sea lions. However, since the eastern population of Steller sea lions has been increasing steadily over the past 20 years and food availability does not appear to be limiting their population recovery, it is unlikely that these additional protection measures would improve their access to prey to the extent that population-level effects would occur. While the spatial/temporal measures under FMP 4.1 could be considered beneficial, they are unlikely to result in substantial changes to the baseline condition and are therefore considered insignificant at the population-level for the eastern population of Steller sea lions.

Disturbance

FMP 4.1 is expected to result in decreased disturbance to Steller sea lions relative to the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under FMP 4.1.

Cumulative Effects

The past/present effects on the eastern population of Steller sea lions in southeast Alaska are described in Section 3.8.1 (Table 3.8-1). The effects considered in this analysis are listed in Table 4.8-5. Representative direct effects used in this analysis include mortality and disturbance. Major indirect effects are availability of prey and spatial/temporal concentration of the fisheries.

Mortality

- **Direct/Indirect Effects.** With regard to incidental take and entanglement, FMP 4.1 is not likely to result in significant changes to the population trajectory of the eastern population of Steller sea lions. No Steller sea lions from the eastern population have been taken incidental to groundfish fisheries from 1995 to 1999 (Angliss *et al*. 2001).

- **Persistent Past Effects.** It is thought that shooting was once a significant source of mortality prior to listing the Steller sea lion as threatened under the ESA. NMFS Alaska Enforcement Division has successfully prosecuted two cases of illegal shooting involving four sea lions from the eastern population (Angliss *et al*. 2001). It is not known to what extent illegal shooting continues in the eastern population, but stranding of sea lions with bullet holes still occurs. Predator control programs associated with mariculture facilities in British Columbia account for a mean of 44 animals killed per year from the eastern population (Angliss, *et al*. 2001). The subsistence harvest in the eastern population of Steller sea lions is very slight and subject to an average of only two sea lions taken per year from southeast Alaska (1992-1997) (Angliss *et al*. 2001). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). The proportion taken from the eastern population is unknown. Intentional shooting of Steller sea lions, other than in subsistence hunts, became illegal after the species was listed as threatened under the ESA in 1990. Steller sea lions are incidentally taken in low numbers by commercial fisheries other than groundfish fisheries, including some state-managed salmon drift and set gillnet fisheries and the salmon troll fishery in southeast Alaska (mean of 1.25 and 0.2 respectively) (Angliss and Lodge 2002). Small numbers of sea lions from the eastern population are taken outside of southeast Alaska in groundfish fisheries (0.45 per year in Washington, Oregon, and California) and set gillnet fisheries in Northern Washington State (0.2 per year) (Angliss *et al*. 2001). The PBR for this population is 1,396 and current human caused mortality is 45.5, substantially less than ten percent of the PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillnet and troll fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely remain relatively low (less than ten per year). Groundfish fisheries in

Washington, Oregon, and California and salmon set gillnets fisheries will continue to take small numbers from this population. Entanglement and intentional shootings would also be expected to continue. Pollution is likely more of a factor for this population due to the closer association with population centers. Climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects.** Cumulative effects of mortality are based on the contribution of the groundfish fishery and external mortality effects. These effects are considered insignificant since the overall human-caused mortality does not approach the PBR for this population. Although this population is listed as threatened under the ESA, the population has been increasing over the last 20 years. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and does not jeopardize the species under the ESA (NMFS 2001b).

<u>Effects of Prey Availability</u>

- **Direct/Indirect Effects.** Only groundfish fisheries in the GOA would be expected to have a potential effect on the eastern population of Steller sea lions. The decreased harvest of Steller sea lion prey species under FMP 4.1 is considered significantly beneficial according to the significance criteria but is unlikely to have population-level effects.

- **Persistent Past Effects.** Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in state waters, and partial overlap with other state-managed fisheries. These species were targeted in the past foreign and JV groundfish fisheries. NMFS issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of Steller sea lion populations or causing adverse impacts to their critical habitat but most of the focus was on the western population. The most recent Steller sea lion BiOp and EIS (NMFS 2001b) explores this subject in great depth.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon and herring are expected to continue in future years in a similar manner to the baseline condition. New fisheries in state or federal waters are not anticipated. Climate change or regime shifts were identified as potentially having adverse effects on availability of prey but the direction and magnitude of these changes are difficult to predict. Climate-induced change has been suspected in the decline of the western population of Steller sea lions, but effects of climate change or regime shifts on the eastern population are largely unknown.

- **Cumulative Effects.** The cumulative effects of prey availability on the eastern population of the Steller sea lion are considered to be insignificant at the population level. The eastern population of Steller sea lions has been increasing steadily over the last 20 years so prey availability is not considered to be limiting the recovery of the population. Decreased harvest levels under FMP 4.1 would therefore be unlikely to result in population-level effects.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** Spatial/temporal fishing measures in FMP 4.1 offer substantially greater temporal and spatial protection to Steller sea lions from the effects of groundfish fisheries. However, while the spatial/temporal measures under FMP 4.1 could be considered beneficial, they are unlikely to result in population-level effects for the eastern population of Steller sea lions, which have been increasing under the baseline conditions, and are therefore considered insignificant.

- **Persistent Past Effects.** Past effects of spatial/temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries, and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of the baseline Steller sea lion protection measures.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon set and drift gillnet fisheries and salmon troll fisheries and herring fisheries are expected to continue in future years in a similar manner to the baseline condition.

- **Cumulative Effects.** Cumulative effects for the spatial and temporal harvest of prey from both internal effects of the groundfish fishery and external effects such as state-managed fisheries would be reduced from the baseline condition, under which the population has increased steadily, and are therefore considered insignificant for the eastern population of Steller sea lions.

Disturbance

- **Direct/Indirect Effects.** The effects of disturbance on Steller sea lions under FMP 4.1 are expected to decrease relative to the baseline. However, because the effects of disturbance are insignificant under the baseline condition, they would also be insignificant under FMP 4.1.

- **Persistent Past Effects.** Past disturbance was identified for foreign, JV, federal domestic groundfish fisheries, and state-managed salmon and herring fisheries. General vessel traffic has contributed to the disturbance level for this population. Intentional shooting has likely been a disturbance factor in past years.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and vessel traffic will likely continue in the future at a level similar to the baseline condition. Disturbance from subsistence harvest is not an issue for this population.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external sources would be reduced from the baseline condition, under which the population has increased steadily, and is therefore considered insignificant for the eastern population of Steller sea lions.

Direct/Indirect Effects FMP 4.2

Under FMP 4.2, the groundfish fisheries would be essentially closed until specific fisheries were certified to have no adverse effects on the environment. The potential impacts to marine mammals would therefore be even less than described under FMP 4.1 but the conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 4.2 are the same as described under FMP 4.1.

Cumulative Effects

Since the groundfish fisheries would be essentially closed under FMP 4.2, the cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance would all be dominated by the same persistent past and external factors discussed under FMP 4.1. Since the contribution of the groundfish fisheries to all of these effects is also greatly reduced relative to the baseline condition under FMP 4.1, the cumulative effects conclusions are the same as discussed under FMP 4.1.

4.8.8.3 Northern Fur Seals

Direct/Indirect Effects FMP 4.1

Incidental Take/Entanglement in Marine Debris

Since fishing effort is greatly reduced relative to the baseline under FMP 4.1, incidental takes of northern fur seal would be expected to decrease under FMP 4.1. Under the baseline conditions, takes and entanglements associated with fishing activities are thought to be insignificant to fur seals at the population level. Reducing these takes even further would also be considered to have insignificant effects on the population trajectory of fur seals.

Fisheries Harvest of Prey Species

Under FMP 4.1, the F of EBS pollock is expected to decrease by an average of 76 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in the harvest of northern fur seal prey species is considered to be significantly beneficial.

Catches of squid and small schooling fish (e.g., fish designated in the forage fish assemblage) in the groundfish fisheries of the BSAI and GOA are low, generally less than 1,000 mt per year. While precise biomass estimates for these groups do not exist, the exploitation rate on these groups in the groundfish fisheries is thought to be very low. For instance, squid biomass in the Bering Sea may be as large as 4 million mt, based on marine mammal food habits, daily ration, and abundance data (Sobolevsky 1996). Similarly, with respect to small schooling fishes, consumption of capelin in the GOA by arrowtooth flounder alone may be as large as 300,000 mt per year (Livingston 1994). Assuming that these crude projections of squid and capelin biomass at least approximate the order of magnitude of the true population levels, then the fisheries removals would amount to only a fraction of one percent of those populations. Fisheries for pollock and Pacific cod do not target fish younger than three years of age (Ianelli *et al.* 1999, Dorn *et al.* 1999, Thompson and Dorn 1999, Thompson and Zenger 1994, Fritz 1996). Catches of pollock smaller than 30 centimeters (cm) are small, and thought to be only one to four percent of the number of one- and two-year olds each year in the EBS and GOA (Fritz 1996).

Therefore, while fisheries do harvest prey of northern fur seals (i.e., pollock and Pacific cod), competition due to the harvest rates of those species may vary depending on the size range consumed by northern fur seals. The overall catch of juvenile pollock has tended to be low in recent years and the degree to which adult pollock occur in the northern fur seal diet is not certain. While the potential overlap with fisheries may be moderated by these factors, effects on northern fur seals may yet exist, the relevance of which is not reflected by estimates of biomass removals over large geographical areas.

The overall harvest of northern fur seal prey species is rated conditionally significant beneficial under the FMP 4.1. Population-level effects are plausible if commercially sized pollock are a substantial component of fur seal diet. This rating is conditional on whether the decreased level of pollock harvest in the groundfish fisheries under FMP 4.1 results in increased prey resources such that fur seals are impacted at the population level.

Spatial/Temporal Concentration of the Fishery

The effects of the spatial/temporal concentration of the fisheries under the baseline conditions were rated conditionally significant adverse for northern fur seals in the Steller sea lion SEIS (NMFS 2001b). Relative to the baseline, FMP 4.1 offers substantially more temporal and spatial protection from the effects of groundfish fisheries on the prey fields of northern fur seals, including the establishment of MPAs and no-take reserves. FMP 4.1 was therefore determined to have significantly beneficial effects on northern fur seals in regards to the spatial/temporal concentration of groundfish fisheries.

Disturbance

FMP 4.1 is expected to result in decreased disturbance to northern fur seals relative to the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under FMP 4.1.

Cumulative Effects

A summary of the effects of the past/present with regard to the northern fur seal is presented in Section 3.8.2 (Table 3.8-2). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The effects considered in this analysis are listed in Table 4.8-5. Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial/temporal concentration of the fisheries.

Mortality

- **Direct/Indirect Effects.** Incidental take and entanglements of northern fur seals would decrease under 4.1, but would continue to be insignificant to the population trajectories due to the low level of mortalities attributed to incidental take and entanglements in fishing gear.

- **Persistent Past Effects.** Effects of past mortality on fur seal populations include commercial harvest of young males up to 1985, harvest of females between 1956 and 1968, incidental take in the JV fisheries, foreign fisheries, and annual subsistence harvest on the Pribilof Islands. Commercial harvest of fur seals peaked in 1961 with over 126,000 animals, but was halted in 1985. The harvest of female fur seals on the Pribilof Islands, as many as 300,000 between 1956 and 1968, likely contributed to the decline of the population in the late 1970s and early 1980s (York and Kozloff 1987). This precipitous decline resulted in its depleted status under the MMPA. Entanglements may have contributed significantly to declining trends of the population during the late 1970's (Fowler, 1987). Since the cessation of commercial harvest in 1985, fur seal numbers have steadily declined (NMFS 1993 and Angliss and Lodge 2002). The contribution of the earlier harvest of fur seals to the subsequent declines is uncertain since it has been nearly 20 years since the commercial harvest was ended. Subsistence harvest has been one of the major contributors to fur seal mortality in recent years. From 1986 to 1996, the average annual subsistence take was 1,605 from St. Paul and St. George Islands. From 1995 to 2000, this average take dropped to 1,340 seals per year, which represents about eight percent of the PBR for this species.

- **Reasonably Foreseeable Future External Effects.** These effects include incidental take from foreign fisheries outside the U.S. EEZ where fur seals are widely dispersed. State-managed fisheries take small numbers of fur seals including the PWS drift gillnet fishery, Alaska Peninsula and Aleutian Island salmon gillnet fisheries, and the Bristol Bay salmon fisheries (Angliss *et al*. 2001). Subsistence will continue to be a major source of mortality in the future but is limited to the Pribilof Islands; however, levels of take are expected to be well below ten percent of the PBR for this species. Short-term and long-term climate change is not considered a major mortality factor for this species.

- **Cumulative Effects.** Cumulative effects of mortality from internal and external factors are considered insignificant because of the size of the fur seal population in relation to existing levels of take, which are well below the PBR of this species. The contribution of the groundfish fisheries is very small and approaches zero.

<u>Availability of Prey</u>

- **Direct/Indirect Effects.** The decreased harvest of northern fur seal prey species under FMP 4.1 was determined to be conditionally significant beneficial relative to the baseline.

- **Persistent Past Effects.** Effects of past harvest of prey are primarily from the foreign and JV fisheries and state and federal domestic fisheries in the BSAI. There has been no concern with regard to displaced/increased fishing effort encroaching into nearshore areas of the Pribilof Islands and resulting in increased overlap with fur seal foraging areas. The proportion of the total June-October pollock harvest in fur seal foraging habitat increased from an average of 40 percent in 1995-1998 to 69 percent in 1999-2000 (NMFS 2001b). There is particular concern for the potential impact of this increased fishing pressure on lactating females from St. George Island where catch rates were consistently higher in areas used by females from St. Paul (Robson *et al*. 2004). Climate and oceanic fluctuations are suspected in past changes to the abundance and distribution of prey.

- **Reasonably Foreseeable Future External Effects.** Effects on prey availability for northern fur seals in the future are considered for State-managed salmon and herring fisheries in nearshore areas. Climate effects are largely unknown, but could potentially have adverse effect on the availability of prey.

- **Cumulative Effects.** Cumulative effects of prey availability have been identified from the internal contribution of the groundfish fisheries, external effects on prey from other fisheries, and possibly long-term climate change. This cumulative effect is considered conditionally significant beneficial and is conditional on whether reduced pollock catches under FMP 4.1 would increase the available pollock for northern fur seal to the extent that beneficial population-level effects occur.

Spatial/Temporal Concentration of Harvest

- **Direct/Indirect Effects.** FMP 4.1 was determined to have significantly beneficial effects on northern fur seals in regards to the spatial/temporal concentration of groundfish fisheries.

- **Persistent Past Effects.** Effects of past harvest of prey occurred in the foreign and JV fisheries and the state and federal domestic fisheries in the BSAI. There has been concern with regard to displaced/increased fishing effort encroaching into nearshore areas of the Pribilof Islands and resulting in increased overlap with fur seal foraging areas. The proportion of the total June-October pollock catch in fur seal foraging habitat increased from an average of 40 percent in 1995-1998 to 69 percent in 1999-2000 (NMFS 2001b). There is particular concern for the potential impact of this increased fishing pressure on lactating females from St. George Island where catch rates were consistently higher than in areas used by females from St. Paul Island (Robson *et al.* 2004).

- **Reasonably Foreseeable Future External Effects.** Effects of the spatial/temporal harvest of prey species occur primarily in the foreign and federal domestic fisheries outside the EEZ, due to the extensive range of the fur seal when they are away from their breeding rookeries. State-managed fisheries have very limited overlap with fur seal prey. Climate change was identified as a potential factor in spatial/temporal effects on prey.

- **Cumulative Effects.** Cumulative effects of the spatial/temporal harvest of prey were based on the presence of internal and external factors and likely to result in substantial improvements in the availability of forage fish to northern fur seals. Since the concentration of fisheries under the baseline conditions may have contributed to past population declines, reductions in competition for localized resources could have population-level effects and are considered significantly beneficial to northern fur seal populations.

Disturbance

- **Direct/Indirect Effects.** FMP 4.1 is expected to result in decreased disturbance to northern fur seals relative to the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would be insignificant at the population level under FMP 4.1.

- **Persistent Past Effects.** Disturbance of fur seals in the past included commercial groundfish harvest by JV fisheries, foreign and federal domestic fisheries, state-managed fisheries and, to a lesser extent, the subsistence harvest of fur seals on the Pribilof Islands. It is unknown whether these past activities persist, but ongoing fishing activities continue and result in some level of disturbance to fur seals in the BSAI region.

- **Reasonably Foreseeable Future External Effects.** Future external disturbance effects on fur seals were identified for State-managed fisheries and subsistence activities on the Pribilof Islands. No new State of Alaska or Federal fisheries are expected within the range of the northern fur seal.

- **Cumulative Effects.** The cumulative effects of disturbance from internal and external factors are considered insignificant to northern fur seals because there is little information indicating an adverse effect at a population level.

Direct/Indirect Effects FMP 4.2

Under FMP 4.2, the groundfish fisheries would be essentially closed until specific fisheries were certified to have no adverse effects on the environment. The potential impacts to marine mammals would therefore be even less than described under FMP 4.1 but the conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 4.2 are the same as described under FMP 4.1.

Cumulative Effects

Since the groundfish fisheries would be essentially closed under FMP 4.2, the cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance would all be dominated by the same persistent past and external factors discussed under FMP 4.1. Since the contribution of the groundfish fisheries to all of these effects is also greatly reduced relative to the baseline condition under FMP 4.1, the cumulative effects conclusions are the same as discussed under FMP 4.1.

4.8.8.4 Harbor Seals

FMP 4.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

Since fishing effort is greatly reduced relative to the baseline under FMP 4.1, incidental takes of harbor seals would be expected to decrease under FMP 4.1. Under the baseline conditions, takes and entanglements associated with fishing activities are thought to be insignificant to harbor seals at the population level. Reducing these takes even further would also be considered to have insignificant effects on the population trajectory of harbor seals.

Fisheries Harvest of Prey Species

Under FMP 4.1, the fishing mortality rate of EBS pollock is expected to decrease by an average of 76 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in the harvest of this key harbor seal prey species is rated significantly beneficial.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 78 percent relative to the comparative baseline over the next five years under FMP 4.1. This change in F is significantly beneficial under the 4.1 scenario at the population level for harbor seals. Fishing mortality rates are not calculated for Aleutian Islands pollock, as there was no directed Aleutian Islands pollock fishery under the baseline conditions. There is no change in the projected catch of Aleutian Islands pollock between the baseline and FMP 4.1; therefore, effects of Aleutian Islands pollock harvests are deemed to be insignificant to harbor seals at the population level for FMP 4.1.

Under FMP 4.1, the BSAI Pacific cod fishing mortality rate is expected to decrease by 71 percent. This change is determined to be significantly beneficial to harbor seals according to the criteria established in Table 4.1-6. Under FMP 4.1, the GOA Pacific cod fishing mortality rate is expected to decrease by 73 percent. This change is determined to be significantly beneficial to harbor seals. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly beneficial to harbor seals with decreases in F of 81 percent under FMP 4.1 relative to the baseline.

Little difference is expected relative to the baseline for harvest of other, non-target species that are prey for harbor seals under the FMP 4.1 management regime (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under FMP 4.1 were determined to be insignificant to harbor seals. The combined harvest of harbor seal prey species under FMP 4.1 is expected to be significantly beneficial to harbor seals relative to the baseline.

Spatial/Temporal Concentration of the Fishery

Relative to the baseline, FMP 4.1 offers substantially more temporal and spatial protection from the effects of groundfish fisheries on harbor seals and was determined to have significantly beneficial effects on harbor seals by substantially reducing potential impacts on their prey fields.

Disturbance

FMP 4.1 is expected to result in decreased disturbance to harbor seals relative to the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under FMP 4.1.

Cumulative Effects

A summary of the effects of the past/present with regards to harbor seals is presented in Section 3.8.4 (Table 3.8-4). The effects considered in this analysis are listed in Table 4.8-5. Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Incidental take of all marine mammals, including harbor seals, would decrease under FMP 4.1 but would still be insignificant to the population trajectories of marine mammals due to the low level of mortalities attributed to incidental take and entanglement in fishing gear.

- **Persistent Past Effects.** Residual effects on local populations from State of Alaska predator control programs (1950s to 1972) and commercial hunts (1963 to 1972) may still occur in some areas, although there are no data on these factors. Foreign and JV groundfish fisheries in the 1960s and 1970s have likely contributed to some level of direct harbor seal mortality from entanglement in gear, but based on the near shore distribution of harbor seals, there was likely minimal direct interaction and mortality is believed to have been very low. From 1990 to 1996, minimum estimates of harbor seals taken incidentally in groundfish gear in the Bering Sea were four per year and less than one per year in the GOA. In southeast Alaska, four harbor seals are estimated to be killed each year on longlines. Harvest of harbor seals for subsistence purposes is likely the highest cause of anthropogenic mortality for this species, since the cessation of commercial harvests in the early 1970s. Between 1992 and 1998, the state-wide harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which were taken in southeast Alaska (Wolfe and Hutchinson-Scarbrough 1999). Subsistence harvest of Bering sea stock of harbor seals approximately 161 animals, 42 percent of PBR for this species. For the GOA stock, the subsistence harvest is approximately 91 percent of the PBR for this stock. For the southeast stock, harvest is approximately 83 percent of PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take of harbor seals in state-managed fisheries such as salmon set and drift gillnet fisheries would be expected to continue at its present low rate. Subsistence take is expected to continue to be the greatest source of human-controlled mortality with a relatively high percentage of the PBR in both the GOA and southeast Alaska stock and a lower take in the BSAI region. Climate change is likely not a factor in the direct mortality of harbor seals although there would likely be indirect effects.

- **Cumulative Effects.** Cumulative effects of mortality are based on internal effects of the groundfish fishery and external sources such as subsistence and state-managed fisheries. Total human-caused mortality is expected to be below the PBR for all stocks of harbor seals and is considered insignificant.

Availability of Prey

- **Direct/Indirect Effects.** The combined harvest of harbor seal prey species under FMP 4.1 is expected to result in significantly beneficial population-level effects to harbor seals.

- **Persistent Past Effects.** Availability of prey for harbor seals in the past has likely been affected by foreign and JV fisheries, Federal domestic groundfish fisheries and state-managed salmon and herring fisheries, since the fish targeted by these fisheries are also prey of the harbor seal. Climate change/regime shift could possibly have been a factor in fluctuations in prey availability in the past.

- **Reasonably Foreseeable Future External Effects.** State-managed salmon and herring fisheries are identified as having potential adverse effects on harbor seal prey availability. Climate change/regime shift will continue to be a contributing factor although the effects can be either beneficial or adverse, depending on direction and magnitude of the change.

- **Cumulative Effects.** Cumulative effects of prey availability were based on internal effects of the groundfish fisheries and external factors. These effects were determined to likely result in population-level effects based on the substantial decrease in harvest of harbor seal prey species in the groundfish fisheries and are considered significantly beneficial.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** FMP 4.1 offers substantially more temporal and spatial protection from the effects of groundfish fisheries on harbor seals relative to the baseline and is considered to have significantly beneficial effects on harbor seals.

- **Persistent Past Effects.** Effect of groundfish harvest in the past has likely occurred from overlap of harbor seal prey species, fish targeted, and areas fished by the foreign and JV fisheries in the BSAI as well as the State of Alaska and federal fisheries.

- **Reasonably Foreseeable Future External Effects.** Future effects on spatial/temporal harvest were considered for the state-managed fisheries in nearshore areas such as salmon and herring. Since these fisheries generally occur in the nearshore areas in comparison to groundfish fisheries, overlap is more pronounced. Effects of climate change/regime shifts on prey species abundance and distribution are likely in the foreseeable future.

- **Cumulative Effects.** Cumulative effects of spatial/temporal harvest of prey were based on internal effects of the groundfish fisheries and external effect of other fisheries. These effects were determined to be significantly beneficial based on a significantly beneficial rating assigned to the internal effect of the FMP for extensive areas closures, MPAs for prey species, and no take reserves. These measures would be likely to substantially reduce potential impacts on the prey fields of harbor seals and therefore have beneficial population level effects.

Disturbance

- **Direct/Indirect Effects.** The effects of disturbance on harbor seals are considered to be insignificant at the population level.

- **Persistent Past Effects.** Disturbance of harbor seals in the past included commercial groundfish fisheries harvest by JV fisheries, foreign and federal domestic fisheries, commercial harvest, State of Alaska predator control programs, and to a lesser extent, the subsistence harvest of harbor seals. It is unknown whether these past activities have persistent effects but the ongoing fishing activities and subsistence do continue to result in some level of disturbance to harbor seal.

- **Reasonablely Foreseeable Future Effects.** State-managed fisheries, general vessel traffic, and subsistence activities would be expected to continue to create some level of disturbance to harbor seals in the foreseeable future.

- **Cumulative Effects.** Cumulative effects of disturbance were based on the presence of both internal and external sources of disturbance. Since there is little to indicate that harbor seals have suffered any adverse effects from the baseline level of disturbance, reduced levels of disturbance under FMP 4.1 are unlikely to have population-level effects and are therefore considered insignificant.

Direct/Indirect Effects FMP 4.2

Under FMP 4.2, the groundfish fisheries would be essentially closed until specific fisheries were certified to have no adverse effects on the environment. The potential impacts to marine mammals would therefore be even less than described under FMP 4.1 but the conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 4.2 are the same as described under FMP 4.1.

Cumulative Effects

Since the groundfish fisheries would be essentially closed under FMP 4.2, the cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance would all be dominated by the same persistent past and external factors discussed under FMP 4.1. Since the contribution of the groundfish fisheries to all of these effects is also greatly reduced relative to the baseline condition under FMP 4.1, the cumulative effects conclusions are the same as discussed under FMP 4.1.

4.8.8.5 Other Pinnipeds

Direct/Indirect Effects FMP 4.1

Incidental Take/Entanglement in Marine Debris

Since fishing effort is greatly reduced relative to the baseline under FMP 4.1, incidental takes of other pinnipeds would be expected to decrease under FMP 4.1. Under the baseline conditions, takes and entanglements associated with fishing activities are thought to be insignificant to other pinnipeds at the population level. Reducing these takes even further would also be considered to have insignificant effects on the population trajectory of other pinnipeds.

Fisheries Harvest of Prey Species

Due to limited overlap in prey species taken (see section 4.5.8.5), the effects of groundfish fisheries harvest under FMP 4.1 are determined to be insignificant to all pinnipeds in this group except northern elephant seal. The diet of northern elephant seals in the GOA is unknown; however, the species is known to be a deep diver. This behavior suggests that their foraging may be partitioned by depth from most groundfish fishing activities. The effects of groundfish harvests on prey species for northern elephant seals are therefore considered to be unknown.

Spatial/Temporal Concentration of the Fishery

Due to the limited potential for competitive overlap to occur between pinnipeds included in this section and the groundfish fisheries, the spatial/temporal concentrations of the fisheries are expected to be inconsequential to animals in this category under FMP 4.1.

Disturbance

FMP 4.1 is expected to result in decreased disturbance to pinnipeds relative to the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under FMP 4.1.

Cumulative Effects

A summary of the effects of the past/present with regards to other pinnipeds is presented in Section 3.8.2 and Sections 3.8.5 through 3.8.9 (Table 3.8-3 and Tables 3.8-5 through 3.8-9). The predicted direct/indirect effects of the groundfish fishery under FMP 4.1 are described above (Table 4.8-5). Cumulative effects are summarized in Table 4.5-66.

Mortality

- **Direct/Indirect Effects.** Incidental take of pinnipeds would decrease under FMP 4.1 relative to the baseline and would be insignificant.

- **Persistent Past Effects.** Past external effects on the populations of pinniped include low levels of incidental take in the foreign, JV, and domestic groundfish fisheries and low levels of take in the State-managed fisheries. Spotted seal incidental mortality in groundfish fisheries is one per year between 1995 and 1999 (Angliss and Lodge 2002). For bearded seal, the BSAI groundfish fisheries take an average of 0.6 per year. The Bristol Bay salmon drift gillnet fishery from 1990-1993 indicated 14 mortalities and 31 injuries of bearded seals. No mortalities of ringed seals have been observed in the last ten years in the BSAI groundfish (Angliss *et al*. 2001). For ribbon seal incidental take, the Bering Sea trawl fishery had one take in 1990, one in 1991, and one in 1997. An average of 86 elephant seals are taken each year in various gillnet fisheries from California to Washington. Incidental take included one in the Bering Sea trawl fishery in 1990, two in the GOA trawl fishery in 1990, and three in the GOA longline fishery in 1990. One juvenile elephant seal, originally misidentified as a bearded seal, was taken in the Bering Sea trawl fishery in 1991 (Angliss *et al*. 2001). Of the 17 Pacific walrus that were caught each year in groundfish trawl fisheries in the EBS between 1990 and 1997, over 80 percent were already decomposed (Gorbics *et al.* 1998). Subsistence is the major human-cause external factor for morality. Subsistence annual harvest rates include 5,265 spotted seal, 6,788 bearded seal, 100 ribbon seal, 9,567 ringed seal, 1,000 walrus and zero elephant seal.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries will likely continue to take very small numbers of seals in this group. Subsistence take of these marine mammals will likely continue at a similar rate to the baseline conditions.

- **Cumulative Effect.** The combined effects of mortality within the other pinniped group resulting from internal effects of the groundfish fisheries and external effects, such as subsistence harvest, are considered insignificant. For spotted, ringed, bearded, and ribbon seals, PBRs cannot be calculated. Walrus take is below PBR and population level effects are unlikely. Elephant seal populations are expanding so overall mortality is considered insignificant. Contributions of the groundfish fisheries to overall mortality is very small.

Abundance of Prey

- **Direct/Indirect Effects.** Except for elephant seals, where the amount of prey overlap is unknown, there is very little overlap of species taken in the groundfish fisheries with prey of the pinnipeds in this group and the effects of fisheries harvest on prey species are determined to be insignificant under FMP 4.1.

- **Persistent Past Effects.** Past effects on spotted seal prey include foreign, JV, and domestic groundfish fisheries and state-managed fisheries for salmon and herring. For the other ice seals, elephant seals, and walrus, no persistent past effects were identified due to minimal overlap with commercial fisheries.

- **Reasonably Foreseeable Future External Effects.** Future effects were identified for state-managed fisheries for the spotted seal. Climate change may be either a beneficial factor or adverse factor for the ice seals due to the extent of ice cover in the Bering Sea and effect on abundance and distribution of prey.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance of prey for pinnipeds is considered insignificant for all species. Spotted seals have some overlap of prey with the groundfish fisheries but the harvest of prey by the fisheries is not expected to have population level effects. The amount of groundfish fishery overlap with elephant seals is unknown but, since the elephant seal population is expanding, food does not appear to be limiting so cumulative effects on prey availability are considered insignificant. The amount of prey overlap with the other pinniped species is very limited and is considered insignificant for all species in this group.

Spatial/Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** The effects from spatial/temporal concentrations of the fisheries are expected to be insignificant for pinnipeds in this category under FMP 4.1.

- **Persistent Past Effects.** Persistent past effects on spotted seals include foreign, JV, and domestic groundfish fisheries and State of Alaska-fisheries. For other species, no past effects are identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries within the range of spotted seals would be expected in the future in a manner similar to the baseline conditions. Future effects of spatial/temporal concentration of fisheries on ice seals and walrus would not be expected.

- **Cumulative Effects.** The spatial/temporal concentration of the groundfish fishery and all other fisheries is considered to have an insignificant cumulative effect on pinniped prey due to limited seasonal overlap. Population-level effects are unlikely for any of the species in this group.

Disturbance

- **Direct/Indirect Effects.** FMP 4.1 is expected to result in decreased disturbance to pinnipeds relative to the baseline. However, because the effects of disturbance are insignificant, under the baseline conditions they would also be insignificant.

- **Persistent Past Effects.** Past sources of disturbance of spotted seals have come from the foreign, JV, and federal domestic groundfish fisheries in the BSAI and state-managed fisheries for salmon. Overlap of fisheries is minimal for most of species. The primary source of external disturbance to the other pinniped category would be related to subsistence harvest.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries could be expected to continue at a level similar to the baseline conditions. Disturbance from subsistence harvest activities in future years would be expected to remain similar to the baseline conditions.

- **Cumulative Effects.** Cumulative effects of disturbance were based on both internal and external effects. These cumulative effects are found to be insignificant for all species based on very limited overlap with the fisheries and the lack of evidence that disturbance results in population-level effects for any of these species.

Direct/Indirect Effects FMP 4.2 – Other Pinnipeds

Under FMP 4.2, the groundfish fisheries would be essentially closed until specific fisheries were certified to have no adverse effects on the environment. The potential impacts to marine mammals would therefore be even less than described under FMP 4.1 but the conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 4.2 are the same as described under FMP 4.1.

Cumulative Effects

Since the groundfish fisheries would be essentially closed under FMP 4.2, the cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance would all be dominated by the same persistent past and external factors discussed under FMP 4.1. Since the contribution of the groundfish fisheries to all of these effects is also greatly reduced relative to the baseline condition under FMP 4.1, the cumulative effects conclusions are the same as discussed under FMP 4.1.

4.8.8.6 Transient Killer Whales

Direct/Indirect Effects FMP 4.1

Incidental Take/Entanglement in Marine Debris

Since fishing effort is greatly reduced relative to the baseline under FMP 4.1, incidental takes of transient killer whales would be expected to decrease under FMP 4.1. Under the baseline conditions, takes and entanglements associated with fishing activities are thought to be insignificant to transient killer whales at the population level. Reducing these takes even further would also be considered to have insignificant effects on the population trajectory of transient killer whales.

Fisheries Harvest of Prey Species

The diet of transient killer whales consists of marine mammals. Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant under FMP 4.1.

Spatial/Temporal Concentration of the Fishery

The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant under FMP 4.1.

Disturbance

FMP 4.1 would likely result in decreased disturbance to transient killer whales relative to the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under FMP 4.1.

Cumulative Effects

The past/present effects on transient killer whales are described in Section 3.8.22 (Table 3.8-22). The effects considered in this analysis are listed in Table 4.5-66. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Incidental takes of transient killer whales would decrease under FMP 4.1 and would be insignificant.

- **Persistent Past Effects.** Mortality has been documented in the JV fisheries, domestic groundfish fisheries, state-managed fisheries, and intentional shootings. Past incidental take in the groundfish fisheries is less than two animals per year, but it is not known if these animals were transients or residents. In addition to mortalities caused by entanglement, killer whales are susceptible to injury or mortality through vessel strikes. One killer whale was reported to be killed when it struck the propeller of a BSAI groundfish trawl vessel in 1998 (Angliss and Lodge 2002). The EVOS resulted in the loss of half of the individual killer whales from the AT1 transient group in PWS (Matkin *et al.* 1999). This distinct group of whales is being evaluated for recognition as a separate stock and protection as a depleted stock under the MMPA. Contaminant levels in whales in this group were found to be many times higher than other killer whales (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects**. Mortality from external factors is identified for other state-managed fisheries, intentional shooting, and marine pollution, particularly bioaccumulating compounds such as PCBs and DDT (Matkin *et al.* 2001).

- **Cumulative Effects.** Cumulative effects of mortality resulting from internal effects of the groundfish fisheries and external factors are determined to be insignificant. The exception to this finding is in the AT1 transient group in PWS. The cumulative effects of mortality on this group were determined to be significantly adverse due to the past external effects of the EVOS and their subsequent population decline.

Prey Availability

- **Direct/Indirect Effects.** Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant.

- **Persistent Past Effects.** Since marine mammals are the primary prey of transient killer whales, all of the factors that have been identified as affecting the abundance or distribution of cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include commercial and subsistence harvest, intentional shootings, incidental take in all fisheries, marine pollution, climate change, and regime shifts. In addition, there is the potential for past indirect effects of fisheries on the abundance of Steller sea lions, fur seals, and harbor seals, all of which are important prey species for transient killer whales. Declines in harbor seals in PWS after the EVOS could have affected the AT1 group of transient killer whales through their food supply (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey species important to transient killer whales, primarily marine mammals, would include state-managed fisheries to a small extent and subsistence harvest of the various marine mammals.

- **Cumulative Effects.** The cumulative effects on different marine mammal species are varied, with some populations declining substantially while others increase. Although some individual whales may specialize on particular prey species, the ability of these top predators to switch prey and forage over vast areas is believed to decrease the importance of any one species or stock of marine mammal prey. The overall availability of prey does not appear to be having population level effects on transient killer whales and therefore the cumulative effect is considered insignificant.

Spatial/Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant.

- **Persistent Past Effects.** All persistent past effects that have been identified for cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include the potential contribution of the spatial/temporal concentration of past fisheries to have caused localized depletion of prey for Steller sea lions, harbor seals, and northern fur seals with consequent population-level effects on those species.

- **Reasonably Foreseeable Future External Effects.** The future spatial/temporal concentration of external fisheries could have indirect effects on the abundance and distribution of marine mammals that are important prey for transient killer whales.

- **Cumulative Effects.** The cumulative effects of the spatial/temporal concentration of fisheries on different marine mammal species result in changes to the abundance and distribution of prey to transient killer whales. Since transient killer whales. are able to switch prey and forage over vast areas, the potential localized depletion of any one species or stock of marine mammal prey is unlikely to have population level effects on the killer whales. The cumulative effect of the spatial and temporal harvest of fish from all fisheries does not appear to be having population level effects on transient killer whales and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance to transient killer whales are expected to be similar to baseline conditions and are expected to be insignificant.

- **Persistent Past Effects.** Some level of disturbance has likely occurred from foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Vessel traffic external to the fisheries has contributed to overall disturbance of these animals. Effects of the level of disturbance on transient killer whales are largely unknown.

- **Reasonably Foreseeable Future External Effects.** External effects of state-managed fisheries and other vessel traffic on disturbance will likely occur in future years at a level similar to the baseline.

- **Cumulative Effects.** Cumulative effects of disturbance to transient killer whales are not likely to result in any population-level effects and are therefore considered insignificant.

Direct/Indirect Effects FMP 4.2

Under FMP 4.2, the groundfish fisheries would be essentially closed until specific fisheries were certified to have no adverse effects on the environment. The potential impacts to marine mammals would therefore be even less than described under FMP 4.1 but the conclusions regarding direct/indirect effects for incidental

take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 4.2 are the same as described under FMP 4.1.

Cumulative Effects

Since the groundfish fisheries would be essentially closed under FMP 4.2, the cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance would all be dominated by the same persistent past and external factors discussed under FMP 4.1. Since the contribution of the groundfish fisheries to all of these effects is also greatly reduced relative to the baseline condition under FMP 4.1, the cumulative effects conclusions are the same as discussed under FMP 4.1.

4.8.8.7 Other Toothed Whales

FMP 4.1 – Direct/Indirect Effects

Incidental Take/Entanglement in Marine Debris

Since fishing effort is greatly reduced relative to the baseline under FMP 4.1, incidental takes of other toothed whales would be expected to decrease under FMP 4.1. Under the baseline conditions, takes and entanglements associated with fishing activities are thought to be insignificant to other toothed whales at the population level. Reducing these takes even further would also be considered to have insignificant effects on the population trajectory of other toothed whales.

Fisheries Harvest of Prey Species

The effects of the groundfish fisheries under FMP 4.1 on the toothed whales are largely constrained by differences between their prey and the fisheries harvest targets. FMP 4.1 is not expected to increase the level of interactions relative to the baseline for the endangered sperm whale or non ESA-listed toothed whales and is therefore determined to be insignificant at the population level for all species.

Spatial/Temporal Concentration of the Fishery

Groundfish fisheries have little competitive overlap with toothed whales (see Section 4.5.8.7). Changes to the spatial/temporal concentration of the fisheries under FMP 4.1 are expected to have insignificant effects on toothed whales at the population level.

Disturbance

FMP 4.1 is expected to result in decreased disturbance to endangered sperm whales and other toothed whales relative to the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under FMP 4.1.

Cumulative Effects

The past/present effects on the other toothed whale group are described in Sections 3.8.19 through 3.8.21 and Section 3.8.23 to 3.8.25 (Tables 3.8-19 through 3.8-25). The effects considered in this analysis are listed in Table 4.5-68. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** Incidental take of toothed whales would decrease under FMP 4.1 and is considered insignificant.

- **Persistent Past Effects.** Persistent past effects on species within the other toothed whale group include incidental take and entanglement in foreign, JV, Federal domestic groundfish fisheries and State-managed fisheries, and subsistence hunting of beluga whales. The decline of the Cook Inlet beluga population is thought to have been the result of subsistence harvests, which ranged from 21 to 123 animals per year between 1993 and 1998. Only one beluga was harvested in 2001 by hunters from the Native Village of Tyonek and one beluga was harvested in 2002 by the Cook Inlet community hunters. Belugas are incidentally taken during the State-managed salmon gillnet fisheries in Bristol Bay and Cook Inlet with one beluga reported taken from the eastern Bering stock in 1996 and seven reported taken in Bristol Bay in 2000. In the BSAI and GOA groundfish fisheries, no mortality or serious injuries to belugas have been observed. Harbor porpoise have not been taken in the observed groundfish fisheries over a ten year period between 1990 to 1998 (Angliss *et al*. 2001). Salmon gillnet fisheries in southeast Alaska take approximately three individuals per year. Dall porpoise mean annual mortality was 6.0 for the Bering Sea groundfish trawl fishery, 1.2 for the GOA groundfish trawl fishery, and 1.6 for the Bering Sea groundfish longline fishery. The Alaska Peninsula/Aleutian Island salmon drift gillnet fishery has a higher take of Dall's Porpoise with an estimated 28 porpoises in one year (1990). Thousands of Pacific white-sided dolphins were killed annually between 1978 and 1991 in the high seas driftnet fisheries, which no long occur (Angliss *et al*. 2001). One Pacific white-sided dolphin was taken in the BSAI trawl fishery and one in the BSAI longline fishery during the same time span (Angliss *et al*. 2001). State-managed salmon gillnet fisheries take approximately two dolphins per year.

  Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987, with high counts in 1968 when 16,357 sperm whales were harvested, after which the population were severely depleted. Sperm whale interactions with longline fisheries operating in the GOA are known to occur and may be increasing in frequency. Sperm whales have been known to prey on sablefish caught on commercial longline gear in the GOA. Only three entanglements have been reported in the GOA longline fishery.

  For killer whales, the combined mortality from the observed groundfish fisheries was 1.4 whales per year (Angliss *et al*. 2001). While it is most likely that whales interacting with fisheries are from resident pods (since they eat fish), no genetic testing has been done on whales incidentally taken in the groundfish fisheries to ascertain whether they were from resident or transient stocks.

For beaked whales (Baird's, Cuvier's, or Stejneger's), no incidental takes or entanglements in BSAI and GOA groundfish trawl, longline, and pot fisheries have been documented (Hill and DeMaster 1999).

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the U.S. EEZ and State-managed fisheries were identified as potential effects in the futures. Several of these species range outside of BSAI and GOA during the winter months. Subsistence takes of some beluga whales would be expected to continue similar to the baseline conditions. Other species are not taken for subsistence purposes.

- **Cumulative Effects.** Cumulative effects of mortality resulting from internal and external factors are considered insignificant for all non-ESA listed species due to the low level of incidental take in the groundfish fisheries and limited external human-caused mortality.

  For the endangered sperm whale, the cumulative effect was also considered insignificant because the very low level of incidental take in the groundfish fisheries and very limited human-caused mortality from external sources is not expected to delay the recovery of sperm whale populations.

Prey Availability

- **Direct/Indirect Effects.** The groundfish fishery under FMP4.1 is not expected to increase the level of competitive interactions for toothed whale prey from the baseline condition and is therefore considered to have insignificant effects on toothed whale prey.

- **Persistent Past Effects.** Although this group preys on a wide variety of fish species, past effects on the availability of prey for this group are identified for fisheries in general and include the foreign, JV, and Federal domestic groundfish fisheries and the State-managed fisheries for salmon and herring. The diversity of diet in this whale group results in limited overlap for most species with the possible exception of sperm whales and resident killer whales.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries were identified as an external factor having a potential effect on prey for these species in the future. Climate and regime shift are also identified but the direction and magnitude of these effects are difficult to predict.

- **Cumulative Effects.** The ability of these whale species to forage over wide areas and on a variety of prey species moderates any potential impacts from fisheries competition. Cumulative effects on prey availability were identified for this group, including a very limited contribution from the groundfish fishery, but the degree of fishery harvest and bycatch of prey important to these whale species is not expected to have population-level effects on any species, including the endangered sperm whale, and is therefore considered insignificant.

Spatial/Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects.** The groundfish fisheries have little competitive overlap with toothed whales; therefore, changes to the spatial/temporal concentration of the fisheries is expected to result in effects that are insignificant to sperm whales and other toothed whales at the population level.

- **Persistent Past Effects.** The spatial/temporal concentration of foreign, JV, and domestic groundfish fisheries and the State-managed fisheries are believed to have had minimal effects on the abundance and distribution of toothed whale prey.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue in a similar manner as the under the baseline conditions. Effects of future fishing activities on toothed whale prey are expected to be minimal.

- **Cumulative Effects.** The ability of toothed whales to forage over wide areas and on a variety of prey species moderates any potential impacts from localized depletion of prey from the spatial/temporal concentration of fisheries. Cumulative effects on prey abundance and distribution, including a very limited contribution from the groundfish fishery, are not expected to have population-level effects on any species, including the endangered sperm whale, and are therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects.** Disturbance from the groundfish fishery under FMP 4.1 on sperm whale and other toothed whale populations is determined to be insignificant at the population level.

- **Persistent Past Effects.** Past potential disturbance effects on species in this group were identified for foreign, JV, and Federal domestic groundfish fisheries; however, there is little indication of an adverse effect from this level of disturbance. General vessel traffic likely also contributes to disturbance to these species.

- **Reasonably Foreseeable Future External Effects.** Increases in the general marine vessel traffic and continued fishing activity in the state-managed fisheries were identified as potential sources of disturbance.

- **Cumulative Effects.** The cumulative effect of disturbance from both internal and external factors is found to be insignificant for endangered sperm whales and other toothed whale species based on the lack of evidence that disturbance has a population-level effect for any of these species. For sperm whales, there is growing evidence that the whales are attracted to fishing vessels as reliable and easy sources of food.

Direct/Indirect Effects FMP 4.2 – Other Toothed Whales

Under FMP 4.2, the groundfish fisheries would be essentially closed until specific fisheries were certified to have no adverse effects on the environment. The potential impacts to marine mammals would therefore be even less than described under FMP 4.1 but the conclusions regarding direct/indirect effects for incidental

take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 4.2 are the same as described under FMP 4.1.

Cumulative Effects

Since the groundfish fisheries would be essentially closed under FMP 4.2, the cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance would all be dominated by the same persistent past and external factors discussed under FMP 4.1. Since the contribution of the groundfish fisheries to all of these effects is also greatly reduced relative to the baseline condition under FMP 4.1, the cumulative effects conclusions are the same as discussed under FMP 4.1.

4.8.8.8 Baleen Whales

Direct/Indirect Effects FMP 4.1

Incidental Take/Entanglement in Marine Debris

Since fishing effort is greatly reduced relative to the baseline under FMP 4.1, incidental takes of baleen whales would be expected to decrease under FMP 4.1. Under the baseline conditions, takes and entanglements associated with fishing activities are thought to be insignificant to baleen whales at the population level. Reducing these takes even further would also be considered to have insignificant effects on the population trajectory of baleen whales.

Fisheries Harvest of Prey Species

The effects of groundfish fisheries under FMP 4.1 are considered insignificant to baleen whales in regards to harvest of prey species due to the lack of competitive overlap in species targeted by each (see Section 4.5.8.8).

Spatial/Temporal Concentration of the Fishery

Groundfish fisheries have little competitive overlap with baleen whales forage species. Changes to the spatial/temporal concentration of the fisheries under FMP 4.1 are expected to result in effects that are insignificant to baleen whales at the population level.

Disturbance

FMP 4.1 is expected to result in decreased disturbance to baleen whales relative to the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level.

Cumulative Effects

The past/present effects on the baleen whale group are described in Section 3.8.11 through 3.8.18 (Tables 3.8-11 through 3.8-18). The effects considered in this analysis are listed in Table 4.5-69.

Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The reduced level of takes and entanglements of baleen whales projected to occur under the FMP 4.1 is considered insignificant at the population level for all species.

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- **Persistent Past Effects.** Commercial whaling in the last century has had lingering effects on most of the baleen whales in this group with the possible exception of the minke whale. These include endangered blue whales, fin whales, sei whales, humpback whales, northern right whale and the non-ESA-listed gray whales and right whales. A full discussion of the effects of commercial whaling is presented in Section 3.8.

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and State-managed fisheries are expected to continue to take small numbers of baleen whales in the coming years. Entanglements in fishing gear will continue to effect baleen whales throughout their ranges. Subsistence for gray whales and bowhead will continue to be the largest source of human-caused mortality.

- **Cumulative Effects.** Cumulative effects of mortality resulting from internal effects of the fishery and contributions from external factors are considered conditionally significant adverse for fin, humpback, and northern right whales due to past effects on their population, potential for interactions with fisheries, and their endangered status. Right whales are very rare so even one human-caused mortality could be considered significant. Given the overlap of their preferred habitat with the BSAI fisheries, the chances of future adverse interactions with fishing gear are more than negligible. The adverse rating for these three species is conditional on whether future take or entanglement substantially affects their rates of recovery. Cumulative effects are found to be insignificant for the endangered blue, bowhead, and sei whales. These species rarely interact with the fisheries so population-level effects are not anticipated. Mortality is also considered insignificant for non-ESA-listed minke and gray whales. Population-level effects are not expected for either of these species.

Prey Availability

- **Direct/Indirect Effects.** The effects of FMP 4.1 are determined to have an insignificant effect on baleen whale species in regards to harvest of prey species due to the lack of competitive overlap in species targeted by each.

- **Persistent Past Effects.** Past effects on availability of prey were not identified due to the lack of competitive overlap in prey species targeted.

- **Reasonably Foreseeable Future External Effects.** Future effects were identified as state-managed fisheries such as herring, which are preyed on by humpback whales and fin whales. Other species would not be directly affected through their prey.

- **Cumulative Effects.** Cumulative effects of prey availability on baleen whale species are not anticipated on a population level for any of the species in this group primarily due to the limited overlap of prey species with fisheries. The effects are considered insignificant for all species.

Temporal and Spatial Concentration of the Fishery

- **Direct/Indirect Effects.** Due to limited overlap of prey species taken, changes to the spatial/temporal concentration of the fisheries under FMP 4.1 are expected to have insignificant effects on baleen whales at the population level.

- **Persistent Past Effects.** Persistent past effects of temporal and spatial concentrations of the fisheries were not identified.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries would be expected to continue to contribute some degree of effect on several species in the baleen whales group.

- **Cumulative Effects.** Cumulative effects on the spatial and temporal concentration of harvest of baleen whale prey resulting from internal effects of the fishery and contributions from external factors are considered insignificant for endangered and non-ESA listed species in this group due to the limited overlap of prey species within the fisheries.

Disturbance

- **Direct/Indirect Effects.** FMP 4.1 is expected to result in decreased disturbance to endangered and non-ESA-listed baleen whales, but the effects are considered insignificant at the population level.

- **Persistent Past Effects.** Some level of disturbance has likely occurred from foreign, JV, and domestic groundfish fishing and State-managed fisheries along with general vessel traffic. For some species such as the gray and bowhead whales, subsistence activities have contributed to disturbance of these animals.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries and general vessel traffic from recreational boating and whale watching to commercial vessels would be expected to continue in future years as well as subsistence activities.

- **Cumulative Effects.** Cumulative effects of disturbance resulting from internal and external sources are determined to be similar to the baseline condition and not likely to result in a population-level effect for any of the species in this group. Therefore, the cumulative effect is considered to be insignificant for both endangered and non ESA-listed baleen whales.

Direct/Indirect Effects FMP 4.2

Under FMP 4.2, the groundfish fisheries would be essentially closed until specific fisheries were certified to have no adverse effects on the environment. The potential impacts to marine mammals would therefore be even less than described under FMP 4.1 but the conclusions regarding direct/indirect effects for incidental

take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 4.2 are the same as described under FMP 4.1.

Cumulative Effects

Since the groundfish fisheries would be essentially closed under FMP 4.2, the cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance would all be dominated by the same persistent past and external factors discussed under FMP 4.1. Since the contribution of the groundfish fisheries to all of these effects is also greatly reduced relative to the baseline condition under FMP 4.1, the cumulative effects conclusions are the same as discussed under FMP 4.1.

4.8.8.9 Sea Otters

Direct/Indirect Effects FMP 4.1

Incidental Take/Entanglement in Marine Debris

Since fishing effort is greatly reduced relative to the baseline under FMP 4.1, incidental takes of sea otters would be expected to decrease under FMP 4.1. Under the baseline conditions, takes and entanglements associated with fishing activities are thought to be insignificant to sea otters at the population level. Reducing these takes even further would also be considered to have insignificant effects on the population trajectory of sea otters.

Fisheries Harvest of Prey Species

Given the minor importance of groundfish in their diet (see Section 4.5.8.9), fisheries removals under FMP 4.1 are expected to be substantially reduced relative to the baseline condition but the effects on prey availability to otters are considered insignificant at the population level.

Spatial/Temporal Concentration of the Fishery

Because of the habitat preference of sea otters for shallow areas, they do not overlap spatially with groundfish fisheries. Therefore, the effects of the spatial/temporal concentrations of the fisheries under FMP 4.1 are insignificant for sea otters.

Disturbance

FMP 4.1 may result in decreased disturbance to sea otters relative to the baseline. However, because the effects of disturbance are insignificant under the baseline conditions they would also be insignificant at the population level under FMP 4.1.

Cumulative Effects

The past/present effects on the sea otter are described in Section 3.8.10 (Table 3.8-10). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. This analysis seeks to provide an overall assessment of the species' population level response to its environment as it is influenced by the groundfish fishery. The effects considered in this analysis are listed in Table 4.5-70. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. The effects of incidental take and entanglement on sea otters under FMP 4.1 are considered insignificant.

- **Persistent Past Effects.** Commercial exploitation for pelts had a huge impact on sea otters dating from the mid-1700s to the late 1800s, causing them to become nearly extinct (Bancroft 1959, Lensink 1962). Alaska Natives have hunted sea otters for pelts and meat throughout history. Current harvest levels represent nine percent of PBR for the southwestern stock, 15 percent of PBR for the southcentral stock, and 35 percent of PBR for southeast stock (USFWS 2002a, 2002b and 2002c). Oils spills, such as the EVOS, can result in substantial mortality of sea otters. Sea otter numbers have declined dramatically from the Alaska Peninsula to the Bering Sea, and this stock is being considered for listing under the ESA.

- **Reasonably Foreseeable Future External Effects.** Low levels of incidental take in commercial and subsistence fisheries, subsistence hunting, and periodic mortalities from oil spills are likely to continue in the future. Population-level effects from transient killer whale predation may continue in the southwest Alaska stock, depending on the recovery of alternate prey and behavior of whales.

- **Cumulative Effects.** The cumulative effects of mortality from all sources are different for different stocks of sea otters. The populations of the southeast and southcentral stocks of sea otters appear to be stable or increasing and are not expected to have additional mortality pressures in the future. These stocks are considered to have insignificant cumulative effects from mortality. The rapid decline of the southwest Alaska stock does not appear to be the result of food shortages, disease, or toxic contamination and is likely the result of increased predation by killer whales following the collapse of their preferred sea lion prey population in the 1980s (Estes *et al*. 1998). Since the mechanism(s) of the population decline is still under investigation, the cumulative effect on the southwest stock is considered to be conditionally significant adverse through mortality.

Prey Availability

- **Direct/Indirect Effects.** The effects of harvest of key prey species in groundfish fisheries under FMP 4.1 are determined to be insignificant for sea otters.

- **Persistent Past Effects.** The groundfish fisheries have had little effect on the availability of prey in the past due to the limited overlap in prey species of the sea otter and the fish targeted by the groundfish fisheries. There is some minor overlap in State-managed crab fisheries and sea otter prey.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries that take crab from shallow waters were identified as external effects. The overlap primarily occurs in inshore areas or offshore areas with relatively shallow water.

- **Cumulative Effects.** Effects on prey availability were determined to be cumulative based on both internal effects of the groundfish fisheries and external factors as in the crab fisheries. These cumulative effects are determined to be insignificant due to the very limited overlap of these fisheries and the sea otter forage species and not likely to have population-level effects.

<u>Spatial/Temporal Concentration of the Fisheries</u>

- **Direct/Indirect Effects.** The effects of the spatial/temporal concentrations of the fisheries under FMP 4.1 are insignificant for sea otters.

- **Persistent Past Effects.** The limited spatial overlap of groundfish fisheries and other fisheries in the past have limited their interaction with sea otter prey. Past effects of spatial/temporal concentration have likely been in very specific areas and associated with State-managed crab fisheries.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries are likely to continue into the future at a level similar to the baseline conditions.

- **Cumulative Effects.** The cumulative effect of the spatial/temporal harvest of prey in the internal and external fisheries is considered to be insignificant due their limited spatial overlap with sea otter habitat. These fisheries are unlikely to have population-level effects.

<u>Disturbance</u>

- **Direct/Indirect Effects.** Levels of disturbance under FMP 4.1 are expected to be similar to the baseline and are therefore considered to be insignificant.

- **Persistent Past Effects.** Past effects of disturbance are primarily related to some minor disturbance by vessel traffic from fisheries and other vessels and disturbance associated with subsistence harvest of sea otters.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue at a level similar to the baseline. Commercial vessel traffic within sea otter habitat in future years would be expected to be similar the baseline.

- **Cumulative Effects.** Cumulative effects of disturbance on sea otters are considered insignificant and are unlikely to result in any population-level effects. The contribution of the groundfish fishery to the overall cumulative effect is minor.

Direct/Indirect Effects FMP 4.2

Under FMP 4.2, the groundfish fisheries would be essentially closed until specific fisheries were certified to have no adverse effects on the environment. The potential impacts to marine mammals would therefore be even less than described under FMP 4.1 but the conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, and spatial and temporal concentration of the fishery under FMP 4.2 are the same as described under FMP 4.1.

Cumulative Effects

Since the groundfish fisheries would be essentially closed under FMP 4.2, the cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance would all be dominated by the same persistent past and external factors discussed under FMP 4.1. Since the contribution of the groundfish fisheries to all of these effects is also greatly reduced relative to the baseline condition under FMP 4.1, the cumulative effects conclusions are the same as discussed under FMP 4.1.

4.8.9 Socioeconomic Alternative 4 Analysis

Alternative 4 represents a highly precautionary approach to managing fisheries under scientific uncertainty. This section contains both quantitative and qualitative assessments of select economic and social effects of FMP 4.1 and FMP 4.2.

4.8.9.1 Harvesting and Processing Sectors

The model and analytical framework used in the analysis of the effects of FMP 4.1 on the harvesting and processing sectors are described in Section 4.1.7.

Model projections of ex-vessel value and product value for this FMP are based on 2001 prices and product mixes. Because FMP 4.1 results in large reductions in catches of pollock and Pacific cod for both catcher vessels and catcher processors, actual prices might be expected to increase as a result of a reduction in the quantity of fish and the subsequent product supplied. The extent to which prices would increase depends on demand elasticities. Due to the presence of a large number of substitutes for Alaska groundfish products, the demand for these products is believed to be relatively elastic. In other words, prices for groundfish products are unlikely to be substantially influenced by changes in harvests. Also, ex-vessel prices are determined by negotiations between individual processors on one side and either bargaining associations for catcher vessels or individual fishermen on the other side. Ex-vessel prices may not behave as one might expect in a competitive market. Actual prices will ultimately depend on the relative bargaining power of harvesters and processors.

Historically, the product quality and prices for headed and gutted cod have often been higher for Pacific cod caught with fixed gear. Therefore, the elimination of the trawl fisheries and the expansion of the fixed-gear fisheries might be expected to increase the prices of headed and gutted Pacific cod. The use of product prices that are not gear-specific could underestimate the total product value for FMP 4.1 and would overstate the reduction in product value due to this FMP bookend. There is not a similar problem with ex-vessel value projections because gear-specific ex-vessel prices were used.

However, the assumption of constant prices and product mix may also result in bias in the opposite direction if a decline in catch quality puts downward pressure on average prices. This FMP would result in large shifts in catch both spatially and temporally relative to the comparative baseline. It is reasonable to assume that, subject to regulatory constraints, harvesters target catch in areas and time periods that maximize its value either by increasing the value (quality) of the fish or by decreasing the harvesting cost or both. If catch quality is lower, prices received are lower and total gross revenue is affected. The model projections for FMP 4.1 may understate the actual impact since 2001 ex-vessel prices are used to calculate ex-vessel value.

It is also possible that catch estimates from the model projections may be overstated. If catch rates are reduced substantially due to the spatial/temporal shift of harvests, it may not be possible or cost-effective for the fleet to take the full projected catch. Moreover, the concentration of fishing effort in the areas that remain open may lead to localized depletion of stocks and a decline in catch per unit of effort over the long-term. The model projections do not reflect these possibilities and therefore may overstate ex-vessel value and product value by overstating the quantity of catch.

It should also be noted that the model projections indicate that catches of Pacific cod do not decline significantly under this FMP. This projection is believed to be erroneous and an artifact of the way in which the model apportions catch between catcher vessels and catcher processors. The model redistributes a significant amount of catch from longline catcher processors to pot catcher vessels. In reality, such a reapportionment would not be expected to occur. Therefore, the model output overstates catcher vessel catches and understates catcher processor catches.

Finally, it is important to note that this analysis assumes that the no-take MPA established under this FMP bookend only apply to the groundfish fisheries. Non-groundfish fisheries would be allowed to be prosecuted within the borders of the marine protected areas subject to current regulations. However, it is possible that the no-take concept would be applied more broadly to include fisheries not managed under the groundfish FMPs. For example, the area closures could be applied in federal waters so as to prohibit crab fisheries in the BSAI, salmon fisheries in the southeast GOA, Bering Sea scallop fisheries, and halibut fisheries. It is also possible that the area closures could extend into State of Alaska waters if the state chose to implement complementary measures. The broader application of no-take marine protected areas would magnify the adverse economic impacts described in this analysis. In particular, small vessels that participate in non-groundfish fisheries may experience a larger decrease in revenues than what is projected in this analysis, as these vessels may be unable to travel beyond the boundaries of the area closures.

The net impact of upward and downward bias in projections of ex-vessel value and product value is difficult to determine; however, we expect that model projections of ex-vessel value and product value are likely to understate the adverse impact of FMP 4.1 on these variables. Whether the bias in projections is high or low, we expect large reductions in ex-vessel value and product value to occur under FMP 4.1 relative to the comparative baseline.

Table 4.8-6 summarizes projected impacts of FMP 4.1 on the harvesting and processing sectors. The numbers in the table reflect the 5-year average of outcomes projected for 2003 to 2007. Under FMP 4.1, there would be significant decreases in the harvest of groundfish species as a result of a large projected decrease in the TAC. The 5-year mean estimate of groundfish wholesale product value is about $0.5 billion, a 64 percent decrease when compared to the baseline.

The 5-year mean estimate of the pollock harvest is 1,035,000 mt (71 percent) lower than the comparative baseline. Pacific cod harvest are expected to decrease by 126,000 mt (58 percent), and harvest of species in the A-R-S-O species aggregation as a whole are predicted to decrease by 109,000 mt (74 percent). Only flatfish harvests do not change significantly in comparison to the comparative baseline. Total groundfish payments to labor are expected to decrease by 64 percent, and groundfish employment will decrease by about 6,000 FTE positions.

4.8.9.1.1 Catcher Vessels

Direct/Indirect Effects of FMP 4.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003 to 2007 period to 2001 catcher vessel conditions reveals that the large decrease in groundfish TAC that occurs under FMP 4.1 will cause retained catches of all groundfish species to significantly decline (see the earlier discussion regarding the erroneous model projections of Pacific cod catches for this FMP).

Ex-Vessel Value

As a result of the overall decrease in retained catch, the total ex-vessel value of groundfish landed by catcher vessels is expected to decrease significantly relative to the comparative baseline. Fixed-gear catcher vessels are expected to experience a less dramatic decline in groundfish ex-vessel value in comparison to classes of trawl catcher vessels because of the measure in FMP 4.1 that prohibits trawling in all fisheries that can be prosecuted with other gear types. In effect, this measure represents an allocation of groundfish TAC to users of fixed gear. Nevertheless, the decrease in the TAC for Pacific cod is expected to cause the ex-vessel value of fixed-gear catcher vessels to decline significantly.

Employment and Payments to Labor

Groundfish employment and payments to labor by all classes of catcher vessels are expected to decrease significantly under FMP 4.1. Most of the decrease in employment and payments to labor is incurred by the three classes of AFA-eligible trawl catcher vessels and fixed-gear catcher vessels 33 to 59 ft in length.

Impacts on Excess Capacity

Because FMP 4.1 would result in a large decrease in the quantity of catch and products from the groundfish fisheries, it is expected to generally lead to significantly higher excess capacity in the harvesting sector. However, the impacts of FMP 4.1 on excess capacity will vary by vessel class. Vessels using trawl gear will see a significant increase in excess capacity because of the reapportionment of Pacific cod to fixed gear. For fixed-gear vessels, the FMP measures are expected to have both adverse and beneficial effects in terms of harvest capacity. The reapportionment of Pacific cod to fixed-gear vessels will reduce excess capacity. However, the decrease in the TAC will cause a decline in the overall catches of fixed-gear catcher vessels.

To control capacity in the groundfish fisheries, FMP 4.1 includes all current measures that address overcapacity, including the LLP, the sablefish longline fishery IFQ program; the cooperatives established in the BSAI pollock fishery under the AFA, and the western Alaska CDQ program. In addition, FMP 4.1 would implement effort-based measures (also referred to as input-based methods) to further control fishing capacity. These effort-based measures may include limits on trips, gear size, vessel size or vessel horsepower or seasonal exclusive area registration. All effort-based measures attempt to control capacity by directly regulating the character, amount or usage of various fishing inputs. Gear and vessel restrictions limit the type or quantity of those particular inputs. Seasonal exclusive area registration prohibits individual fishing units from operating outside a specified area each season, thereby restricting where inputs can be used. Trip limits restrict the extent to which inputs can be used by imposing a catch ceiling for an individual fishing trip. Trip limits are often accompanied by a limit on the frequency of landings, which restricts the duration of use of inputs.

Obviously such measures would have to be associated with a restriction on the number of fishermen, otherwise it is clear that no control is placed on total potential effort. The number of participants in the Alaska groundfish fisheries is currently capped by the LLP. The LLP also limits the number of vessels that can use fixed gear. Even if the number of fishermen is restricted, effort-based measures do little towards mitigating the race for fish, and fishermen will continue to have an incentive to fish harder in order to maintain or increase their share of the TAC. Moreover, while the measures considered here can severely restrict the type, amount or use of fishing inputs, experience in fisheries worldwide shows that, given time to adjust, fishermen will often find ways of increasing their fishing effort by substituting inputs that are not controlled.

Average Costs

FMP 4.1 is expected to a have a significantly adverse impact on the average costs of many fishing operations. The closure of sea lion critical habitat to trawling, establishment of no-take marine protected areas, and the TAC component of FMP 4.1 would lower harvest rates for most classes of catcher vessels. Consequently, average costs per unit of catch for catcher vessels can be expected to increase substantially under FMP 4.1 because of the reduction in the overall level of production resulting from lower catches. Many costs are fixed (e.g., loan repayments, general office and accounting expenses and insurance costs); and are not reduced with the level of production. These costs would be allocated to a smaller amount of product, raising the average cost per unit of product.

Additionally, the redistribution of fishing effort to fixed gear vessels may lead to grounds congestion, increased gear conflicts, increased fishing costs and reduced gross revenue for these vessels. For example, grounds crowding with pots and longline gear occurred in the halibut and sablefish fisheries prior to the implementation of the IFQ program.

The spatial displacement of fishing effort resulting from implementation of FMP 4.1 would be substantial for some catcher vessels. These changes can be expected to lead to increased operating costs since vessels will have to travel farther to reach open areas and will likely be required to fish in less productive areas in some cases. The greatest impact would be on smaller trawl and fixed-gear vessels because of their more limited fishing range.

It is reasonable to assume that, subject to regulatory constraints, harvesters target catch with the gear that maximizes its value either by increasing the quality of the fish or by decreasing the harvesting costs, or both. For example, bottom trawl gear and fixed gear are actively used in the BSAI and GOA Pacific cod fisheries. The fixed-gear cod fishery is an economically viable fishery; however, the feasibility and cost of having it completely replace the bottom trawl cod fishery is not known. The information required to compare harvesting costs by gear is unavailable. However, to the extent that the historical fishing gear was used because it has the lowest cost per unit of catch, the replacement of several bottom trawl fisheries with fixed-gear fisheries would increase cost per unit of catch.

The effort-based methods implemented under FMP 4.1 to control harvesting and processing capacity would impose additional costs on fishermen. In general, these methods are designed to increase the cost of producing effort for individual fishing units by prohibiting certain cost-effective ways of operating (Anderson 1989). To adjust to these imposed inefficiencies, fishermen will continue to increase their outlays on doing whatever is permitted to maintain or increase their share of the catch. These permitted adjustment costs may include expenditures not only on vessel and gear improvements or storing fish on board longer, but also on reequipping their vessels to make them usable in other fisheries (Scott 1979).

The expanded observer coverage, scale and VMS requirements would also impose additional operating costs on fishery participants. In addition to the cost of paying for additional observers (expected to be about $355 per deployment day, not including food costs), some smaller vessels may have difficulty in providing berths for observers.

Fishing Vessel Safety

FMP 4.1 is expected to result in a significant reduction in safety for the fishing vessels that remain active. While the large decrease in the groundfish TAC may reduce the number of active vessels and thereby decrease the number of persons at risk, it is likely that the decrease in catches will encourage vessel owners to reduce crew size in an effort to compensate for reduced earnings. Reductions in crew size, in turn, may increase the risk of vessel accidents. Both the closure of sea lion critical habitat to trawling and the establishment of no-take marine protected areas would result in vessels fishing farther from port and possibly in more hazardous areas. The adverse effects would be more extreme for smaller vessels. In addition, effort-based measures such as gear and vessel restrictions may require fishermen to employ smaller vessels, thereby decreasing fishing safety. Moreover, effort-based measures to control overcapacity require fishermen to use inefficient fishing methods and do little to reduce their impulse to intensify their fishing operations by, for example, operating farther from shore or in areas and seasons with more hazardous weather conditions.

Cumulative Effects of FMP 4.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety. Table 4.8-6 summarizes this cumulative effects analysis.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. Significantly adverse effects are expected under FMP 4.1 due to the decrease in harvest.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects**. Given the current downward trends in the commercial salmon and crab fisheries, the predicted change in retained harvests under FMP 4.1 is expected to result in significantly adverse cumulative effects. The significant reduction in harvest levels will further exacerbate the cumulative effects of reductions in other fisheries. Groundfish landings by species will be reduced resulting in significantly adverse cumulative effects.

Ex-Vessel Value

- **Direct/Indirect Effects.** The total ex-vessel value of groundfish landed by catcher vessels is expected to result in significantly adverse effects under FMP 4.1.

- **Persistent Past Effects.** The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects.** Overall reductions in groundfish catch is likely to dramatically decrease ex-vessel value for fixed-gear vessels while a less dramatic decline is likely for trawl vessels. Decreases in ex-vessel value in other fisheries such as salmon and crab may continue to occur, thereby exacerbating the cumulative effects of FMP 4.1. Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization and contributions to education programs have been decreasing. Given the potential of these conditions to contribute to decreased levels of harvest under FMP 4.1, cumulative effects ex-vessel value on are expected to be significantly adverse.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Significantly adverse effects are projected for employment and payments to labor.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. Overall reductions in other fisheries such as salmon and crab, and the fact that many fishermen often rely on participation in multiple fisheries, significantly adverse cumulative effects are anticipated for FMP 4.1. The projected decrease in employment (60 percent) for the groundfish fisheries under this FMP will intensify the adverse effects experienced in other fisheries. While other economic activities and other sources of municipal and state revenue have the potential to mitigate these effects by providing other employment opportunities, many rural Alaska villages rely so heavily on fishing that other such options for earning income are not always available. This is particularly true if the economy and government spending are down. Thus, the reductions in harvesting under FMP 4.1 are expected to result in significantly adverse cumulative effects.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. Changes in excess capacity are likely to be significantly adverse under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. Historical expansions in fishing capacity followed by reductions in harvest levels and product value have resulted in persistent adverse effects on excess capacity. Excess capacity has not only been a problem in the groundfish fishery but exists in other fisheries as well. The number of fishing permits would be greatly reduced under FMP 4.1 but the number of vessels would remain high, resulting in many vessels sitting idle, not permitted to fish. The dramatic reductions in harvest levels under FMP 4.1 combined with the persistent past effects of overcapacity are projected to result in significantly adverse cumulative effects on excess capacity. (For details refer to the Overcapacity Paper in Appendix F-8).

Average Costs

- **Direct/Indirect Effects**. Significantly adverse effects are expected to occur for average costs under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with average costs in the groundfish fishery, cumulative effects may result. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. Although the overall reductions in TAC under FMP 4.1 may reduce costs, the increases in closure areas and the collective pressure of fixed costs are such that significantly adverse cumulative effects are anticipated.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Significantly adverse effects are predicted under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. The extent of closures proposed under FMP 4.1 are likely to increase the risk to the few vessels still permitted to harvest, as they may have to travel much greater distances to harvest fish. Significantly adverse cumulative effects are predicted under FMP 4.1.

4.8.9.1.2 Catcher Processors

Direct/Indirect Effects of FMP 4.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 catcher processor conditions reveals that the large decrease in groundfish TAC that occurs under FMP 4.1 will cause catches of all groundfish species except flatfish to decline significantly.

Groundfish Gross Product Value

Groundfish employment and payments to labor by all classes of catcher processors are expected to decrease significantly under FMP 4.1.

Employment and Payments to Labor

As a result of the decrease in catch, the overall wholesale product value of groundfish processed by catcher processors is expected to decrease significantly relative to the comparative baseline. All classes of catcher processors would experience a significant decline in product value. Notwithstanding the model projection that flatfish catches will remain relatively stable compared to the baseline, the head-and-gut trawl catcher processors that focus on flatfish are expected to experience a significant decline in product value because of the reapportionment of Pacific cod to fixed-gear vessels. Moreover, fixed-gear catcher processors are expected to experience a significant decline in product value despite the reapportionment because of the overall reduction in the TAC.

Product Quality and Product Utilization Rate

A conditionally significant decrease in product quality is expected under this FMP relative to the comparative baseline. The additional area closures that are implemented under FMP 4.1 are expected to cause product quality to decline, but the intensity of this effect and the probability of its occurrence are uncertain. It is reasonable to assume that, subject to regulatory constraints, harvesters target catch in areas that maximizes its value either by increasing the quality of the fish or by decreasing the harvesting cost or both. Consequently, a measure that prohibits vessels from using historical fishing grounds may result in a decline in product quality (e.g., fish may be smaller or a less uniform size). In contrast, FMP 4.1 is expected to result in a conditionally significant increase in product utilization rates relative to the comparative baseline. The extension of improved retention and utilization regulations to all target fisheries is expected to result in an increase in product utilization. Moreover, the large decrease in catch that occurs under FMP 4.1 provides a strong incentive for processors to use the fish that are harvested to the fullest possible extent. However, the intensity of this effect and the probability of its occurrence are uncertain.

Excess Capacity

As with catcher vessels, FMP 4.1 is predicted to generally lead to significantly higher excess capacity.

Average Costs

As with catcher vessels, FMP 4.1 is predicted to generally lead to significantly higher average costs. The closure of sea lion critical habitat to trawling, establishment of no-take marine protected areas, and the TAC component of FMP 4.1 would lower harvest rates for catcher processors and consequently, average costs per unit of catch can be expected to increase substantially under FMP 4.1. Perhaps more importantly the overall reduction in TACs will reduce average costs. Many costs are fixed (e.g., loan repayments, general office and accounting expenses and insurance costs) and are not reduced with the level of production. These costs would be allocated to a smaller amount of product, raising the average cost per unit of product.

The extension of improved retention and utilization regulations to all target fisheries is expected to have a significantly adverse economic impact on all head-and-gut trawl catcher processors by decreasing gross revenues and/or increasing operating costs. The flatfish discard rates of these vessels are high in fisheries that target flatfish and in fisheries in which flatfish are caught incidentally. To the extent that the race for fish allows it, head-and-gut trawl catcher processors may offset the lost revenues or additional costs experienced under IR/IU regulations by taking additional fishing trips. However, the number of profitable trips vessels can make may be limited by seasonal decreases in fish quality and/or roe content that lower ex-vessel prices. Smaller head-and-gut trawl catcher processors may be disproportionately affected by IR/IU regulations, as they are more likely constrained by hold space during a fishing trip, their processing capacity is more limited, and their slower speed restricts their ability to increase revenue by taking additional trips.

The expanded observer coverage and scale and VMS requirements would also impose additional operating costs on fishery participants. In addition to the cost of paying for additional observers (expected to be about $355 per deployment day, not including food costs), some smaller vessels may have difficulty in providing berths for observers. A motion-compensated platform scale would cost between $6,000 and $12,000. In addition, smaller (less than 200 ft. LOA) at-sea processors may have insufficient space in which to install scales without considerable reconfiguration or removal of existing processing equipment (J. Gauvin, Groundfish Forum, pers. comm., December 2003.). The current list price of a VMS unit is about $2,000.

Fishing Vessel Safety

As with catcher vessels, FMP 4.1 is expected to result in a significant reduction in fishing vessel safety relative to the comparative baseline.

Cumulative Effects of FMP 4.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety. For a summary of the cumulative effects analysis, please refer to Table 4.8-6.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. Significantly adverse effects are expected under FMP 4.1due to the decrease in harvest.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to an increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects**. As with catcher vessels, given the current downward trends in the commercial salmon and crab fisheries, the predicted change in retained harvests under FMP 4.1 is expected to result in significantly adverse cumulative effects. The significant reduction in harvest levels will further exacerbate the cumulative effects of reductions in other fisheries. Groundfish Landings by Species will be reduced resulting in significantly adverse cumulative effects.

Groundfish Gross Product Value

- **Direct/Indirect Effects**. The total gross product value of groundfish landed by catcher processors is expected to result in significantly adverse effects under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. As with catcher vessels, during recent years, state municipal revenue sharing, power cost equalization, and contributions to education programs have been decreasing. This often causes communities to rely on fish taxes for municipal revenue which may affect gross product value. The decreased level of harvest under FMP 4.1 is significant enough that reductions in harvest combined with increased municipal pressure will result in significantly adverse cumulative effects on gross product value, particularly for fixed-gear processors due to the reduction in TAC.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Significantly adverse effects are projected for employment and payments to labor.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. Similar to catcher vessels, the overall reductions in other fisheries such as salmon and crab, contribute to the decrease in harvest levels under FMP 4.1. The projected decrease in employment (65 percent) for the groundfish fisheries under this FMP will exacerbate the adverse effects experienced in other fisheries. While other economic activities and other sources of municipal and state revenue have the potential to mitigate these effects by providing other employment opportunities, many rural Alaska villages rely so heavily on fishing that other such options for earning income are not always available. This is particularly true in smaller villages and if the economy and government spending are down. Thus, the reductions in harvesting under FMP 4.1 are expected to result in significantly adverse cumulative effects.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects**. Conditionally significant adverse effects are likely for product quality, but conditionally significant beneficial effects for product utilization rates are expected under FMP 4.1 relative to the baseline.

- **Persistent Past Effects**. For details on persistent past effects, please refer to the beginning of Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed under the Section 4.5.9.1.

- **Cumulative Effects**. Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, any continuation of this harvest strategy in fisheries may hinder some of these improvements. Improvements in product quality might be expected in the future; however, the increased number of closure areas under FMP 4.1 may jeopardize some of the quality gained through better handling and techniques by the greater distances vessels may have to travel to harvest fish. Thus, conditionally significant adverse effects are predicted for product quality and significantly beneficial cumulative effects are projected for product utilization rate under FMP 4.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. Changes in excess capacity are likely to be significantly adverse under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. Historical expansions in fishing capacity followed by reductions in harvest levels and product value have resulted in persistent adverse effects on excess capacity. Excess capacity has not only been a problem in the groundfish fishery but exists in other fisheries as well. The number of fishing permits would be greatly reduced under FMP 4.1 but the number of catcher processors would remain high, especially in the short-term. The dramatic reductions in harvest levels under FMP 4.1 combined with the persistent past effects of overcapacity are projected to result in significantly adverse cumulative effects on excess capacity. (For details please refer to the Overcapacity Paper in Appendix F-8).

Average Costs

- **Direct/Indirect Effects**. Significantly adverse effects are expected to occur for average costs under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. As with catcher vessels, average costs in for catcher processors are often associated or shared with other fisheries and include fixed and variable costs. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with the increase in closure areas and reduced harvest rates under FMP 4.1 in the groundfish fishery, significantly adverse cumulative effects are likely. Should costs in other fisheries increase or decrease, catcher processors in the groundfish fishery may experience fewer or greater impacts to average costs.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Significantly adverse effects are predicted under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. The extent of closures proposed under FMP 4.1 are likely to increase the risk catcher processors, as they may have to travel much greater distances to harvest fish. Significantly adverse cumulative effects are predicted under FMP 4.1.

4.8.9.1.3 Inshore Processors and Motherships

Direct/Indirect Effects FMP 4.1

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003 to 2007 period to 2001 inshore processor and mothership conditions reveals the large decrease in groundfish TAC that occurs under FMP 4.1 will cause catches of all groundfish species to decline significantly (see the earlier discussion regarding the erroneous model projections of Pacific cod catches for this FMP).

Groundfish Gross Product Value

As a result of the decrease in catch, the overall wholesale product value of groundfish processed by inshore processors and motherships is expected to decrease significantly relative to the comparative baseline. The economic impact of this decrease in groundfish product value would differ across processing facilities depending on the extent to which plants process other types of fish and shellfish resources, such as salmon, crab, halibut, and other finfish. For example, under FMP 4.1, the value of groundfish products produced by southcentral Alaska inshore plants would decline significantly but the decrease in total wholesale value of all fish and shellfish processed by these plants may not be significant. In contrast, groundfish represents a large portion of the wholesale production value of Bering Sea pollock shore plants. Under FMP 4.1, the decline in groundfish production value for these plants would result in a significant reduction in their total (groundfish and non-groundfish) wholesale value.

A significant decline in groundfish product value is also expected for southeast Alaska shore plants, Alaska Peninsula and Aleutian Islands shore plants, and Kodiak shore plants. This decline reflects the dependence of these processors on groundfish harvested in sea lion critical habitat or no-take marine protected areas.

Employment and Payments to Labor

Groundfish employment and payments to labor by all classes of inshore processors and motherships are expected to decrease significantly under FMP 4.1. Most of the decrease in employment and payments to labor is incurred by Bering Sea shore plants.

Product Quality and Product Utilization Rate

A significant decrease in product quality is expected under this FMP relative to the comparative baseline. The additional area closures that are implemented under FMP 4.1 may cause product quality to decline. It is reasonable to assume that, subject to regulatory constraints, harvesters target catch in areas that maximizes its value either by increasing the quality of the fish or by decreasing the harvesting cost or both.

Consequently, a measure that prohibits vessels from using historical fishing grounds may result in a decline in product quality (e.g., fish may be smaller or a less uniform size). In addition, Pacific cod and Alaska pollock are fragile fish whose quality deteriorates rapidly the longer the time between harvest and processing. Consequently, any factors that will increase the length of time to processing will lower the quality of the product produced. To the extent that FMP 4.1 results in catcher vessels traveling farther distances from (inshore) processors, and thereby lengthening the time between harvest and processing, the quality of surimi, fillets, and roe will be adversely affected.

In contrast, FMP 4.1 is expected to result in a conditionally significant increase in product utilization rates relative to the comparative baseline. The large decrease in catch that occurs under FMP 4.1 provides a strong incentive for processors to use the fish that are harvested to the fullest possible extent. However, both the intensity of this effect and the probability of its occurrence are uncertain.

Excess Capacity

As a result of the large decrease in groundfish catches, FMP 4.1 is predicted to generally lead to significantly higher excess capacity in both the harvesting and processing sectors, but some exceptions are expected. For example, those processing plants, such as southcentral Alaska inshore plants and floating inshore plants, that are only marginally dependent on groundfish may not experience a significantly higher excess capacity. This leads to direct/indirect effects ratings of insignificant/significantly adverse for excess capacity under FMP 4.1.

Average Costs

As a result of the large decrease in groundfish catches, FMP 4.1 is predicted to lead to significantly higher average costs. The overall amount of target species delivered to processors would decrease substantially. Average costs will increase because of the reduction in the overall level of production resulting from lower catches. Many costs are fixed (e.g., loan repayments, general office and accounting expenses and insurance costs) and will not change with the level of production. These costs would be allocated to a smaller amount of product, thereby raising the average cost per unit of product. The increase will be larger for those processors that are most dependent on groundfish. As average costs per unit of production rise, it is possible that they would exceed the value of production and lead to a shutdown or permanent closing of some processing plants and motherships.

Variable costs may also be increased under FMP 4.1. The reduction in supply of fish is likely to put upward pressure on ex-vessel prices. If spatial shifting of production raises average costs for catcher vessels, inshore plants and motherships may face increased pressure to pay higher prices for fish. The extent to which processors versus catcher vessels would absorb increased harvesting costs and be able to demand higher prices as total supply declines will depend on their relative bargaining power as well as price elasticities of the products made from the fish. However, increased ex-vessel prices are likely, and this could substantially raise variable costs of production for processors that have to purchase fish.

Cumulative Effects of FMP 4.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety (see Table 4.8-6 for a summary of the cumulative effects).

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. Significantly adverse effects are expected under FMP 4.1 due to the decrease in harvest.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed in Section 4.5.9.1 under FMP 1.

- **Cumulative Effects**. As with catcher processors, given the current downward trends in the commercial salmon and crab fisheries, the predicted change in retained harvests under FMP 4.1 is expected to result in significantly adverse cumulative effects. The significant reduction in harvest levels will further exacerbate the cumulative effects of reductions in other fisheries. Groundfish Landings by Species will be reduced resulting in significantly adverse cumulative effects.

Groundfish Gross Product Value

- **Direct/Indirect Effects**. The total gross product value of groundfish landed by inshore processors and motherships is expected to result in significantly adverse effects under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. As with catcher processors, during recent years, state municipal revenue sharing, power cost equalization, and contributions to education programs have been decreasing. This often causes communities to rely on fish taxes for municipal revenue which may affect gross product value. The decreased level of harvest under FMP 4.1 is significant enough that reductions in harvest combined with increased municipal pressure will result in significantly adverse cumulative effects on gross product value, particularly for fixed-gear processors due to the reduction in TAC.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Significantly adverse effects are projected for employment and payments to labor.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. Similar to catcher processors, the overall reductions in other fisheries such as salmon and crab, contribute to the decrease in harvest levels under FMP 4.1. The projected decrease in employment (60 percent) for the groundfish fisheries under this FMP will exacerbate the adverse effects experienced in other fisheries. While other economic activities and other sources of municipal and state revenue have the potential to mitigate these effects by providing other employment opportunities, many rural Alaska villages rely so heavily on fishing that other such options for earning income are not always available. This is particularly true in smaller villages and if the economy and government spending are down. Thus, the reductions in harvesting under FMP 4.1 are expected to result in significantly adverse cumulative effects.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects**. Conditionally significant adverse effects are likely for product quality but conditionally significant beneficial effects for product utilization rates are expected under FMP 4.1 relative to the baseline.

- **Persistent Past Effects**. For details on persistent past effects, please refer to the beginning of Section 4.5.9.1 Groundfish Landings By Species Group.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed under the Section 4.5.9.1.

- **Cumulative Effects**. Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has also made significant differences in product quality and utilization, however, any continuation of this harvest strategy in fisheries may hinder some of these improvements. Improvements in product quality might be expected in the future; however, the increased number of closure areas under FMP 4.1 may jeopardize some of the quality gained through better handling and techniques due to the greater distances vessels may have to travel to harvest fish. The reduction in harvest levels under this FMP are likely to cause processors to maximize unit utilization rate as there may be much fewer fish to process. Thus, conditionally significant adverse effects are predicted for product quality but conditionally significant beneficial cumulative effects are projected for product utilization rate under FMP 4.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. Changes in excess capacity are likely to be significantly adverse or insignificant under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. Historical expansions in fishing capacity followed by reductions in harvest levels and product value have resulted in persistent adverse effects on excess capacity. Excess capacity has not only been a problem in the groundfish fishery but exists in other fisheries as well. The number of fishing permits would be greatly reduced under FMP 4.1 but the number of catcher processors would remain high, especially in the short-term. The dramatic reductions in harvest levels under FMP 4.1 combined with the persistent past effects of overcapacity are projected to result in significantly adverse cumulative effects on excess capacity. (For details refer to the Overcapacity Paper in Appendix F-8).

Average Costs

- **Direct/Indirect Effects**. Significantly adverse effects are expected to occur for average costs under FMP 4.1.

- **Persistent Past Effects**. The persistent past effects include: foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of joint venture fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. The combination of these factors has contributed to increased demand for groundfish species. These effects are discussed in more detail under Groundfish Landings By Species Group at the beginning of Section 4.5.9.1.

- **Reasonably Foreseeable Future External Effects.** The future external effects include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.1.

- **Cumulative Effects**. As with catcher vessels, average costs in for catcher processors are often associated or shared with other fisheries and include fixed and variable costs. Depending on area closures or the fixed or variable costs in other fisheries, when considered in combination with the increase in closure areas and reduced harvest rates under FMP 4.1 in the groundfish fishery, significantly adverse cumulative effects are likely. Should costs in other fisheries increase or decrease, catcher processors in the groundfish fishery may experience fewer or greater impacts to average costs.

Direct/Indirect Effects of FMP 4.2

FMP 4.2 would suspend the harvest of groundfish until more information is known on the impacts of fishing on the environment. Only fisheries certified by NOAA Fisheries to have no significantly adverse effects on the environment would be authorized to operate in the EEZ off Alaska.

During the period in which groundfish fisheries are suspended, all revenue from the fisheries would be reduced by 100 percent from the baseline case under this FMP. Approximately $1.5 billion in product value is projected to be foregone if no fisheries are certified by 2004. About 11,300 FTE positions are projected to be lost if no fisheries are certified by that year.

Under this FMP, all 917 catcher vessels, 89 catcher processors, 3 motherships and 3 floating inshore plants that were active in the Alaska groundfish fisheries in 2001 would be displaced until fisheries are certified. This suspension is expected to have a significantly adverse effect on the catches of all groundfish species, groundfish ex-vessel value and product value, groundfish employment and payments to labor, excess capacity, product quality, product utilization rates, and average costs. In the absence of the groundfish fisheries, fishing vessel safety is expected to significantly improve.

While boats across and within various vessel classes differ in their dependence on groundfish fisheries, the suspension of the groundfish fisheries is expected to have an adverse economic effect on the average boat in all the vessel classes. AFA-eligible trawl catcher vessel classes generated more than 85 percent of their annual ex-vessel value (gross revenue) from groundfish in 2001, while pot catcher vessels generated only about 10 percent of their total gross revenue from groundfish. From this perspective, impacts of the suspension of the groundfish fisheries are likely to be much greater for vessels that are more dependent on groundfish. This effect is also true for processors (both catcher processors and inshore plants and motherships) who are heavily dependent on groundfish harvests. However, vessel classes that catch relatively small quantities of groundfish and processors who process small quantities of groundfish may still be significantly adversely affected. For instance, a study by Northern Economics, Inc. (1999) on the importance of salmon to the Aleutians East Borough showed that many fixed-gear catcher vessels 33-59 ft in length that use seine gear in salmon fisheries and fixed gear for groundfish are only marginally profitable. Loss of revenue from either groundfish or salmon is likely to push a number of these vessels and processors toward bankruptcy.

Cumulative Effects of FMP 4.2

Displaced fishermen could either shift to different fisheries or tie up their vessels. Those displaced fishermen who successfully shift to other fisheries are likely to recover some portion of the revenue previously generated from fishing for groundfish. However, it is probable that displaced vessel owners will have difficulty relocating their operations given the limited access programs that have been implemented in State of Alaska fisheries and other U.S. fisheries. Thus, the effect on processors will be similar due to the reduction in groundfish harvest overall. Moreover, while some vessels and processors are already outfitted to participate in non-groundfish fisheries, other boat owners or processors may not be capable of shifting into other fisheries without substantial additional capital outlays. It is also likely that some fishermen or processors may face increased costs and uncertain markets if they are forced to shift their operations away from the communities in which they live.

Given that opportunities for displaced fishermen and processors to recover their lost harvest and income would be limited, it is likely that some displaced fishermen would be forced to sell out or retire. It is uncertain how active the Alaska, nationwide or world market is for the types of vessels, gear and other investment capital used in the groundfish fisheries. However, it is possible that the Alaska market for these assets could quickly be flooded. Suspension of the groundfish fisheries would likely depress the immediate resale market for fishing equipment and vessels as well as diminish the long-term investment value of the vessels owned by displaced fishermen who opt to continue fishing. The same fate is possible for processors who rely heavily on groundfish harvests. This could create an economic hardship for those fishermen or processors who are relying on money earned from selling their fishing assets to supplement their retirement funds.

Transfer of effort from groundfish to non-groundfish fisheries could also indirectly create economic hardship in the form of reduced profitability for those already engaged in non-groundfish fisheries. The majority of fisheries in Alaska and other areas of the U.S. are fully utilized. If fishermen in Alaska groundfish fisheries were to shift their effort to other fisheries, catch per unit of effort and individual harvest for non-groundfish fishermen would likely decline due to the intensified fishing pressure on fish stocks. Lower individual catches would mean a decrease in the incomes of part-time and full-time commercial fishermen and possibly a reduction in the non-market value of the recreational fishing experience to the sport anglers who participate in non-groundfish fisheries.

See Table 4.8-6 for a summary of the cumulative effects on catcher vessels, catcher processors and inshore processors and motherships under FMP 4.2.

4.8.9.2 Regional Socioeconomic Effects

The predicted direct and indirect effects of the groundfish fishery under FMP 4.1 and FMP 4.2 are described below. The past/present effects on regions that participate in the groundfish fishery are described in Section 3.9 (and summarized in Table 3.9-126) and below; these regions (illustrated in Figures 3.9-9 through 3.9-13) include the Aleutian Islands/Alaska Peninsula (comprised of the Aleutians East Borough and the Aleutians West Census Area, which includes the communities of Unalaska, Nikolski, Atka, Adak and the Pribilof Islands), Kodiak Island (Kodiak Island Borough, which includes the City of Kodiak) southcentral Alaska (the Kenai Peninsula Borough, Matanuska-Susitna Borough, Municipality of Anchorage, and the Valdez-Cordova Census Area, which includes the PWS region), southeast Alaska (all of the southeastern part of the state, from Yakutat Borough to Dixon Entrance), Washington inland waters (all counties bordering Puget Sound and the Strait of Juan de Fuca), and Oregon coast (Lincoln, Tillamook, and Clatsop counties, the three northernmost Oregon coastal counties). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case (Table 4.8-6).

Due to the linkages of potential effects on regions that participate in the groundfish fishery to changes in harvest and processing levels under each of the policy alternatives and illustrative FMP bookends, the direct and indirect effects of each alternative are based on an economic model that distributes potential effects to each of the participating regions. The indicators used to assess potential regional effects include the following:

- In-Region Processing and Related Effects;
- Regionally Owned At-Sea Processors;
- Extra-regional Deliveries of Regionally Owned Catcher Vessels;
- In-region Deliveries of Regionally Owned Catcher Vessels; and
- Total Direct, Indirect, and Induced Labor Income and FTEs.

As discussed earlier, these indicators also reflect changes in other important regional characteristics such as secondary economic activity associated with the support of fishing, state and municipal revenue generated by fishing, and indirectly population, to the extent that it is related to employment opportunities. For more information on the economic model used to assess direct and indirect regional effects, see analysis for FMP 1 and Section 4.1.7 of the document.

Direct/Indirect Effects of FMP 4.1

Alternative 4 represents a highly precautionary approach, in which TAC is reduced, or in the case of FMP 4.2, eliminated until fishing activity is determined not to have significantly adverse effects. Additional management measures related to bycatch, protection of prohibited species, and habitat protection, including closures by gear types, are applied. Under FMP 4.1, in general there is a strong net overall decrease in fishery socioeconomic indicator values over baseline conditions for all regions. For example, total value of processing sales decreases by about 64 percent over baseline conditions, while total processing and harvesting related income and employment decrease by 64 and 61 percent, respectively, for all regions combined. The decreases are large (and significant) for each of the regions. The overall regional level (and individual community level) impacts will ultimately be based on the relative dependency of the locally operating (or owned) fishing sector components on the groundfish fishery, and, in turn, the dependency of local community and regional economies on the commercial fishing in overall. While there are a number of exceptions, in general the economies of Alaska Peninsula and Aleutian Islands communities (and the region as a whole) are less diversified into non-fishery related activity (and therefore more vulnerable at a higher level) than those seen in other Alaska regions, and particularly those of southcentral and southeast Alaska (with Kodiak in between). The following subsections provide a region-by-region summary of change under FMP 4.1 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under FMP 4.1, total in-region groundfish processing value would decrease by 62 percent (with decreases in both the BSAI portion and GOA portion of the total). In region processing associated labor income and FTE jobs would also decrease by 62 percent. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would decline sharply in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease by 61 and 58 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would decrease by about 61 and 65 percent respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 58 and 59 percent, respectively, but for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the decrease seen in processing values would be disproportionately important in relation to changes seen in the other sectors. (Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes.) The total regional direct, indirect, and induced labor income would decrease by about 62 percent and FTE employment would also decrease by about 62 percent under this FMP (from a base of $226 million in labor income and 4,796 FTEs). Under FMP 4.1, the Alaska Peninsula and Aleutian Islands region would experience significantly adverse impacts on the local sector level, the regional level, and the community level for all of the substantially engaged communities.

In addition to the profound adverse regional and community social impacts that would result from loss of revenues, economic opportunities and employment under from this FMP, the location of marine reserves may further disadvantage specific communities in this as well as other regions. Especially impacted would be communities with small vessel fleets with more limited options in terms of alternate areas to fish due to limited range (and a lack practical ability to switch between major gear types and fisheries).

Kodiak Island. Total in-region groundfish processing value would decrease by 64 percent (with a lower value for GOA; BSAI values are not a significant portion of the regional total). Associated labor income and FTE jobs would also decrease by 64 percent. Regionally owned at-sea processing value would decline by 77 percent (with the vast majority of the decline attributable to changes in BSAI values), and associated labor income and FTEs would decline by 79 and 75 percent, respectively. (In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total; labor income and FTEs distribution between these processing sectors follow a similar pattern.) The value of extra-regional deliveries by regionally owned catcher vessels would decrease by 19 percent and the value of in-region deliveries by regionally owned catcher vessels would decrease 55 percent. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would decrease by about 19 and 20 percent respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 55 and 57 percent, respectively, but over a smaller base than seen for extra-regional deliveries. On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would decrease by about 62 percent and FTE employment would decrease by about 57 percent under this FMP (from a base of $66 million in labor income and 1,600 FTEs). In the Kodiak Island region under FMP 4.1, significantly adverse impacts would occur at the local sector level. The city and region of Kodiak is somewhat less vulnerable to community and regional level impacts than is the case in the Alaska Peninsula and Aleutian Islands region and communities, due to greater size and economic diversity along with a lesser degree of dependence on groundfish per se, but there would be adverse impacts felt at the community and regional level (and within the commercial fishing sector of the economy, groundfish dependency is as important in Kodiak as it is in the Alaska Peninsula and Aleutian Islands region).

Southcentral Alaska. Total in-region groundfish processing value would decrease by 29 percent (all attributable to GOA decreases). Associated labor income and FTE jobs would also decrease by 29 percent. Regionally owned at-sea processing value would decrease by 62 percent (with relatively large decreases in BSAI values and smaller declines in GOA values), and associated labor income and FTEs both decreasing by 62 percent. (In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease by 49 and 36 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would decrease by about 49 and 54 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 36 and 40 percent, respectively. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease by about 39 percent and FTE employment would decrease about 44 percent (from a base of $23 million in labor income and 567 FTEs). Under FMP 4.1, significantly adverse impacts would accrue to local sectors within the southcentral Alaska region. No significant impacts would be felt at the regional level, and community level impacts would tend to be attenuated by the relative size and economic diversity of the engaged communities. Overall, groundfish dependency is substantially lower for southcentral entities than for those in the Alaska Peninsula and Aleutian Islands region as well as the Kodiak Island region.

Southeast Alaska. Total in-region groundfish processing value would decrease by 88 percent (all attributable to GOA decreases). Associated labor income and FTE jobs would also decrease by 88 percent (but both are relatively low values). Regionally owned at-sea processing value would decrease by 94 percent (with decreases in both BSAI and GOA values), and associated labor income and FTEs both decreasing by 94 percent. (In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector.) The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease by 25 and 88 percent, respectively. Catcher vessel payments to labor associated with extra regional deliveries would decrease by about 25 percent and FTE jobs would decrease by 23 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would both decrease by about 88 percent. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, however, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease by about 77 percent and FTE employment would decrease by about 70 percent (from a base of $34 million in labor income and 879 FTEs). FMP 4.1 would have significantly adverse impacts on local sectors in the southeast Alaska region. In general, regional and community level impacts would be less pronounced than the output data might otherwise suggest, given the lower degree of dependency on groundfish than seen in some of the other Alaska regions, but impacts would still be felt at the community level for some of the smaller communities in the region that are relatively heavily engaged in the fishery.

Washington Inland Waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would decrease by 29 percent, but their overall low value render these changes not significant. Regionally owned at-sea processing value would decrease by 67 percent (with decreases in both BSAI and GOA values, although GOA values are comparatively very small), and associated labor income and FTEs would decrease by 67 and 64 percent, respectively. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would both decrease by 64 percent. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would decrease by about 64 and 40 percent, respectively. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 64 and 22 percent, respectively. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would decrease by about 66 percent and FTE employment would decrease by about 64 percent (from a base of $557 million in labor income and 10,316 FTEs). Under FMP 4.1, impacts to local sectors would be adverse and significant. Community level impacts would not be significant, given the nature of the concentration of the sectors in the greater Seattle metropolitan area.

Oregon Coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this FMP. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this FMP, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would decrease by 64 percent, and associated labor income and FTE jobs would decrease 64 and 40 percent, respectively. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this FMP. The total regional direct, indirect, and induced labor income would decrease by about 64 percent and FTE employment would decrease by about 54 percent (from a base of $15 million in labor income and 318 FTEs). Under FMP 4.1, Oregon coast catcher vessels would experience significantly adverse impacts, but regional and community level impacts would be less than significant, given the scale and diversity of the local economies and communities.

Cumulative Effects of FMP 4.1

For a summary of the direct/indirect and cumulative ratings see Table 4.8-6.

In-Region Processing and Related Effects

- **Direct/Indirect Effects**. For FMP 4.1, direct/indirect effects are considered significantly adverse for the Alaska Peninsula/Aleutian Islands and Kodiak Island regions, conditionally significant adverse for the southcentral Alaska and southeast Alaska regions and insignificant for the Washington inland waters and Oregon coast regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, refer to the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. Other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, refer to the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.1, cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are conditionally significant adverse for the four Alaska regions (Alaska Peninsula/Aleutian Islands, Kodiak Island, southcentral Alaska, and southeast Alaska). The influence of external factors is adverse for many of the in-region processors based in Alaska and their associated regions. Trends in multi-species fisheries and other sources of municipal and state revenue, primarily due to the continued crab closures, downturn in salmon and reductions in state and municipal revenue, result in adverse effects on in-region processing and municipal revenue. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant, and there are no reasonably foreseeable events that would have a significant contribution, resulting in a finding of insignificant cumulative effect.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects**. Under FMP 4.1, direct/indirect effects are considered insignificant for the Alaska Peninsula/Aleutian Islands (negligible regional ownership) and Oregon coast (no regional ownership, and significantly adverse for the Kodiak Island, southcentral Alaska, southeast Alaska, and Washington inland waters regions.

- **Persistent Past Effects** The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. For more detail see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.1, direct/indirect effects are insignificant or significantly adverse. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Cumulative effects for these regions are insignificant. Adverse trends in other fisheries (particularly salmon) and reductions on municipal revenue, decrease regional labor income and employment benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects for these regions are conditionally significant adverse.

<u>Extra-Regional Deliveries of Regionally Owned Catcher Vessels</u>

- **Direct/Indirect Effects**. Under FMP 4.1, direct and indirect effects are significantly adverse for all regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. Other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.1, direct/indirect effects significantly adverse for all six regions. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Cumulative effects for these regions are insignificant. Adverse trends in other fisheries (particularly salmon) and reductions on municipal revenue, decrease regional labor income and employment benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects for these regions are conditionally significant adverse.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects**. Under FMP 4.1, direct/indirect effects are considered significantly adverse for all regions except the Oregon coast (no in-region deliveries), which is insignificant.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.1, the direct/indirect effects conditionally significant adverse for five of the six regions, and insignificant for one. Given the size and diversity of regional economies, in southcentral Alaska, Washington inland waters, and the Oregon coast, adverse external effects are offset and cumulative effects are insignificant. The significant decrease in extra-regional deliveries to the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska, in conjunction with adverse external effects related to other fisheries and revenue sharing results in a conditionally significant adverse cumulative effect for these three regions.

Total Direct, Indirect, and Induced Labor Income and FTEs

- **Direct/Indirect Effects**. Under FMP 4.1, direct/indirect effects on labor income and employment are significantly adverse for all six regions.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.1 direct/indirect effects on labor income and employment are significantly adverse for all regions. Within southcentral Alaska, Washington inland waters, and

Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Cumulative effects for these regions are insignificant. Adverse trends in other fisheries (salmon and crab) and reductions on municipal revenue, decrease regional labor income and employment benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Islands, and southeast Alaska regions. Cumulative effects for the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions are conditionally significant adverse.

Direct/Indirect Effects of FMP 4.2

Under this FMP, the commercial harvest of groundfish would be suspended for an indeterminate period of time until it can be determined that fishing activities are not having a significantly adverse effect on sustainable fisheries, habitat, and the ecosystem. The regional impacts of the discontinuation of the fishery would be immediate, adverse, and significant for all regions in all categories of effects.

Cumulative Effects of FMP 4.2

For a summary of the direct/indirect and cumulative ratings see Table 4.8-6.

<u>In-Region Processing and Related Effects</u>

- **Direct/Indirect Effects**. For FMP 4.2, the indeterminate cessation in fishing would result in significantly adverse direct/indirect effects for all regions, except for the Oregon coast region, which has no in-region processing and is insignificant. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, refer to the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. Other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, refer to the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.2, significantly adverse direct/indirect effects would combine with adverse trends in multi-species fisheries (crab closures, downturn in salmon fishery) and other sources of municipal and state revenue, resulting in significantly adverse cumulative effects for the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Although the direct/indirect effects would be significantly adverse for the participants in the fishery in southcentral Alaska and Washington inland waters regions, because of the diversity of regional economies, the cumulative effects would be insignificant. For the Oregon coast region, direct/indirect effects are insignificant, and there are no reasonably foreseeable future events that would have a significant contribution, resulting in a finding of insignificant cumulative effect.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects**. For FMP 4.2, the indeterminate cessation in fishing would result in significantly adverse direct/ indirect effects for all regions, except for the Oregon coast, which has no at-sea processing and is insignificant. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue. For more detail see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. For more detail, see the analysis for in-region processing, FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.2, significantly adverse direct/indirect effects would combine with adverse trends in multi-species fisheries (crab closures, downturn in salmon fishery) and other sources of municipal and state revenue, resulting in significantly adverse cumulative effects for the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Although the direct/indirect effects would be significantly adverse for the participants in the fishery in southcentral Alaska and Washington inland waters regions, because of the diversity of regional economies, the cumulative effects would be insignificant. For the Oregon coast region, direct/indirect effects are insignificant, and there are no reasonably foreseeable future events that would have a significant contribution, resulting in a finding of insignificant cumulative effect.

Extra-Regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects**. For FMP 4.2, the indeterminate cessation in fishing would result in significantly adverse direct/indirect effects for all regions. See the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects.** Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. Other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.2, significantly adverse direct/indirect effects would combine with adverse trends in multi-species fisheries (crab closures, downturn in salmon fishery) and other sources of municipal and state revenue, resulting in significantly adverse cumulative effects for the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Although the direct/indirect effects would be significantly adverse for the participants in the fishery in southcentral Alaska, Washington inland waters, and Oregon coast regions, because of the diversity of regional economies, the cumulative effects would be insignificant.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects**. For FMP 4.2, the indeterminate cessation in fishing would result in significantly adverse direct/ indirect effects for all regions, except for the Oregon coast, which has no in-region deliveries and is insignificant. See the previous section for a more detailed discussion of direct/ indirect effects.

- **Persistent Past Effects.** The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under In-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.2, significantly adverse direct/indirect effects would combine with adverse trends in multi-species fisheries (crab closures, downturn in salmon fishery) and other sources of municipal and state revenue, resulting in significantly adverse cumulative effects for the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Although the direct/indirect effects would be significantly adverse for the participants in the fishery in southcentral Alaska and, Washington inland waters regions, because of the diversity of regional economies, the cumulative effects would be insignificant. For the Oregon coast region, direct/indirect effects are insignificant, and there are no reasonably foreseeable future events that would have a significant contribution, resulting in a finding of insignificant cumulative effect.

Total Direct, Indirect, and Induced Labor Income and FTEs

- **Direct/Indirect Effects.** For FMP 4.2, the indeterminate cessation in fishing would result in significantly adverse direct/ indirect effects for all regions. See previous section for a more detailed discussion of direct/ indirect effects.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future External Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate change and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in FMP 1, Section 4.5.9.2.

- **Cumulative Effects**. Under FMP 4.2, significantly adverse direct/indirect effects would combine with adverse trends in multi-species fisheries (crab closures, downturn in salmon fishery) and other sources of municipal and state revenue, resulting in significantly adverse cumulative effects for the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Although the direct/indirect effects would be significantly adverse for the participants in the fishery in southcentral Alaska, Washington inland waters, and Oregon coast regions, because of the diversity of regional economies, the cumulative effects would be insignificant.

4.8.9.3 Community Development Quota Program

The predicted direct and indirect effects of the groundfish fishery under FMP 4.1 and FMP 4.2 are described below. The past/present effects on CDQ are described in Section 3.9 and below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is allocation of catch to CDQ groups. It should be noted that allocation reflects potential revenue to CDQ groups, and indirectly the potential funds that are available for approved economic development activities in CDQ communities (Table 4.8-6).

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

The CDQ program would continue in its present structure under FMP 4.1, but the steep declines in the overall fishery would be mirrored by similarly steep declines in CDQ royalties, employment, and income. As with the rest of the regions participating in the fishery, impacts to the CDQ region would be significantly adverse.

The CDQ region would also experience significantly adverse social impacts under FMP 4.2. While the multi-species CDQ program would continue, this would allow royalties, income, and employment levels to continue at only a fraction of the level seen under baseline conditions.

Cumulative Effects of FMP 4.1 and FMP 4.2

For a summary of the direct/indirect and cumulative ratings see Table 4.8-6.

- **Direct/Indirect Effects**. The direct/indirect effects on the CDQ program under FMP 4.1 and FMP 4.2 are significantly adverse.

- **Persistent Past Effects**. The past/present effects on the CDQ program for groundfish fisheries include establishment of CDQ program; FMP amendments that further added or defined CDQ in 1992,1995,1996, and 1998; establishment of multi-species CDQ programs, and persistent limitations on economic development and associated employment activities. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects**. Other fisheries, other economic development activities, other sources of municipal and state revenue all have the potential to affect the CDQ program adversely or beneficially. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Cumulative Effects**. Under FMP 4.1 and FMP 4.2, a cumulative effect is identified for the CDQ Program, and the effect is judged to be significantly adverse. Impacts to the CDQ region would be significantly adverse due to declines in CDQ royalties, employment and income.

4.8.9.4 Subsistence

The predicted direct and indirect effects of the groundfish fishery under FMP 4.1 and FMP 4.2 are described below. The past/present effects on subsistence are described in Section 3.9 and below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis are other fisheries such as foreign JV, domestic, and state-managed fisheries, other economic development activities, sport and personal use, and long-term climate change and regime shift (Table 4.8-6).

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

Potential impacts to subsistence fall into four main categories: subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon in western Alaska and bycatch in the groundfish fisheries, and indirect impacts on other subsistence activities, including loss of income that would be otherwise directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would be otherwise be available for joint production opportunities. Under this FMP, commercial fishery activity is sharply reduced, but it is not clear that this would have direct beneficial or adverse impacts on the subsistence groundfish fishing conditions in relation to the subsistence fishery that is occurring under baseline conditions, but it is assumed that any change would not be large enough to reach significant levels. Steller sea lion populations are expected to benefit under this FMP due to a beneficial effect on pelagic forage availability. This would be a conditionally significant beneficial benefit for Steller sea lion subsistence activities, with the condition being that Steller populations would need to increase to point where subsistence activities substantially benefit through a reduction in effort needed for hunting success and/or the perceived recovery of the Steller population fostered a substantial increase in subsistence activity. Salmon bycatch would be reduced under this FMP, however, current information does not allow a determination that the level of bycatch reduction would result in significant increases in salmon returns to subsistence fishery areas. Therefore, while reduction in salmon bycatch would be generally beneficial for subsistence salmon fisheries, current data do not suggest that these benefits would rise to the level of significance. Catcher vessel activity and labor income are anticipated to decline sharply under this FMP, therefore it is expected that adverse indirect impacts to subsistence through a decline in income or joint production opportunities will occur.

It is not clear whether subsistence related groundfish fishing would experience direct impacts under FMP 4.2. Local groundfish availability may increase with the elimination of the commercial groundfish fishery, but the magnitude of this increase is unknown and the effect of this increase on subsistence activity is unknown. Given the relatively low level of groundfish subsistence use, it is assumed that any direct increase groundfish subsistence likely under this FMP would be insignificant. Steller sea lion populations are expected to benefit under this FMP due to a beneficial effect on pelagic forage availability. This would be a conditionally significant beneficial benefit for Steller sea lion subsistence activities, with the condition being that Steller populations would need to increase to point where subsistence activities substantially benefit through a reduction in effort needed for hunting success and/or the perceived recovery of the Steller population fostered a substantial increase in subsistence activity. Salmon bycatch would be eliminated under this FMP. This would result in a conditionally significant beneficial benefit for salmon subsistence fisheries, with the condition being that as a result of bycatch elimination salmon returns increased significantly to subsistence salmon fishery areas. Indirect impacts to subsistence in the form of loss of income and the loss of joint production opportunities would occur, and are considered significantly adverse.

Cumulative Effects of FMP 4.1 and FMP 4.2

The predicted direct and indirect effects of the groundfish fishery under FMP 4.1 and FMP 4.2 are described above. The past/present effects on subsistence are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. Representative indicators used in this analysis are the same as those used in the direct/indirect analysis and include subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon, and indirect impacts on other subsistence activities such as income and joint production opportunities. For a summary of the direct/indirect and cumulative ratings see Table 4.8-6.

<u>Subsistence Use of Groundfish</u>

- **Direct/Indirect Effects**. Under FMP 4.1, commercial fishery activity is sharply reduced, but it is not clear that this would have direct beneficial or adverse impacts on the subsistence groundfish fishing conditions in relation to the subsistence fishery that is occurring under baseline conditions, but it is assumed that any change would not be large enough to reach significant levels. Under FMP 4.2 it is not clear whether subsistence related groundfish fishing would experience direct impacts under this FMP. Local groundfish availability may increase with the elimination of the commercial groundfish fishery, but the magnitude of this increase is unknown and the effect of this increase on subsistence activity is unknown. Given the relatively low level of groundfish subsistence use, it is assumed that any direct increase groundfish subsistence likely under this FMP would be insignificant.

- **Persistent Past Effects**. Foreign JV, domestic, and state-managed fisheries have decreased populations of some species of groundfish used for subsistence. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects**. Other fisheries and long-term climate change have a potential to adversely contribute to subsistence use of the groundfish fisheries. Economic development and sport and personal use are not likely to adversely contribute to subsistence use of the groundfish fisheries. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Cumulative Effects**. Under FMP 4.1 and FMP 4.2, a cumulative effect is identified for subsistence use of groundfish, and the effect is judged to be insignificant. Under FMP 4.1 commercial fishery activities are sharply reduced and under FMP 4.2 subsistence groundfish harvest in federal waters fishing is suspended. The cumulative effects could be adverse, but not enough to have significant indirect impacts to subsistence. The external impacts of economic development activities and sport and personal use of groundfish are not likely to contribute adversely to the groundfish fisheries. However, other state-managed fisheries could have adverse impacts to the subsistence use of groundfish due to the direct competition for the same species, but those impacts are not considered to be significant. The long-term climate change could adversely effect groundfish stocks.

<u>Subsistence Use of Steller Sea Lions</u>

- **Direct/Indirect Effects**. Under FMP 4.1 Steller sea lion populations are expected to benefit due to a beneficial effect on pelagic forage availability. This would be a conditionally significant beneficial benefit for Steller sea lion subsistence activities, with the condition being that Steller populations would need to increase to point where subsistence activities substantially benefit through a reduction in effort needed for hunting success and/or the perceived recovery of the Steller population fostered a substantial increase in subsistence activity. Under FMP 4.2 Steller sea lion populations are expected to benefit due to a beneficial effect on pelagic forage availability. This would be a conditionally significant beneficial benefit for Steller sea lion subsistence activities, with the condition being that Steller populations would need to increase to point where subsistence activities substantially benefit through a reduction in effort needed for hunting success and/or the perceived recovery of the Steller population fostered a substantial increase in subsistence activity.

- **Persistent Past Effects**. The past/present effects on subsistence use of Steller sea lions include the following: a long-term decline in population of Steller sea lions due to a number of factors; a long-term decline in relative importance of marine mammals in local diets; commercial groundfish fishing taking prey species utilized by Steller sea lions; and Steller sea lion protection measures designed to assist in population recovery instituted in 2000. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects**. Other fisheries, economic development, and long-term climate change have a potential to adversely contribute to Steller sea lions subsistence activities. Sport and personal use is not likely to adversely contribute to subsistence use of Steller sea lions. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Cumulative Effects**. Under FMP 4.1 and FMP 4.2, a cumulative effect is identified for subsistence use of Steller sea lions and the effect is judged to be conditionally significant beneficial. The reduction of open fisheries under FMP 4.1 and the closure of fisheries under FMP 4.2 could have a beneficial impact on Steller population levels.

Subsistence Use of Western Alaskan Salmon and Bycatch in the Groundfish Fishery

- **Direct/Indirect Effects**. Under FMP 4.1, salmon bycatch would be reduced, however, current information does not allow a determination that the level of bycatch reduction would result in significant increases in salmon returns to subsistence fishery areas. Therefore, while reduction in salmon bycatch would be generally beneficial for subsistence salmon fisheries, current data do not suggest that these benefits would rise to the level of significance. Under FMP 4.2 salmon bycatch would be eliminated under this FMP. This would result in a conditionally significant beneficial benefit for salmon subsistence fisheries, with the condition being that as a result of bycatch elimination salmon returns increased significantly to subsistence salmon fishery areas.

- **Persistent Past Effects**. The past/present effects on subsistence use of salmon include the following: utilization for subsistence since pre-contact times; and Area M closures implemented to decrease intercept of salmon. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects**. Other fisheries, other economic development activities and long-term climate change and regime shift could all adversely contribute to salmon subsistence activities. Sport and personal use is not likely to adversely contribute to salmon subsistence activities. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Cumulative Effects**. Under FMP 4.1, a cumulative effect is identified for subsistence use of salmon, and is judged to be insignificant. The reduction in salmon bycatch is offset by external effects that adversely affect subsistence use of salmon. Under FMP 4.2 a cumulative effect is identified for subsistence use of salmon and the effect is judged to be conditionally significant beneficial. Given the poor stock status of salmon runs in western Alaska, decreasing bycatch in BSAI and GOA could help to restore stock and improve recovery.

Indirect Impacts on Other Subsistence Activities

- **Direct/Indirect Effects**. Under FMP 4.1, catcher vessel activity and labor income are anticipated to decline sharply, therefore it is expected that significantly adverse indirect impacts to subsistence through a decline in income or joint production opportunities will occur. Under FMP 4.2 indirect impacts to subsistence in the form of loss of income and the loss of joint production opportunities would occur.

- **Persistent Past Effects**. The past/present effects on the indirect impacts on other subsistence activities include joint production as a part of local groundfish and other commercial fishery development from the outset; and income from fishing used for investment in subsistence is similar to use of income from other activities. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects**. Other fisheries, other economic development activities, and long-term climate change and regime shift could all adversely or beneficially contribute to indirect subsistence activities. Sport and personal use is not likely to adversely contribute to indirect impacts on other subsistence activities. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Cumulative Effects**. Under FMP 4.1 and FMP 4.2 a cumulative effect is identified for subsistence use of salmon and the effect is judged to be significantly adverse. Under FMP 4.1 income, catcher vessel activity, and joint production opportunities are adversely affected by reduced fishing activities. Under FMP 4.2 income, catcher vessel activity, and joint production opportunities are eliminated.

4.8.9.5 Environmental Justice

The predicted direct and indirect effects of the groundfish fishery under FMP 4.1 and FMP 4.2 are described below. The past/present effects on Environmental Justice are described in Section 3.9 (Table 3.9-126) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The external factors used in this analysis are other fisheries such as foreign, domestic, and state-managed fisheries; other economic development activities; other sources of municipal/state revenue; and long-term climate change and regime shift (Table 4.8-6).

Direct/Indirect Effects of FMP 4.1

Potential impacts that drive Environmental Justice issues include employment/municipal revenue and taxes in communities with significant percentages of special populations (Alaska Native and minority processing workforce); revenue to Native-owned catcher vessels; revenue to Native-owned catcher processors; subsistence activities associated with groundfish, Steller sea lion, and salmon; and the loss of income from fishing that would be otherwise directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. The regions that could experience potential impacts include the Alaska Peninsula and Aleutian Islands, Kodiak Island, southcentral Alaska, southeast Alaska, Washington inland waters, Oregon coast, the CDQ regions, and western Alaska communities that harvest salmon for subsistence purposes.

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which several have predominantly Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. in-region processing employment would decrease below baseline conditions by about 2,131 jobs; therefore, this loss of jobs in a region with predominantly minority populations engaged in the processing industry would result in a marked Environmental Justice impact. Total in-region groundfish processing value would decrease from $464 million to $178 million. Decreased in-region processing value would correspond to reduced municipal revenue and taxes to the local communities and would therefore result in associated Environmental Justice impacts for those communities with substantial minority populations. In this region the ownership and crews of the catcher vessels are assumed to tend to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under this FMP bookend, the total value of catcher vessel operations would decrease as would corresponding labor income and employment; therefore, an Environmental Justice impact would likely result.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. in-region processing employment would decrease over baseline conditions by about 367 jobs; therefore, an Environmental Justice impact would result. Total in-region groundfish processing value would decrease from $81 million to $29 million. Decreased in-region processing value would correspond to reduced municipal revenue and taxes to the City and the Kodiak Island Borough, but given local and regional demographics, this is not likely to be an Environmental Justice issue. Ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the City of Kodiak itself, and therefore the local fleet associated population is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under this FMP bookend, the total value of catcher vessel operations would decrease as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be an Environmental Justice issue.

Southcentral Alaska. As described in existing conditions, Environmental Justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and thus it is unlikely that Environmental Justice issues will be associated with any employment change. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs decrease, but this change is not linked to Environmental Justice concerns. Similarly, processing value decreases, as do catcher vessel associated values, but these changes are not tied to Environmental Justice concerns.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall Environmental Justice concerns appear not to apply in this region. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs decrease, but this change is not linked to Environmental Justice concerns. Similarly, processing value decreases as do analogous catcher vessel associated values, but this change is not associated with Environmental Justice concerns. See

Washington Inland Waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. in-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, Environmental Justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under this FMP , at-sea processing labor income and FTEs decrease by 67 and 64 percent, respectively, which would result in Environmental Justice impacts. See

Oregon Coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under this FMP overall combined direct, indirect, and induced labor income and FTEs decrease, as do catcher vessel related values, but these changes are not linked to Environmental Justice concerns. See

CDQ Region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve Environmental Justice concerns. Under this FMP, the structure of the CDQ program would not change from baseline conditions. However, the precipitous decline of the fishery due to reductions in TAC and area closures associated with specific gear types would result in adverse impacts to the CDQ program (income and employment opportunities for Alaska Natives, economic development revenue available to CDQ communities), and these would be considered Environmental Justice impacts.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations, and in a few cases (such as Steller sea lion subsistence) exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve Environmental Justice concerns. Subsistence activities where there are potential Environmental Justice issues include the following:

- Harvest of groundfish (which occurs to some extent in all four Alaska regions), Steller sea lion (primarily and activity in the Alaska Peninsula/Aleutian Islands region), and salmon (primarily an issue in western Alaska, where poor runs have adversely affected subsistence harvests).

- The loss of income from fishing that would otherwise be directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production (which occurs to some extent in all four Alaska regions).

Management measures associated with reductions in TAC and salmon bycatch, and increases in area closures to protect habitat will benefit subsistence harvest of Salmon and Steller sea lions. As a result there would be insignificant Environmental Justice effects on subsistence harvests. However, this FMP would result in significant loss of income and joint production opportunities, primarily in the Alaska Peninsula/Aleutian Island region, resulting in an adverse Environmental Justice effect.

Cumulative Effects of FMP 4.1

The predicted direct and indirect effects of the groundfish fishery under the Alternative 4 are described above. The past/present effects on Environmental Justice Issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicator used in this analysis is the same as that used in the direct/indirect analysis (Table 4.8-6).

Environmental Justice

- **Direct/Indirect Effects**. Under FMP 4.1, significantly adverse Environmental Justice effects would result from reductions in minority processing income employment (Alaska Peninsula/Aleutian

Islands, Kodiak Island, Washington inland waters); Alaskan Native harvesting income and employment (Alaska Peninsula/Aleutian Islands); tax revenues to communities with significant Alaskan Native populations (Alaska Peninsula/Aleutian Islands); CDQ region income, employment and economic development funds; and income and joint production opportunities that support subsistence harvests (Alaska Peninsula/Aleutian Islands).

- **Persistent Past Effects**. Persistent past effects include trends and developments in other fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects**. Other fisheries, other economic development activities, other sources of municipal state revenue and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Cumulative Effects**. Under FMP 4.1, the reductions in TAC and large closure areas would create significantly adverse cumulative Environmental Justice effects for the Alaska Peninsula/Aleutian Islands, Kodiak and Washington inland waters. The adverse direct/indirect effects on special population income and employment activities, CDQ region income/employment/ development funds, and income and joint production for subsistence pursuits combined with adverse external effects and trends (salmon and crab downturns, reductions in municipal revenue) to result in significantly adverse cumulative Environmental Justice issues in the Alaska Peninsula/ Aleutian Islands, Kodiak Island, Washington inland waters, and CDQ regions. Cumulative effects on subsistence harvest of salmon and Steller sea lion are beneficial but insignificant, and do not raise Environmental Justice concerns.

Direct/Indirect Effects of FMP 4.2

FMP 4.2 suspends the fishery for an indeterminate amount time, and significantly adverse impacts to Alaska Native fishing communities would result in Environmental Justice impacts. Processing worker job losses in the in-region processing sectors in the Alaska Peninsula/Aleutian Islands and Kodiak regions would result in Environmental Justice impacts, as would losses of jobs to at-sea processing workers operating out of the Washington inland waters region. Catcher vessel income and job losses in Alaska Native communities (primarily in the Alaska Peninsula/Aleutian Islands region) would also involve Environmental Justice concerns, as would the loss of tax revenue to communities with predominant Alaska Native populations. Further, impacts to the CDQ program, due to the loss of revenue, employment opportunities, and economic development funds, would be significantly adverse; given the demography of the CDQ region, these constitute Environmental Justice impacts. While subsistence harvest of salmon and Steller sea lions would benefit, the loss of income and joint production opportunities, primarily in the Alaska Peninsula/Aleutian Islands region, would also qualify as an Environmental Justice issue.

Cumulative Effects of FMP 4.2

The predicted direct and indirect effects of the groundfish fishery under the Alternative 4 are described above. The past/present effects on Environmental Justice Issues are described in Section 3.9. This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. The representative indicator used in this analysis is the same as that used in the direct/indirect analysis (Table 4.8-6).

Environmental Justice

- **Direct/Indirect Effects**. Under FMP 4.2, significantly adverse Environmental Justice effects would result from reductions in minority processing income employment (Alaska Peninsula/Aleutian Islands, Kodiak Island, Washington inland waters); Alaskan Native harvesting income and employment (Alaska Peninsula/Aleutian Islands); tax revenues to communities with significant Alaskan Native populations (Alaska Peninsula/Aleutian Islands); CDQ region income, employment and economic development funds; and income and joint production opportunities that support subsistence harvests (Alaska Peninsula/Aleutian Islands).

- **Persistent Past Effects**. Persistent past effects include trends and developments in other fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects**. Other fisheries, other economic development activities, other sources of municipal state revenue and long-term climate change and regime shift have the potential to adversely or beneficially affect Environmental Justice issues. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Cumulative Effects.** Under FMP 4.2, the suspension of fisheries would create significantly adverse cumulative Environmental Justice effects similar to FMP 4.1, only more severe. The adverse direct/indirect effects on special population income and employment activities, CDQ region income/employment/ development funds, and income and joint production for subsistence pursuits combine with adverse external effects and trends (salmon and crab downturns, reductions in municipal revenue) to result in conditionally significant cumulative Environmental Justice issues in the Alaska Peninsula/ Aleutian Islands, Kodiak Island, Washington inland waters, and CDQ regions. Cumulative effects on subsistence harvest of salmon and Steller sea lion are beneficial but insignificant, and do not raise Environmental Justice concerns.

4.8.9.6 Market Channels and Benefits to United States Consumers

The predicted direct and indirect effects of the groundfish fishery under FMP 4.1 and FMP 4.2 are described below. The past/present effects on Market Channels and Benefits to U.S. Consumers are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. Representative indicators used in this analysis include product quantity, product year-round availability, product quality, and product diversity on Market Channels and Benefits to U.S. Consumers activities (Table 4.8-6).

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

FMP 4.1 is not expected to have a significant effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. FMP 4.1 will result in large reductions in the domestic production of several different groundfish products. The projected 5-year mean of the wholesale product value of BSAI and GOA groundfish after primary processing is $0.5 billion. This product value mean is approximately one-third of the comparative baseline. The most likely result of the decrease in the production would be an adverse effect on the U.S. seafood trade balance, as more groundfish products are imported to offset the reduced domestic supply. The imported groundfish products, such as the twice-frozen fillets and blocks imported from China, may be generally lower in quality than domestic products. The price elasticity of demand for groundfish products is fairly high in the U.S. market, but assuming that demand is not perfectly elastic, the decreased production could result in higher prices and a loss of consumer surplus (i.e., net benefits) to the American public. The magnitude of that loss will depend on price elasticities that are not quantifiable at this time and on the degree to which production is shifted toward or away from the export markets. However, it is unlikely that the decrease in consumer surplus will be significant relative to the comparative baseline using the 20 percent standard as the significance criterion.

FMP 4.2 is expected to have a conditionally significant adverse effect on benefits to U.S. consumers of groundfish products relative to the comparative baseline. Both the intensity of this effect and the probability of its occurrence are uncertain. Under FMP 4.2, the production of groundfish products in fisheries occurring in the EEZ off Alaska will be suspended until more information is known on the impacts of fishing on the environment. An estimate of the final market value of BSAI and GOA seafood products that will be foregone under this FMP is not available; however, it would be substantially greater than $1.5 billion, the estimated product value of BSAI and GOA groundfish after primary processing that will be foregone under FMP 4.2. The most likely result of the decrease in the production would be a adverse effect on the U.S. seafood trade balance, as more groundfish products are imported to offset the reduced domestic supply. The imported products, such as the "twice-frozen" fillets and blocks imported from China, may be generally lower in quality than domestic products. Even if more foreign groundfish products are imported, the increase may be unable to compensate for the effects of a suspension of U.S. harvests of groundfish in the EEZ off Alaska. The result could be a significant decrease in the supply of pollock and Pacific cod fillets to the U.S. market. The supply of surimi for the domestic seafood analog market and other products may also be reduced. In turn, these decreases in supply could have adverse effects on American seafood consumers. The price elasticity of demand for groundfish products is fairly high in the U.S. market, but assuming that demand is not perfectly elastic, the suspension of the Alaska groundfish fisheries could result in higher prices for groundfish products and a loss of consumer surplus (i.e., net benefits) to the American public.

Cumulative Effects of FMP 4.1 and FMP 4.2

For a summary of the direct/indirect and cumulative ratings see Table 4.8-6.

Market Channels and Benefits to U.S. Consumers

- **Direct/Indirect Effects of FMP 4.1 and FMP 4.2**. Under FMP 4.1, increases in benefits to U.S. consumers of groundfish products are expected to occur but are insignificant. Under FMP 4.2 the production of groundfish products in fisheries occurring in the EEZ off Alaska will be suspended and the supply of seafood products to the U.S. market will decrease. This is expected to have a conditionally significant adverse effect on benefits to U.S. consumers of groundfish products.

- **Persistent Past Effects**. These effects on benefits to U.S. consumers of groundfish products include: Alaska Seafood Marketing Institute product promotion activities, research and public awareness regarding the health benefits of seafood consumption, aquaculture development increasing overall availability and demand for seafood products, and changes in processing technology increasing seafood quality.

- **Reasonably Foreseeable Future External Effects**. Reasonably foreseeable effects include other fisheries (supply of product) and long-term climate change and regime shift. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Cumulative Effects**. Under FMP 4.1, a cumulative effect is identified for benefits to U.S. consumers of groundfish products, and the effect is judged to be insignificant. The external impacts of other fisheries have the potential to contribute adversely or beneficially to the U.S. consumers of groundfish products and the groundfish market channels. However, the wholesale groundfish product value in conjunction with products from other fisheries is not expected to change benefits to U.S. consumers. The long-term climate change and regime shift could adversely effect availability for market channels due to the natural fluctuations in groundfish stocks. Under FMP 4.2 a cumulative effect is identified for benefits to U.S. consumers of groundfish products, and the effect is judged to be significantly adverse. The suspension of production of groundfish products in fisheries occurring in the EEZ off Alaska could decrease product quality, supply, and production of pollock and Pacific cod fillets, offset the seafood trade balance as more groundfish products are imported, increase prices for groundfish products, and have an adverse effect on seafood consumers.

4.8.9.7 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (including Non-Consumptive and Non-Use Benefits)

The predicted direct and indirect effects of the groundfish fishery under FMP 4.1 and FMP 4.2 are described below. Benefits derived from marine ecosystems and associated species are used as a surrogate to evaluate non-consumptive and non-use benefits. The past/present effects on non-consumptive and non-use benefits to U.S. general public are described in Section 3.9 (Table 3.9-127) and below. This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits) (Table 4.8-6).

Direct/Indirect Effects of FMP 4.1 and FMP 4.2

FMP 4.1 is predicted to significantly increase the level of benefits the Bering Sea and GOA marine ecosystems and associated species provide relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 4.1 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.8.10 of the draft Programmatic SEIS.

As described in Section 3.9.7, the Bering Sea and GOA marine ecosystems and species associated with them provide a broad range of benefits to the American public. Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. While there are difficulties in estimating the value the public places on protecting ecological conditions, Section 3.9.7 provides a qualitative discussion of possible benefits provided by the Bering Sea and GOA marine ecosystems. In addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing. Furthermore, some people may not directly interact with the Bering Sea and GOA marine ecosystems and the various species associated with them but derive satisfaction from knowing that the structure and function of these ecosystems are protected.

The focus in this analysis is on the direct and indirect effects of the alternatives on ecosystem benefits other than those that accrue to members of society who make a living harvesting, processing and distributing BSAI and GOA groundfish products or who purchase and consume these products. The direct and indirect effects of the alternatives on firms and communities that derive value from the commercial harvest and processing of groundfish are described elsewhere in the draft Programmatic SEIS. Similarly, the effects of the alternatives on consumers of groundfish products are discussed in a separate section of the draft Programmatic SEIS.

The value people assign to those marine ecosystem benefits that are unrelated to commercial groundfish fisheries are thought to be considerable. For example, the value of protecting the Steller sea lion alone may be substantial. As discussed in Section 3.9.7, a contingent valuation study suggests that there is a significant willingness to pay on the part of the American public for an expanded federal Steller sea lion recovery program. At this time, however, there is insufficient information to provide a comprehensive measure of the benefits derived from these ecosystems and the various species associated with them.

FMP 4.1 assumes that the current groundfish fisheries are producing large-scale adverse effects on the Bering Sea and GOA marine ecosystems. A primary purpose of this FMP bookend is to provide increased protection for habitat and the overall ecosystem. To mitigate the possibility of detrimental biological and environmental impacts from fishing, for example, this bookend would designate 20-50 percent of the management area as no-take marine reserves covering the full range of marine habitats within the 1,000-m bathymetric line (Figure 4.2-6). As part of this area in the Aleutian Islands, a Special Management Area would be established to protect coral and other live bottom habitats. This area would also include spawning reserve areas for intensively fished species. Comprehensive trawl exclusion zones would be set aside to protect all Steller sea lion critical habitat, and trawling itself would be restricted to only those fisheries that cannot be prosecuted with other gear types.

As discussed in Section 4.8.10, the measures implemented under FMP 4.1 are expected to have significantly or conditionally significant beneficial consequences for predator-prey relationships, energy flow and balance, and diversity. In turn, these beneficial effects on the Bering Sea and GOA marine ecosystems and associated species are expected to lead to a significant increase in the levels of some of the benefits these ecosystems and species provide.

FMP 4.2 is predicted to significantly increase the level of benefits the Bering Sea and GOA marine ecosystems and associated species provide relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of FMP 4.2 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.8.10 of the draft Programmatic SEIS.

By suspending all fishing, FMP 4.2 would remove all risk that groundfish fisheries have an adverse effects on the Bering Sea and GOA marine ecosystems and species associated with them. A groundfish fishery may be reopened under this FMP bookend, but only if it can be shown to pose no significant threat of adverse environmental impacts or if adverse effects can be successfully mitigated through use of fishery-specific regulations. As discussed in Section 4.8.10, these measures are expected to have significantly or conditionally significant beneficial consequences for predator-prey relationships, energy flow and balance, and diversity. In turn, these beneficial effects on the Bering Sea and GOA marine ecosystems and associated species are expected to lead to a significant increase in the levels of some of the benefits these ecosystems and species provide.

Cumulative Effects of FMP 4.1 and FMP 4.2

For a summary of the direct/indirect and cumulative ratings, refer to Table 4.8-6.

<u>Benefits Derived from Marine Ecosystems and Associated Species</u>

- **Direct/Indirect Effects**. FMP 4.1 is predicted to have a significantly beneficial impact on the levels of benefits these ecosystems and associated species generate. Under FMP 4.2 fishing is suspended this is assumed to contribute to healthier ecosystems and significantly increase the benefits these ecosystems and species provide relative to the comparative baseline.

- **Persistent Past Effects**. Persistent past effects on non-consumptive and non-use benefits) include: an increase in public awareness of marine ecosystems; increased participation in recreational fishing and eco-tourism activities; and public perceptions with regard to fisheries management. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Reasonably Foreseeable Future External Effects**. Reasonably foreseeable future effects include other fisheries, and long-term climate change and regime shifts. These factors do not vary among alternatives; for more detail refer to the analysis in FMP 1.

- **Cumulative Effects**. Under FMP 4.1, a cumulative effect is identified for benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits), and the effect is judged to be conditionally significant beneficial. The external impacts of other fisheries have the potential to contribute adversely to benefits the public derives from marine ecosystems and associated species. FMP 4.1 management measures could have adverse effects on the introduction of non-native species. However, the bookend could have beneficial effects on the change in pelagic forage availability, spacial and temporal concentration of fishery impact on forage, removal of top predators (potential for seabird bycatch and subsistence harvests of marine mammals), energy removal and energy redirection, changes in species, functional, and structural habitat diversity for the ecosystem. The long-term climate change and regime shift could adversely effect ecosystems and associated species due to the natural fluctuations in groundfish stocks.

Under FMP 4.2, a cumulative effect is identified for benefits the public derives from marine ecosystems and associated species (including non-consumptive and non-use benefits), and the effect is judged to be conditionally significant beneficial. The external impacts of other fisheries have the potential to contribute adversely to benefits the public derives from marine ecosystems and associated species. The elimination of fishing under FMP 4.2 will provide increased protection for the habitat and overall ecosystem. FMP 4.2 could have beneficial effects on the change in pelagic forage availability, spacial and temporal concentration of fishery impact on forage, removal of top predators (potential for seabird bycatch and subsistence harvests of marine mammals), energy removal and energy redirection, changes in species, functional, and structural habitat diversity for the ecosystem. Future climatic conditions, in combination with fisheries-related pressures, could also affect species diversity.

4.8.10 Ecosystem Alternative 4 Analysis

Ecosystems are populations (consisting of single species) and communities (consisting of two or more species) of interacting organisms and their physical environment that form a functional unit with a characteristic trophic structure (food web) and material cycles (movement of mass and energy among the groups). The following analyses of potential direct/indirect and cumulative effects of Alternative 4 apply to the BSAI and GOA ecosystems. Where available information allows, each ecosystem is addressed separately. In most cases, however, information is insufficient to allow individual consideration, and the two ecosystems are treated as a single entity.

As explained in Section 4.5.10, the analyses include numerous indicators representing potential direct, indirect, and cumulative effects of the alternative and specific bookends where applicable. Significance thresholds for the effect categories are presented in Table 4.1-7.

Direct/Indirect Effects – FMP 4.1

The following discussions assess the potential direct/indirect effects of FMP 4.1 on the BSAI and GOA ecosystems.

<u>Change in Pelagic Forage Availability</u>

Pelagic forage availability is assessed by evaluating population trends in pelagic forage biomass for species with age-structured population models. These include walleye pollock in the GOA (Figure H.4-17 of Appendix H) and Bering Sea walleye pollock and Aleutian Islands Atka mackerel (Figure H.4-18 of Appendix H). Trends in bycatch of other forage species (herring, squid, and forage species group) in the groundfish fisheries are a measure of the potential impact on those groups in the BSAI and GOA (Figure H.4-19 and Figure H.4-20 of Appendix H). Table 4.5-81 summarizes the average values from 2003-2008 for these measures and the percent change in these values from the baseline. In FMP 4.1, pelagic forage biomass in the BSAI (Bering Sea walleye pollock + Aleutian Islands Atka mackerel) would increase slightly by about 2 percent. In the GOA, pelagic forage biomass (specifically, walleye pollock) would increase by 63 percent relative to the baseline. These increases would result from setting F75 percent for prey species in this FMP. Average biomass remains within the bounds of historically estimated biomass that occurred before a target fishery emerged. Bycatch of other forage species would decline by about 45 percent in the BSAI and 79 percent in the GOA. The extensive fishing closure areas in this alternative may change bycatch estimates. The absolute amount of pelagic forage bycatch in each region would be relatively small (900 mt and 60 mt, respectively). Estimates of forage biomass from food web models of the EBS indicate that this bycatch would be a small proportion of the total forage biomass (Aydin *et al*. 2002). However, the lack of population-level assessments for some of the species in the forage species group means that species-level effects are unknown.

On the basis of the above considerations, FMP 4.1 is determined to have an insignificant effect on the BSAI and GOA ecosystems with respect to pelagic forage availability to target species. The increases in target species forage in this alternative have the potential to provide beneficial benefits to marine mammals such as Steller sea lions, harbor seals, and northern fur seals. Therefore, FMP 4.1 is determined to have significantly beneficial (Steller sea lions) and conditionally significant beneficial (northern fur seals) effects on prey availability to marine mammals. Sections 4.8.1 through 4.8.8 discuss the effects of pelagic forage abundance on these groups.

Spatial and Temporal Concentration of Fishery Impact on Forage

The impact of the spatial/temporal concentration of fisheries on forage species is assessed qualitatively by looking at the potential for the alternatives to concentrate fishing on forage species (walleye pollock, Atka mackerel, herring, squid, and other groups) in regions used by predators that are tied to land, such as pinnipeds and breeding seabirds. Additionally, concentration levels high enough to lead to ESA listing or prevention of recovery in an ESA-listed species are also considered. FMP 4.1 has comprehensive trawl exclusion zones to protect all designated SSL critical habitat, continues the ban on forage fish, sets precautionary harvest levels for target species that are prey (pollock and Atka mackerel, in particular), and has finer spatial allocations of TAC. These controls on spatial/temporal allocations of catch are more stringent than those included in the baseline and are judged to have significantly beneficial effects on spatial/temporal forage availability to Steller sea lions and harbor seals. FMP 4.1 is also considered conditionally significant beneficial on the prey availability of northern fur seals. For seabirds, these measures would have an insignificant effect on the spatial/temporal concentration of the fishery on forage species.

Removal of Top Predators

Removal of top predators, either through directed fishing or bycatch, is assessed by evaluating the trophic level of the catch relative to trophic level of the groundfish biomass (Figures H.4-21 through H.4-24 of Appendix H), bycatch levels of sensitive top predator species such as birds and sharks (Figures H.4-25 and H.4-26), and a qualitative evaluation of the potential for catch levels to cause one or more top-level predator species to fall below biologically acceptable limits (minimum stock size threshold for groundfish, ESA listing or prevention of recovery for an ESA-listed species). Trophic level of the catch in both the BSAI and GOA is a very stable property, changing less than 3 percent on average from the baseline, and the trophic level of the groundfish species for which we have age-structured models and which dominate the catch changes less than 1 percent on average. Under FMP 4.1, top-predator bycatch amounts would decrease relative to the baseline by an average of about 13 percent in the BSAI and about 86 percent in the GOA. The absolute values of average catch for these species are estimated to be 585 mt and 180 mt in the respective regions under this FMP (Table 4.5-81). These are large decreases relative to the baseline and would be considered an improvement over existing conditions.

The baseline determination is that historical whaling has resulted in low present-day abundance of whale species in the North Pacific. FMP 4.1 would not further impair the recovery of whale species through direct takes. Although this FMP could increase the amount of longline fishing, which tends to have higher levels of seabird bycatch relative to other fisheries, it proposes to set protection measures for all seabird species and to develop fishing methods that reduce incidental take. Consequently, levels of seabird and pinniped bycatch under FMP 4.1 would not lead to an ESA listing for any of those populations or prevent any of these species from recovery under the ESA. Sections 4.8.7 and 4.8.8 discuss the effects of groundfish fishery direct takes on specific seabird and marine mammal populations. The effect of shark bycatch on shark populations is unknown at present, and research directed at better assessing population levels of these sensitive (late maturing, low fecundity, low natural mortality) species is needed to better assess the potential for groundfish fisheries to affect these populations. By breaking sharks out of the other species group for TAC setting and setting the TAC level on the basis of the least abundant member of the group, FMP 4.1 may provide increased protection for sharks. Thus, it could have a significantly beneficial effect on this top predator group. Stability in trophic level of the catch is indicative of little effect of the fishery on target and PSC species top predators (Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut). Overall, FMP 4.1 would have a significantly beneficial effect on top predators.

Introduction of Non-Native Species

The introduction of non-native species through ballast water exchange and hull-fouling organism release from fishing vessels could potentially disrupt the Alaskan marine food web structure (Fay 2002). There have been 24 species of non-indigenous species of plants and animals documented primarily in shallow-water marine and estuarine ecosystems of Alaska, with 15 species recorded in PWS. It is possible that most of these introductions were from tankers or other large commercial vessels that have large amounts of ballast exchange. However, exchange via fishery vessels that take on ballast from areas where invasive species have already been established and then transit through Alaskan inshore waters has been identified as a threat in a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). Consequently, this effect is evaluated as conditionally significant adverse in the baseline.

Total groundfish catch levels are used as indicators for potential changes in the amount of these releases via groundfish fishery vessels (Figures H.4-27 and H.4-28 of Appendix H). Total catch would decrease by about 64 percent in the BSAI and 63 percent in the GOA under FMP 4.1, relative to the baseline. Therefore, FMP 4.1 would substantially reduce the potential for fishing vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms. However, there is insufficient information regarding fishing effort levels that would result in a successful introduction and this potential effect is evaluated as conditionally significant beneficial with respect to predator-prey relationships.

Energy Flow and Balance

As discussed in Section 3.10, fishing may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal back into the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. Baseline energy removals, in the form of total catch, were less than one percent of the total system energy determined by mass-balance modeling of the system and were determined to have an insignificant effect on the ecosystem. FMP 4.1 catch removals (Table 4.5-81), which decrease by about 64 percent and

63 percent from the baseline in the BSAI and GOA, respectively, show the potential for large improvements relative to the baseline with respect to producing changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7). Because of existing uncertainty regarding these potential effects, FMP 4.1 is rated conditionally significant beneficial with respect to energy removal.

Energy re-direction, in the form of discards, fishery offal production, or unobserved gear-related mortality, can potentially change the natural pathways of energy flow in the system. Animals damaged when passing through the meshes of trawls may later die and be consumed by scavengers. Bottom trawls can expose benthic organisms and make them more vulnerable to predation. Discards and offal production can cause local enrichment and changes in species composition or water quality if discards or offal returns are concentrated there. These effects were determined to be insignificant at the ecosystem level in the baseline. Estimates of total discards (Figures H.4-29 and H.4-30 of Appendix H) under FMP 4.1 show a 46 percent decrease in the BSAI and a 64 percent decrease in the GOA relative to the baseline. Because these amounts of change would be large improvements over baseline conditions, they would create the potential for a conditionally significant beneficial effect on ecosystem-level energy cycling characteristics. The conditional rating, however, reflects uncertainty regarding the degree to which fishery-related discards, offal release, and gear-related mortality actually affect energy re-direction at the ecosystem level.

Change in Species Diversity

Fishing can alter different measures of diversity. Species-level diversity, or the number of species, can be altered if fishing essentially removes a species from the system. Fishing can alter functional diversity from a trophic standpoint if it selectively removes or depletes a trophic guild member and thus changes the way biomass is distributed within a trophic guild. Functional diversity can be altered if fishing methods, such as bottom trawling, remove or deplete organisms such as corals, sea anemones, or sponges that provide structural habitat for other species. Fishing can alter genetic diversity by selectively removing faster-growing fish or removing spawning aggregations that might have genetic characteristics that are different from other spawning aggregations. Larger, older fishes may be more heterozygous (i.e., have more genetic differences or diversity) and some stock structures may have a genetic component (see review in Jennings and Kaiser 1998). Consequently, one would expect a decline in genetic diversity to result from heavy exploitation of a fishery.

Significance thresholds for effects of fishing on species diversity have catch removals high enough to cause the biomass of one or more species (target or non-target) to fall below, or to be kept from recovering from levels already below minimum biologically acceptable limits (MSST for target species, ESA listing for non-target species) (Table 4.1-7). Bycatch amounts of sensitive (low population turnover rates) groups that lack population estimates (skates, sharks, grenadiers, and sessile invertebrates, such as corals, inhabiting Habitat Areas of Particular Concern, or HAPC) may also indicate potential for fishing impact on these species (Figures H.4-31 and H.4-32 of Appendix H). Closed areas also provide protection, particularly to less-mobile species like HAPC biota, so the amount of area closures across habitat types can indicate the degree of species-level diversity protection. Baseline determinations were made of insignificance for some species and unknown for skates and sharks.

Under FMP 4.1, bycatch of HAPC biota would decrease by about 44 percent in the BSAI and 60 percent in the GOA (Table 4.5-81). This FMP would also provide substantial increases in closed areas in the form of no-take reserves. These closures would produce even greater decreases in HAPC biota bycatches that are not modeled here and would likely be sufficient to prevent species extinction for these sessile animals. Catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring these species below minimum population thresholds. The practice of setting TAC for a group based on the least abundance species in the complex, and breaking species out of complexes when possible, would prevent skates, sharks, and grenadiers from reaching minimum population thresholds. Although forage species population levels are not known, their relatively high turnover rates, the ban on forage fish fisheries in this FMP, and the practice of breaking species out of a complex when possible, are considered sufficient to protect them from falling below minimum biologically acceptable limits. Therefore, this alternative is determined to be significantly beneficial since it provides substantial improvements to species diversity relative to the baseline. Sections 4.8.1 through 4.8.8 discuss more detailed analyses of the potential for fishery removals to affect minimum population thresholds for each of these groups and thus ultimately to affect species diversity.

Change in Functional Diversity

Functional (either trophic or structural habitat) diversity can be altered through fishing if fishing selectively removes one member of a functional guild, which may result in increases in other guild members. Indicators of the possible magnitude of effects include qualitative evaluation of guild or size diversity changes relative to fishery removals, bottom gear effort changes that would provide a measure of benthic guild disturbance, and bycatch amounts of HAPC biota, a structural habitat guild. Members of the HAPC biota guild serve important functional roles in providing fish and invertebrates with structural habitat and refuge from predation. The long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. Some of the area closures in FMP 4.1 have been designed with corals in mind and would ensure that there is a broad spatial distribution of corals in the Aleutian Islands, in particular. Therefore, FMP 4.1 is determined to have potential for significant improvements relative to the baseline condition for structural habitat diversity. Thus, FMP 4.1 may provide significantly beneficial improvements relative to the baseline with respect to both trophic and structural habitat diversity.

Change in Genetic Diversity

Genetic diversity can be affected by fishing through heavy exploitation of certain spawning aggregations or systematic targeting of older age classes that tend to have greater genetic diversity. Under FMP 4.1, no target species would fall below MSST, there would be finer areas for spatial management of TAC, and spawning area reserves would be established to protect exploited species that are fished intensively at spawning time. Consequently, the groundfish fisheries would have an insignificant effect on genetic diversity as managed under FMP 4.1. However, baseline genetic diversity remains unknown for most species and the actual direct/indirect effects of fishing on genetic diversity are also largely unknown.

Cumulative Effects Analysis – FMP 4.1

The following sections discuss the potential cumulative effects on the ecosystem of FMP 4.1, acting additively or interactively with the effects of external human actions and natural processes persisting from the past, ongoing in the present, and predicted for the reasonably foreseeable future. These potential cumulative effects are summarized in Table 4.8-7. Data and calculations supporting the cumulative energy removal analyses for all of the alternatives are presented in Table 4.5-81.

Change in Pelagic Forage Availability

- **Direct/Indirect Effects.** The effects of FMP 4.1 are expected to be significantly beneficial for prey species utilized by the Steller sea lion, and conditionally significant beneficial for northern fur seal forage availability. FMP 4.1 would have an insignificant effect on BSAI and GOA groundfish target species with respect to pelagic forage availability.

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from about 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate changes, especially a regime shift, would likely affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** Based on the direct/indirect effects conclusions for FMP 4.1, the groundfish fisheries would contribute a beneficial increment to any broader cumulative effect. A potentially adverse contribution by one or more external factors, including State of Alaska directed fishery removals and subsistence harvests of forage fishes such as herring, capelin, or eulachon, could offset the beneficial contribution of the groundfish fisheries by some increment of forage fish removal. In addition, a large marine oil or fuel spill would have the potential to deplete forage fish populations to a significant extent. Therefore, the potential cumulative effect associated with FMP 4.1 is considered to be conditionally significant beneficial because the beneficial contribution of this FMP could be offset by external factors under the conditions described.

Spatial/Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** The effects of implementing FMP 4.1 are expected to be significantly beneficial for prey species utilized by the Steller sea lion, and conditionally significant beneficial for northern fur seal forage availability. FMP 4.1 would have an insignificant effect on seabirds with respect to pelagic forage availability.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may have persisted into the present and future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have shown effects on recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may be exerting a persistent effect on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and places that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlapping with the groundfish fishery is more likely temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial/temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill that coincides in space and time with herring or capelin spawning would most likely produce population declines and adversely impact other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial/temporal distributions of pelagic forage species in ways that are synergistic with spatial/temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** The potential effects of the spatial/temporal concentration of fisheries on forage species availability as modeled under FMP 4.1 are rated as significantly beneficial for Steller sea lion prey species, conditionally significant beneficial for northern fur seal prey species, and insignificant for seabird forage availability. A potentially adverse contribution by one or more external factors could offset this beneficial contribution by some increment of forage fish removal in the future. For example, if the fishing efforts of State of Alaska directed fisheries, principally for herring, and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could be depressed sufficiently to impair the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.1-7). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial/temporal distributions of pelagic forage species and offset the beneficial contribution of groundfish fishery management. The potential cumulative effect associated with FMP 4.1 is considered conditionally significant beneficial because the beneficial contribution of these FMPs could be offset by external factors under the conditions described.

Removal of Top Predators

- **Direct/Indirect Effects.** FMP 4.1 would have a significantly beneficial effect on top predators. Under FMP 4.1, the predicted decreases in catch are large relative to the baseline and would be an improvement over existing conditions. Protection measures would be put in place for all seabird species, and fishing methods developed to reduce incidental take. Therefore, levels of seabird and pinniped bycatch in the groundfish fisheries under FMP 4.1 would not lead to an ESA listing for any of those populations or prevent any of these species from recovery under the ESA.

  FMP 4.1 would have a conditionally significant adverse effect on seabirds; an insignificant effect on whales, pinnipeds, top-predator target, and PSC species; and an unknown effect on sharks. The greatest concern regarding the effects of FMP 4.1 on top predators is the increased potential for bycatch of seabirds. Increased fishing effort and the maintenance of former, rather than improved seabird protection measures, under FMP 4.1 are considered conditionally significant adverse measures for ESA-listed seabirds such as short-tailed albatross. Also, removal of area closures around the Pribilof Islands may lead to disproportionate take of fulmars from that colony. The conditionally significant rating reflects uncertainty of future bycatch levels and existing population-level effects of bycatch removals on seabird species (Section 3.7).

- **Persistent Past Effects**. Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the low present-day abundance of whale species in the North Pacific. State of Alaska directed groundfish fisheries, which are small and sustainably regulated, have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than in the past, and past harvests may have had a sustained effect on some populations that persist today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove a sustainable portion of the Pacific halibut population, a top predator. The current management plan is likely to continue in the reasonably foreseeable future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). High levels of seabird bycatch and resulting direct mortality are expected to continue annually from North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea would result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** Based on the potential effects of FMP 4.1 on top predator populations, the groundfish fisheries could contribute a beneficial increment to any broader cumulative effect on top predators. A potentially adverse contribution by one or more external factors, particularly a continuation of high levels of seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ, would incrementally offset the beneficial contribution of FMP 4.1. Because these external fisheries are generally not managed in conjunction with the BSAI and GOA domestic groundfish fisheries, there is a likelihood that the present high levels of seabird bycatch outside the EEZ will continue in the future. The conditions under which the beneficial contribution could be offset are the continuation of high external seabird bycatch rates in conjunction with a large fuel or oil spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future and could influence the potential cumulative effect by affecting biological recruitment. For these reasons, the effects of FMP 4.1 are determined to be conditionally significant beneficial.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** FMP 4.1 may reduce the potential for adverse effects on predator-prey relationships through the introduction of non-native species through limiting fishing vessels in Alaskan waters annually. This potential effect is considered conditionally significant beneficial due to lack of information regarding fishing effort levels and the probability that an introduced exotic species will establish a viable population.

- **Persistent Past Effects.** For decades, the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including diseases and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to be potential sources of exotic introductions in the reasonably foreseeable future. In addition, commercial shipping, including cruise ships, barges and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapes and releases of farmed Atlantic salmon from Washington State and British Columbia net-pens might eventually establish runs in GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could infect wild stocks. A future regime shift or long-term warming trend could remove the protection that colder conditions may currently provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** The potential effect of FMP 4.1 on the introduction of non-native species is rated conditionally significant beneficial. However, when sources of exotic species external to the domestic groundfish industry are considered in combination with FMP 4.1, it is conceivable that viable populations could eventually become established in the BSAI and/or GOA (Table 4.1-7). If these external factors remain similar to baseline conditions in the future, the cumulative outcome would be beneficially influenced under FMP 4.1. One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that might allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA. In considering these conditions, the potential cumulative effects of FMP 4.1 are rated conditionally significant beneficial for the introduction of non-native species.

Energy Removal

- **Direct/Indirect Effects.** The effects of FMP 4.1 on energy removal would be conditionally significant beneficial. Total catch under FMP 4.1 and FMP 4.2 decreases by about 64 and 63 percent from the baseline in the BSAI and GOA, respectively (Table 4.5-81). These are large improvements relative to the baseline in producing changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.1-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch, and these removals, in a regulated and mitigated form, continue today (Section 3.10). Aggregate biomass levels removed by unregulated past human activities would have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines**.**

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. The incremental contribution of the combined State of Alaska herring and crab and IPHC halibut fisheries is estimated at about 4 percent of the cumulative biomass that would be removed annually under this FMP (Table 4.5-81). The State of Alaska directed groundfish and subsistence fisheries will remove an additional small increment annually (ADF&G 2003b, 2001). It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (doughnut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that are viewed as only partly comparable systems, and their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of FMP 4.1 is predicted to have a conditionally significant beneficial cumulative effect on energy removal. If the annual total catches of the State of Alaska herring and crab and IPHC halibut fisheries in the future are similar to the 1997-2001 averages, the combined total catch of these external fisheries will represent a 17.3 percent addition to the estimated total catch for the groundfish fisheries alone under this FMP (Table 4.5-81). Thus, under FMP 4.1, the groundfish fisheries would remove a much smaller portion of the cumulative total energy (as biomass) than under Alternatives 1, 2, or 3, where the relative contributions of the external fisheries would be smaller. Whether this improvement in biomass removal would actually produce a measurable increase in energy within the BSAI and GOA ecosystems, and how that increase would be biologically manifested, cannot be predicted.

Energy Redirection

- **Direct/Indirect Effects.** The effects of FMP 4.1 on energy redirection are evaluated as conditionally significant beneficial. Projections of total discard biomass modeled for FMP 4.1 show about a 46 percent decrease in the BSAI and a 64 percent decrease in the GOA from baseline conditions (Table 4.5-81). These are large changes from baseline conditions, and create the potential for a conditionally significant beneficial effect on ecosystem-level energy cycling characteristics (Table 4.1-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries that existed. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will also enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of FMP 4.1 is predicted to have a conditionally significant beneficial cumulative effect on the ecosystem through energy redirection. The BSAI and GOA groundfish fisheries would remove and return much smaller quantities of energy (as biomass) relative to external sources such as the IPHC halibut fishery, State of Alaska commercial fisheries, annual subsistence harvests of fish and marine mammals. At the local level, water quality degradation will still result from the release of fish processing offal into low-energy environments, such as coves and bays, where nutrients from these wastes can concentrate in sheltered waters and alter local patterns of energy cycling. However, it is expected that the lower quantities of fish processing waste released under FMP 4.1would moderate this effect.

Change in Species Diversity

- **Direct/Indirect Effects.** Potential effects of FMP 4.1 on species diversity are rated as significantly beneficial for all groups. Targeted catch reductions and greater discrimination in TAC setting, substantial bycatch reductions, increases in closed areas in the form of no-take reserves, the ban on forage fish fisheries, and other protective measures under this FMP would all be significant influences in keeping most species above minimum biologically acceptable limits (Table 4.1-7).

- **Persistent Past Effects**. Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate (including HAPC) species are susceptible to bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated in some declines through bycatch potential. Livingston *et al*. (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show beneficial correlations with prey abundance, and that cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, they are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and make it easier for introduced exotics to establish viable populations.

- **Cumulative Effects.** FMP 4.1 would produce a conditionally significant beneficial cumulative effect on species diversity, relative to the baseline, by reducing adverse contributions from the BSAI and GOA groundfish fisheries, particularly with respect to seabird bycatch. The beneficial incremental contribution of FMP 4.1, however, could be offset by any of several possible conditions in the future. Seabird bycatch from the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries could increase. Also, one or more introduced exotic species might establish a viable population that would change species diversity in a adverse way by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify the external adverse contribution. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species.

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** The effects of the groundfish fisheries on trophic diversity under FMP 4.1 are predicted to be significantly beneficial. This rating reflects the potential of the reduced fishing effort and increased protective measures under this FMP to sustain natural levels of species, size, age, and other measures of diversity within trophic guilds and to maintain functional diversity within the range of natural variability observed for the system (Table 4.1-7).

- **Persistent Past Effects**. It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al*. (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, little research on this type of effect was conducted in the BSAI and GOA in past decades.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Releases of ballast water and hull-fouling organisms introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by forcing trends that expand some trophic levels and contract others, and a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic populations.

- **Cumulative Effects.** The implementation of FMP 4.1 would produce a conditionally significant beneficial cumulative effect by reducing fishing pressures and increasing protective measures that would help to sustain diversity within trophic guilds. Incremental contributions from several external sources could offset the beneficial contribution of FMP 4.1. However, none of these potential external conditions is likely to be interactive or synergistic with the direct/indirect effects of FMP 4.1 because different trophic guilds may be affected and an offsetting effect on trophic diversity overall is possible in the future.

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to functional diversity in terms of structural habitat is the removal, by bottom gear, of HAPC biota such as corals, sea anemones and other sessile invertebrates that provide physical structures used as habitat by other species, including economically important groundfish species and their prey. Present trawl closures to protect the Steller's sea lion are spread throughout the Aleutian chain, but these closures are further inshore than areas where corals can be found. Some of the area closures in FMP 4.1 have been designed with corals in mind and would ensure that there is a broad spatial distribution of corals, particularly in the Aleutians. Also, bottom trawl effort would likely decline in this FMP and area closures would provide additional protection to benthic communities. FMP 4.1 is rated as significantly beneficial to structural habitat diversity.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill from commercial shipping could contact areas covered by these sensitive bottom-dwelling organisms and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** The implementation of FMP 4.1 would produce a conditionally significant beneficial cumulative effect on structural habitat diversity. The direct/indirect contribution of FMP 4.1 could be offset under at least three conditions. First, the contribution of the scallop fishery, which employs bottom dredges, could partially offset the reduction in bottom trawling by the groundfish fisheries, continuing to damage and remove HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the reasonably foreseeable future could reduce the productivity (and thus population size, growth, and ability to recover from damage) as well as distribution of sensitive bottom-dwelling invertebrates that provide ecologically important structural habitat.

<u>Change in Genetic Diversity</u>

- **Direct/Indirect Effects.** Under FMP 4.1 it is not expected that target species would fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to present conditions. Fishing pressure would not focus on specific spawning aggregations or systematically target older age classes that tend to have greater genetic diversity. Therefore, effects of the groundfish fisheries on genetic diversity would be insignificant under FMP 4.1. However, baseline genetic diversity remains unknown for most species, and the actual effects of fishing on genetic diversity under this FMP are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data has not been available to indicate whether genetic diversity was measurably affected. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity will tend to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be known in the absence of data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al*. (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Such exotics may also include pathogens introduced by Pacific salmon that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotics to establish viable populations.

- **Cumulative Effects.** The implementation of FMP 4.1 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would directly involve the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. Thus, external sources for potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the future.

Direct/Indirect Effects FMP 4.2

The following discussions assess the potential direct/indirect effects of FMP 4.2 on the BSAI and GOA ecosystems.

FMP 4.2 would close the BSAI and GOA to all commercial fishing for groundfish and initiate a process whereby fisheries could be reopened after being certified as having no adverse effect on the environment. It is assumed that a substantial research program would be initiated to determine foraging needs of dependent species and life-history parameters, genetic characteristics, and abundance and distribution of species proposed for target fisheries. Fishery bycatch of non-target species and gear effects on habitat would also be evaluated before a fishery could be opened. Natural levels of ecosystem variability and the influence of climate on ecosystem production would also have to be determined. Therefore, we determine that FMP 4.2 would produce significantly or conditionally significant beneficial effects on many biological aspects of the marine ecosystem, relative to the baseline. Potential effects of this FMP would be beneficial with respect to pelagic forage availability to marine mammals such as Steller sea lions and northern fur seals. There would be no significant change with respect to forage availability to target species and birds. Significantly beneficial effects to spatial/temporal concentration of fisheries on forage would accrue to Steller sea lions and northern fur seals, but there would be no significant change in this regard for seabirds. FMP 4.2 would bring significantly or conditionally significant improvements to removal of top predator species, introduction of non-native species, energy removal and redirection, species diversity, and functional (trophic and structural habitat) diversity. FMP 4.2 would not significantly affect genetic diversity. However, baseline genetic diversity remains unknown for most species and the actual effects that fisheries would eventually have on genetic diversity under this FMP are largely unknown.

Cumulative Effects Analysis FMP 4.2

The potential cumulative effects resulting from implementation of FMP 4.2 are similar to those predicted for FMP 4.1. Ratings of potential direct/indirect effects predicted for FMP 4.1 would remain the same under FMP 4.2, along with the same contributions from persistent past effects and reasonably foreseeable future external effects. These contributing factors and potential cumulative effects are summarized for both FMP 4.1 and FMP 4.2 in Table 4.8-7.

4.8.11 Summary of Alternative 4 Analysis

The direct, indirect and cumulative ratings for all resource categories analyzed under this alternative are summarized in Tables 4.8-7.

Table number	Resource category	Components	Section 4.8 reference
4.8-1	Target groundfish species	Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) walleye pollock, BSAI and GOA Pacific cod, BSAI and GOA sablefish, BSAI and GOA Atka mackerel, BSAI yellowfin sole, GOA shallow water flatfish, BSAI rock sole, BSAI and GOA flathead sole, BSAI and GOA arrowtooth flounder, BSAI Greenland turbot, GOA deepwater flatfish, BSAI Alaska plaice, BSAI other flatfish, GOA rex sole, BSAI and GOA Pacific ocean perch, GOA thornyhead rockfish, BSAI and GOA northern rockfish, BSAI and GOA shortraker/ rougheye rockfish, BSAI other rockfish, GOA slope rockfish, GOA pelagic shelf rockfish, GOA demersal shelf rockfish.	4.8.1
4.8-2	Prohibited, other, forage and non-specified species	Pacific halibut, Pacific salmon and steelhead trout, Pacific herring, crab. Other species category. Forage fish category. Grenadier.	4.8.2 4.8.3 4.8.4 4.8.5
4.8-3	Habitat	BSAI, GOA	4.8.6
4.8-4	Seabirds	Black-footed albatross, laysan albatross, short-tailed albatross, northern fulmar, shearwaters, storm-petrels, cormorants, spectacled eider, Steller's eider, jaegers, gulls, kittiwakes, terns, murres, guillemots, murrelets, auklets, puffins.	4.8.7

Table number	Resource category	Components	Section 4.8 reference
4.8-5	Marine mammals	Steller sea lion, northern fur seals, Pacific walrus, harbor seals, spotted seal, bearded seal, ringed seal, ribbon seal, northern elephant, sea otter, blue whale, fin whale, sei whale, minke whale, humpback whale, gray whale, northern right whale, bowhead whale, sperm whale, beaked whales (Baird's, Cuvier's and Stejneger's), Pacific white-sided dolphin, killer whale, beluga whale, harbor porpoise, Dall's porpoise.	4.8.8
4.8-6	Socioeconomics	Harvesting and processing sector (catcher vessels, catcher processors , inshore processors and motherships). Regional socioeconomic profiles (population, processing ownership and activity, catcher vessel ownership and activity, tax revenue, employment and income). Community development quota (CDQ) allocations. Subsistence (subsistence use of groundfish, subsistence use of Steller sea lions, salmon subsistence fisheries, indirect subsistence factors: income and joint production). Environmental justice. Market channels and benefits to United States consumers (product quantity, product year-round availability, product quality, product diversity). Non-market goods (benefits derived from marine ecosystems and associated species).	4.8.9.1 4.8.9.2 4.8.9.3 4.8.9.4 4.8.9.5 4.8.9.6 4.8.9.7
4.8-7	Ecosystem	Forage fish availability, spatial/temporal concentration of fisheries, introduction of non-native species, removal of top predators, energy redirection, energy removal, species diversity, guild diversity, genetic diversity.	4.8.10

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4.9 Analysis of Preferred Alternative

The following discussions describe the analyses of expected direct, indirect, and cumulative effects of the Preferred Alternative (PA) on all of the resource categories. The potential effects of two policy "bookends" are analyzed, PA.1 and PA.2. These bookends represent the policy boundaries of the PA. As actually implemented, the PA could include policy measures anywhere within the range between the two bookends. The PA is described in detail in Section 2.6.9.

4.9.1 Target Groundfish Species

This section examines the potential direct, indirect, and cumulative effects that the implementation of the PA is expected to have on the target groundfish species. The impact analyses start with the baseline (2002) status of the BSAI and GOA target groundfish stocks described in Section 3.5.1, including past trends that are likely to persist into the foreseeable future. Then, a computer-based analytic model is used to project how specific characteristics of the target groundfish stocks would respond directly and indirectly to management actions under PA.1 and PA.2. These projections from the model are the predicted direct and indirect effects (impacts) of the FMP on the target groundfish stocks. Section 4.1.5 describes the analytic model and explains how it is applied.

The model output for each target groundfish stock is defined in terms of collected data and calculated measures that are standards used by fisheries managers to regulate the number of fish removed from the sea so that the fisheries will be sustainable over the long-term. These data and measures include the fishing mortality rate (F), the overfishing level (OFL), total and spawning biomass levels (B), the minimum stock size threshold (MSST), maximum sustainable yield (MSY), mean age of the stock in years, and the sex ratio of the stock (number of males compared to number of females). As discussed in the following subsections, relevant data are not always available for all stocks. When data gaps prevent application of the model to a specific stock, the projected direct or indirect effect is evaluated as unknown (U).

Each target groundfish stock is modeled with respect to the following direct and indirect effects:

Direct Effects

Fishing Mortality: This is the rate at which the stock is depleted by direct mortality imposed by removing the fish from the sea.

Change in Biomass Level: This is the change over time in the biomass of the stock, as measured in metric tons (mt). Two measures are used: total biomass, which is the estimated biomass of the entire stock, and spawning biomass, which is the estimated biomass of all of the spawning females in the stock.

Spatial/Temporal Concentration of Catch: This is the degree to which the fishery will concentrate in a particular geographic area during a particular period of time each season. This pattern in space and time can affect fishing mortality and can also influence habitat suitability for spawning, rearing, and feeding.

Direct and/or Indirect Effects

Habitat Suitability: This is the degree to which habitat has the right characteristics to support the target stock at one or more life-history stages (spawning, rearing of juveniles, availability of food at all stages, availability of refuge areas to allow escape from predators at all stages). Habitat suitability can be affected directly, for example by mechanical damage from bottom trawling, or influenced indirectly, for example by the gradual depletion of corals that provide hard substrate.

Prey Availability: This is the extent to which prey species are present in the environment and available as food to the target stock. Like habitat suitability, this measure can be affected directly, for example by the direct removal of prey species by the fishery, or indirectly, for example by a change in the structure of the food web.

To determine their probable significance, the projected direct and indirect effects in each of the impact categories listed above are evaluated against significance criteria. The criteria are designed to be relevant and meaningful in terms of the target groundfish stocks. Each significance criterion includes a threshold value above (or below) which the projected effect would be considered significant. Each criterion also includes a definition of what would constitute a beneficial (positive, +) or adverse (negative, -) effect. The possible evaluations are significant and beneficial (S+), Insignificant (I), significant and adverse (S-), and Unknown (U). Evaluations of Conditionally Significant (CS + or -) are not made for projected direct and indirect effects on target groundfish species, because the model can show only whether the significance threshold is or is not exceeded. The significance criteria used for the target groundfish stocks are presented in Appendix A, Table 4.1-1.

Each of the following subsections presents the model results and rationale for the expected direct and indirect effects of PA.1 and PA.2 on the target groundfish stocks. The significance ratings for these potential direct and indirect effects are presented in Appendix A, Table 4.9-1. Following the direct and indirect effects discussions on each stock, the expected cumulative effects on that stock are evaluated and discussed. The evaluation of potential cumulative effects builds on the direct and indirect effects evaluations as a starting point, and then brings in persistent past effects as well as reasonably foreseeable future natural events and human activities external to fisheries management. The cumulative effects assessment method uses the same impact categories and significance criteria discussed above for direct and indirect effects. This method is described further in Section 4.1.4.

4.9.1.1 Pollock

This section provides the direct, indirect and cumulative effects analysis for EBS and Aleutian Islands and GOA pollock for each of the bookends under the PA. Numerous fishery management actions have been implemented that affect the pollock fisheries in the EBS and GOA. These actions are described in more detail in Section 3.5.1.1 of this Programmatic SEIS. Pollock is managed as separate stocks in the BSAI and GOA, and falls under Tier 1 in both the BSAI and GOA groundfish FMPs.

Direct/Indirect Effects of PA.1

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-42 of Appendix H. Under PA.1, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.3 million mt in 2004, then stabilize to about 11.7 million mt. The 2003-2007 average total biomass is 11.5 million mt.

In the Aleutian Islands region, the assessments are based on trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Assuming that under PA.1 there is no directed fishing for pollock in this region (the exploitation level is quite low, <1 percent or an average annual catch of 1,700 mt from 2003-2007), the expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof Island.

For GOA pollock, the age 2-10+ biomass is expected to increase under this PA.1 from a 2003 low of 799,000 mt to1,263,000 mt by 2007. The average biomass over this period is expected to be 1,052,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels (Table H.4-64 of Appendix H).

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-42 of Appendix H. Under PA.1, projections indicate that EBS pollock spawning biomass will decrease to about 83 percent of the 2002 level by 2007. The projected average for 2003-2007 is 3.07 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Assuming that under PA.1 these regions continue to be managed as bycatch-only, it is expected that the spawning stock size will remain stable or increase in these regions. The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 249,000 mt by 2007 under PA.1. This is above the estimated B_{MSY} level, with an annual average spawning biomass of 193,000 mt from 2003-2007. Model projections of future levels are shown in Table H.4-64 of Appendix H.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase to an average 0.230 for the period 2003-2007. These values are below the $F_{35\%}$ level of 0.448 and the $F_{40\%}$ level of 0.342, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. This pattern in fishing mortality is due to the fact that the projected catch is expected to come closer to the actual ABC in future years (Table H.4-42 of Appendix H). Fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than one percent under PA.1 for as long as these areas are managed as bycatch only regions. Average catch in the Aleutian Islands regions from 2003-2007 is estimated at 1,700 mt (Table H.4-43 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.107 in 2003 followed by increases to 0.164 by 2007. The SPR rate in 2002 is estimated at 55 percent and averages about 63 percent for the period 2003-2007 (Table H.4-64 of Appendix H). Under PA.1, harvest control rules reduce the TAC and subsequently reduce the ABC values due to uncertainty in GOA pollock stock biomass information.

Spatial/Temporal Concentration of Fishing Mortality

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (Jan 20-March). Under FMP PA.1, an average of 1.41 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial and temporal allocations as presented in Section 3.5.1.1. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period for as long as pollock are managed as a bycatch-only fishery. EBS pollock fisheries may be limited somewhat by Pacific halibut PSC limits and bycatch hotspot areas. PSC limits for Pacific halibut are expected to decrease by 0 to 10 percent in the BSAI under PA.1. These measures may contribute to the spatial/temporal concentration of the fishery, although it is unlikely to be significant.

In the GOA pollock fishery, in a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.1. Under PA.1, an average of 69,300 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 108,300 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery will likely change from the 2002 pattern. The effect of these changes is unknown. The GOA pollock fishery may be limited by Pacific halibut bycatch hotspot areas; however, the effects on the spatial and temporal characteristics of the stock due to this measure should not vary from the baseline.

Status Determination

Under PA.1, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years. Under PA.1, the BSAI target fish OY is specified between 1.4 and 2.0 million mt (same as FMP 1 and FMP 3.1). If the sum of the TAC is greater than 2.0 million mt, then the TAC will be adjusted down. This may reduce the EBS pollock TAC, and subsequently the ABC values in future years.

For PA.1, GOA pollock spawning biomass is below the B_{MSY} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007. As mentioned above, harvest control rules implemented under PA.1 reduce the TAC, ABC and OFL values for GOA pollock due to uncertainty in biomass estimates.

Age and Size Composition

Under PA.1, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.52 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.09 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under PA.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.1.

Current closure areas would remain under this preferred alternative bookend, including the eastern GOA trawl closure and the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important pollock habitat.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under PA.1 (for the period 2003-2007).

A direct fishery for forage fish would continue to be banned under PA.1, and the $B_{20\%}$ rule would remain since pollock is an important prey species for many members of the BSAI and GOA ecosystem.

See Table 4.9-1 for a summary of the direct/indirect effects on EBS, Aleutian Islands and GOA pollock.

Cumulative Effects of PA.1 – EBS and Aleutian Islands pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS and Aleutian Islands pollock stock is insignificant under PA.1 (see Section 4.9.1.1 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the EBS pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the EBS pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Removals of pollock occur in the Russian pollock fishery, and the catch is not accounted for in the annual harvest rates set for the US fishery. Therefore, the removals can be considered a potentially adverse effect on fishing mortality. Catch and bycatch of pollock in the State of Alaska pollock fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is also identified as having a reasonably foreseeable potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not considered contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of EBS and Aleutian Islands pollock, but the effects are judged to be insignificant. Pollock are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

<u>Change in Biomass</u>

- **Direct/Indirect Effects.** Change in biomass of the EBS and Aleutian Islands pollock stock is expected to be insignificant under PA.1 (see direct/indirect effects discussion in this section).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to removals in the Russian and State of Alaska pollock fisheries. However, the effects of any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potentially adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not considered contributors to pollock mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under PA.1, however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
   – Change in Genetic Structure of Population
   – Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see Section 4.9.1.1 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had a beneficial effect on pollock recruitment by reducing the adult pollock biomass, lingering beneficial effects are identified for change in reproductive success. In addition, past commercial whaling and sealing also removed large predators of pollock adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to climate changes and regime shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** The Russian and State of Alaska pollock fisheries have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. On the other hand, removals in these fisheries, with the exception of the herring fishery, could have a potentially beneficial effect on pollock recruitment by reducing the adult pollock biomass. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible under PA.1 for spatial and temporal concentration; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see the direct/indirect effects above). However, it is determined that PA.1 would have an insignificant effect on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of pollock prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects**. Future external effects of climate changes and regime shifts on pollock prey species could have potentially beneficial or potentially adverse effects. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-1 are determined to be potentially adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under PA.1; however, the effects are insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that PA.1 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects identified for EBS and Aleutian Islands pollock stock include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.1). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the EBS and Aleutian Islands. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the Russian and State of Alaska fisheries, since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the EBS and Aleutian Islands pollock stocks could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, their significance on the EBS and Aleutian Islands pollock stocks is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-1 for a summary of the cumulative effects on EBS and Aleutian Islands pollock under PA.1.

GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under PA.1 (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, State, and bait fisheries are not expected for the GOA pollock stock. While large removals of pollock did occur in the past, there does not appear to be a lingering effect on the GOA pollock populations (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Catch and bycatch of pollock in the State of Alaska pollock fisheries, and State of Alaska shrimp fisheries are not considered to be contributors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not identified as being contributors to pollock mortality.

- **Cumulative Effects.** Cumulative effects are identified for mortality of GOA pollock, but the effects are judged to be insignificant for PA.1. Pollock are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under PA.1 (see the direct/indirect effects discussion).

- **Persistent Past Effects.** While past large removals of pollock and other past effects on biomass have been identified (see Section 3.5.1.1), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects**. Future external effects on biomass are indicated due to removals in the State of Alaska pollock fisheries. However, any future removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a potentially adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not considered contributors to pollock mortality, therefore would not directly affect biomass.

- **Cumulative Effects**. Cumulative effects for change in biomass are identified, and are considered insignificant. The combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** As the density and quotas of pollock change during the modeled period, the concentration of the pollock fishery will change from the 2002 pattern; it is not possible to predict exactly how the pattern will change. However, for GOA pollock under PA.1, the stock is expected to be above MSST for the years 2003-2007 (see the direct/indirect effects discussion). Therefore, impacts of the spatial and temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** State of Alaska pollock fisheries and the State of Alaska shrimp fishery are identified as potential adverse contributors. However, these fisheries are unlikely to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration under PA.1, and are considered insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see the direct/indirect effects section above). However, it is determined that PA.1 would have insignificant effects on pollock prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign, state, and domestic fisheries catch and bycatch of pollock prey species, and the effects of EVOS on these species, are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on pollock prey species (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** As described for EBS and Aleutian Islands pollock, climate changes and regime shifts could have potentially adverse or beneficial effects on pollock prey species. Marine pollution has been identified as a reasonably foreseeable external contributing factor. The other fisheries shown on Table 4.5-2 are determined to be potentially adverse contributors since bycatch and catch of forage species is likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability and are considered insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.1, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that PA.1 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stock include past foreign, JV, State, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.1). Intense bottom trawling for pollock in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska pollock and shrimp fisheries, since any of these may impact bottom habitat through use of fishing gear. Impacts on habitat from climate changes and regime shifts on the GOA pollock stock would be either beneficial or adverse as described for EBS and Aleutian Islands pollock. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under PA.1; however, the effects on the GOA pollock stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-2 for a summary of the cumulative effects on GOA pollock under PA.1.

Direct/Indirect Effects of PA.2

Total Biomass

Total biomass (ages 1 through 15+) of EBS pollock at the start of 2002 is estimated to be 12.97 million mt. Model projections of future total EBS pollock biomass are shown in Table H.4-42 of Appendix H. Under PA.2, model projections indicate that EBS pollock biomass is expected to decrease to a value of about 11.26 million mt in 2005, then stabilize to about 11.56 million mt. The 2003-2007 average total biomass is estimated at 11.44 million mt.

In the Aleutian Islands region, the assessments are based trawl surveys that occur every other year. The most recent assessment indicates a biomass level of 175,000 mt. Assuming that there is no directed fishing for pollock in this region (the exploitation level is quite low, <1 percent), the expectation is that the stock will remain stable or increase in the future. A similar pattern is expected for the Bogoslof Island.

For GOA pollock, the age 2-10+ biomass is expected to increase under PA.2 from a 2003 low of 799,000 mt to 1,275,000 mt by 2007. The average biomass over this period is expected to be 1,057,000 mt. This increase is anticipated primarily because recruitment is expected to improve from the recent series of relatively low levels (Table H.4-64 of Appendix H).

Spawning Biomass

Female spawning biomass of EBS pollock in 2002 is estimated to be about 3.68 million mt. Model projections of future levels are shown in Table H.4-42 of Appendix H. Under PA.2, projections indicate that EBS pollock spawning biomass will decrease to about 2.91 million mt by 2007. The projected average for 2003-2007 is 3.03 million mt.

In the Aleutian Islands region, spawning biomass is monitored by biannual trawl surveys. In the Bogoslof Island region, spawning stock is monitored by echo-integration trawl surveys. Under PA.2 these areas are expected to be managed at bycatch-only levels, thus, we expect the spawning stock size to remain stable or increase in these regions.

The 2002 GOA female spawning biomass is estimated at about 136,000 mt and is anticipated to increase steadily to 254,000 mt by 2007 under PA.2. This is above the estimated B_{MSY} level, with an average annual spawning biomass of 194,700 mt from 2003-2007. Model projections of future levels are shown in Table H.4-64 of Appendix H. Under PA.2, the methods and tools used to collect the biological information necessary to determine spawning stock biomass estimates would be improved. This would reduce uncertainty in stock estimates, and could subsequently induce changes in catch limits, especially for the GOA pollock stock.

Fishing Mortality

The estimated fishing mortality for the EBS pollock stock in 2002 is 0.187. Model projections show this fishing mortality will increase to an average 0.239 for the period 2003-2007. These values are below the $F_{35\%}$ level of 0.448 and the $F_{40\%}$ level of 0.342, which are taken as proxies for F_{ABC} and F_{OFL}, respectively. This pattern in fishing mortality is due to the fact that the projected catch is expected to come closer to the actual ABC in future years. The proportion of SPR conserved under these mortality rates is 50 percent in 2003, decreasing to 48 percent by 2007; the average implied SPR rate of fishing from 2003-2007 is 48 percent (Table H.4-42 of Appendix H). Under PA.2, pollock are maintained at bycatch-only status, thus the fishing mortality for the Bogoslof and Aleutian Islands region is expected to remain at less than 1 percent (Table H.4-43 of Appendix H).

For the GOA, fishing mortality in 2002 is estimated at 0.174 with projections suggesting a decrease to 0.101 in 2003 followed by increases to 0.142 by 2007. The values for $F_{35\%}$ and $F_{40\%}$ are 0.350 and 0.294, respectively. The SPR rate in 2002 is estimated at 55 percent and averages about 65 percent for the period 2003-2007. This fishing mortality rate pattern is due to the fact that under this bookend, the F_{ABC} is adjusted while the spawning stock is below $B_{40\%}$ (Table H.4-64 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The harvest of EBS pollock occurs largely along the western edge of the EBS shelf during the summer and around the southern areas east of 170°W during the winter season (Jan 20-March). Under PA.2, an average of 1.44 million mt of EBS pollock is projected to be harvested annually from 2003-2007 with spatial and temporal allocations as presented in Section 3.5.1.1. The Bogoslof and Aleutian Island concentration of fishing mortality is anticipated to remain unchanged over this projection period (with an annual average catch of 1,444 mt from 2003-2007). The EBS pollock pelagic trawl fishery may be limited by Pacific halibut PSC limits which are projected to be reduced by 0 to 20 percent in the BSAI under PA.2. Inseason bycatch closures will be reevaluated under this preferred alternative analysis, and has the potential to further restrict the pollock fishery from areas where Pacific halibut bycatch is high.

In the GOA pollock fishery, a broad variety of locales and regional quotas are allocated by season as presented in Section 3.5.1.1. Under PA.2, an average of 64,035 mt of GOA pollock is projected to be harvested annually during 2003-2007 with the largest catch expected to be 96,353 mt in 2007. As the density and quotas of pollock change during this period, the concentration of the pollock fishery will likely change from the 2002 pattern. The effect of these changes is unknown. The GOA pollock fishery may be limited by Pacific halibut PSC limits which are projected to be reduced by 0-10 percent in the GOA under PA.2. Inseason bycatch closures will be developed in the GOA under this preferred alternative analysis, and have the potential to further restrict the pollock fishery from areas where Pacific halibut bycatch is high.

Status Determination

Under PA.2, the ABC is set at a lower level than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of EBS pollock are below the ABC and OFL levels in all years. The EBS pollock are above their respective MSST in the year 2002 and in all subsequent projection years.

For PA.2, GOA pollock spawning biomass is below the B_{MSY} (taken as $B_{35\%}$) in 2002 and remains below this level until 2007. However, based on 10-year status determinations projections, the stock is above the MSST for all years 2003-2007.

Under PA.2, the calculation of OY caps would be determined based on their relevance to current environmental conditions and knowledge of current stock levels. Procedures to account for the uncertainty in estimating ABC for EBS and GOA pollock under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. These changes may increase or reduce catch limits for EBS and GOA pollock in the future. TAC values must be set at levels equal to or less than the ABC for all target species under PA.2.

Age and Size Composition

Under PA.2, the mean age of the EBS pollock stock at the end of 2007, as computed in model projections, is 2.51 years. This compares with a mean age in an equilibrium unfished stock of 3.16 years. For GOA pollock the 2007 value is 3.13 years compared with an unfished estimate of 3.60 years (note that the GOA pollock assessment is modeled from age 2-10+ while the EBS pollock is modeled from age 1-15+).

Sex Ratio

In the models, the sex ratio of GOA and BSAI pollock is assumed to be 50:50. However, observer data and information from surveys are routinely collected and used to monitor the sex ratios of these stocks. Based on these data, it is unlikely that the sex ratio will be affected under PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.2.

Under PA.2, NPFMC and NOAA Fisheries would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands and GOA as MPAs and no-take reserves across a range of different habitat types (similar to FMP 3.2). Existing closures would be reviewed to see if areas may qualify for MPAs under established criteria. Existing areas may be redefined as gear- or fishery-specific. EFH and HAPC designation would continue under PA.2, as would investigations as to whether fishing has adverse impacts on habitats; mitigation measures would be implemented as necessary. An Aleutian Islands management area would be established under PA.2 to protect coral and live bottom habitats. The 2002 Steller sea lion closures and Aleutian Islands critical habitat designations would be reviewed and modified as suggested by new scientific information. Pollock bottom trawling would be prohibited in the BSAI and GOA under PA.2. Please see the FMP 3.2 map (Figure 4.2-5) described in Section 4.2 for more information. All of these measures may reduce the adverse impacts of fishing gear on important pollock habitat.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. An evaluation of potential trophic interactions is presented in Section 3.10. It seems unlikely that significant qualitative changes in predator-prey interactions would be a result of actions taken under PA.2 (for the period 2003-2007). Forage fish commercial fisheries would continue to be banned under PA.2.

Please see Table 4.9-1 for a summary of the direct/indirect effects on EBS, Aleutian Islands and GOA pollock.

Cumulative Effects of PA.2 – EBS and Aleutian Islands Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the EBS and Aleutian Islands pollock stock is insignificant under PA.2 (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on EBS and Aleutian Islands pollock mortality are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on EBS and Aleutian Islands pollock mortality are the same as those considered under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for mortality of EBS and Aleutian Islands pollock, but the effects are judged to be insignificant. Pollock are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the EBS and Aleutian Islands pollock stock is expected to be insignificant under the PA.2 (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the EBS and Aleutian Islands pollock change in biomass level are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on EBS and Aleutian Islands pollock change in biomass level are the same as those considered under PA.1.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under PA.2; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects**. The spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects under PA.2 are identical to those described for PA.1 and include lingering beneficial effects on reproductive success.

- **Reasonably Foreseeable Future External Effects.** Future external effects under PA.2 are the same as those described for the spatial and temporal characteristics of EBS and Aleutian Islands pollock under PA.1.

- **Cumulative Effects**. Cumulative effects are possible for the spatial/temporal concentration; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that PA.2 would have an insignificant effect on pollock prey availability.

- **Persistent Past Effects.** Past effects on EBS and Aleutian Islands prey availability are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on EBS and Aleutian Islands prey availability are the same as those considered under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under PA.2; however, the effects are insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under the PA..2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, as described in the direct/indirect effects section, PA.2 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects**. Past effects identified for EBS and Aleutian Islands habitat suitability are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on EBS and Aleutian Islands habitat suitability are the same as those indicated under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under PA.2; however, their significance on the EBS and Aleutian Islands pollock stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-1 for a summary of the cumulative effects on EBS and Aleutian Islands pollock under PA.2.

GOA Pollock

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA pollock stock is insignificant under PA.2 (see Section 4.9.1.1 direct/indirect effects discussion).

- **Persistent Past Effects**. Past effects identified for GOA pollock mortality are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects**. Future external effects on GOA pollock mortality are the same as those considered under PA.1.

- **Cumulative Effects**. Cumulative effects are identified for mortality of GOA pollock, but the effects are judged to be insignificant under PA.2. Pollock are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA pollock stock is expected to be insignificant under PA.2 (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the GOA change in biomass are identical to those discussed under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on GOA pollock change in biomass are the same as those considered under PA.1.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified and are considered insignificant. The combination of internal and external factors is not expected to sufficiently reduce the pollock biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Spatial/Temporal Concentration of Catch</u>
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** For GOA pollock, the stock is expected to be above MSST for the years 2003-2007 (see direct/indirect effects discussion). Therefore, impacts of the spatial and temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of pollock and other past effects (see Section 3.5.1.1) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.1).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of GOA pollock are the same as those described under PA.1.

- **Cumulative Effects.** Cumulative effects are possible for spatial/temporal concentration and are considered insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see the direct/indirect effects discussion). However, it is determined that PA.2 would have an insignificant effect on pollock prey availability.

- **Persistent Past Effects.** Past effects identified for the change in prey availability of GOA pollock are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the change in prey availability of GOA pollock are the same as those considered under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under PA.2 and are considered insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the pollock stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.2, as with prey-mediated impacts, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that PA.2 would have insignificant effects on pollock habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA pollock stock are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for the change in habitat suitability of GOA pollock are the same as those considered under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, their significance on the GOA pollock stock is considered insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the pollock stock to sustain itself at or above MSST is jeopardized.

Refer to Table 4.5-2 for a summary of the cumulative effects on GOA pollock under PA.2.

4.9.1.2 Pacific Cod

This section provides the direct, indirect and cumulative effects analysis for BSAI and GOA Pacific cod for each of the bookends under the preferred alternative.

Direct/Indirect Effects of PA.1

<u>Total Biomass</u>

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-44 of Appendix H. Under PA.1, model projections indicate that total BSAI Pacific cod biomass is expected to increase steadily to a value of 2,125,000 mt in 2007, with a 2003-2007 average value of 2,089,000 mt. These values for BSAI Pacific cod total biomass are nearly identical to those predicted under FMP 3.1.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA Pacific cod biomasses are shown in Table H.4-65 of Appendix H. Under PA.1, model projections indicate that total GOA Pacific cod biomass is expected to increase steadily to a value of 675,000 mt in 2007, with a 2003-2007 average value of 622,000 mt. These values for GOA Pacific cod total biomass are nearly identical those predicted under FMP 3.1.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI Pacific cod spawning biomasses are shown in Table H.4-44 of Appendix H. Under PA.1, model projections indicate that BSAI Pacific cod spawning biomass is expected to decrease to a value of 403,000 mt in 2003, then increase to a value of 447,300 mt in 2006, then decrease to a value of 445,300 mt in 2007, with a 2003-2007 average value of 431,600 mt. Projected spawning biomass never dips below the B_{MSY} proxy value for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-65 of Appendix H. Under PA.1, model projections indicate that GOA spawning biomass is expected to decrease to a value of 79,100 mt in 2005, then increase to a value of 85,700 mt in 2007, with a 2003-2007 average value of 83,100 mt. Projected spawning biomass never dips below the B_{MSY} proxy value for the years 2003-2007.

Under PA.1, the harvest control rules used to set catch limits will be modified to reduce the TAC, and subsequently the ABC values for BSAI and GOA Pacific cod in an effort to maintain a spawning stock biomass with the potential to produce sustained yields on a continuing basis. The harvest control rules will be modified for GOA pollock and BSAI and GOA Pacific cod under this preferred alternative bookend due to the uncertainty associated with the biomass estimates.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-44 of Appendix H. Under PA.1, model projections indicate that BSAI fishing mortality will increase to a value of 0.284 in 2003, then decrease to a value of 0.266 in 2005, then increase to a value of 0.270 in 2006, then decrease to a value of 0.265 in 2007, with a 2003-2007 average of 0.272. These values are well below the F_{MSY} proxy value (the rate associated with the overfishing level for stocks above $B_{40\%}$).

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-65 of Appendix H. Under PA.1, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.324 in 2003, then decrease to a value of 0.289 in 2005, then increase to a value of 0.312 in 2007, with a 2003-2007 average of 0.304. These values are well below the F_{MSY} proxy value; the rate associated with the overfishing level for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

Current area closures would remain under PA.1, thus the spatial characteristics of the Pacific cod fishery are unlikely to change substantially. BSAI Pacific cod catch limits would continue to be allocated by gear. Catches of Pacific cod are projected to increase in both the BSAI and GOA. Under PA.1, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality; 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

BSAI Pacific cod fisheries may be limited by Pacific halibut PSC limits which are projected to be reduced by 0-10 percent in the BSAI under PA.1.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective overfishing levels in all years under PA.1. The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007 (Tables H.4-44 and H.4-65 of Appendix H).

Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI and between 116,000 and 800,000 mt in the GOA. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI Pacific cod under this preferred alternative bookend (same as FMP 1 and FMP 3.1). As mentioned above, the TAC for BSAI and GOA Pacific cod will also be reduced through modification of the harvest control rules due to uncertainty in the biomass estimates. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Age and Size Composition

Under PA.1, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.78 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.20 years.

Under PA.1, the projected mean age of the GOA Pacific cod stock in 2008 is 2.75 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.19 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative bookend.

Current closure areas would remain under this preferred alternative bookend, including the eastern GOA trawl closure and the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important Pacific cod habitat.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 on Pacific cod would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under this bookend.

A direct fishery for forage fish would continue to be banned under PA.1, and the $B_{20\%}$ rule would remain since Pacific cod (juvenile Pacific cod) is an important prey species for many members of the BSAI and GOA ecosystem.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 on BSAI and GOA Pacific cod.

Cumulative Effects of PA.1 – BSAI Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stock is insignificant under the PA.1 (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the BSAI stock. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery and subsistence/personal use fishery in the BSAI, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not considered contributors to Pacific cod mortality.

- **Cumulative Effects.** Cumulative effects under PA.1 are identified for mortality of BSAI Pacific cod, but the effects are judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stocks is expected to be insignificant under PA.1 (see the Pacific cod PA.1 direct/indirect effects discussion).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery in the BSAI. However, these removals are not expected to affect the ability of the stock to maintain maximum stock size. Marine pollution is identified as having a reasonably foreseeable potentially adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not considered contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under PA.1; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to Climate Changes and Regime Shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, and subsistence use in the BSAI have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** Cumulative effects are possible for the spatial/temporal concentration under PA.1; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify (see direct/indirect effects discussion). However, it is determined that the PA.1 would have insignificant effects on Pacific cod prey availability.

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects**. Future external effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse since a strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-3 are determined to be potentially adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effects are insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, the effect is rated as insignificant (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod stocks include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the BSAI. It is possible that some of these areas have not recovered (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described above for prey availability, impacts on habitat from climate changes and regime shifts on the BSAI Pacific cod stocks could be either beneficial or adverse depending on water temperatures. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects**. Cumulative effects are identified for habitat suitability under and are considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST and the effect is judged insignificant.

See Table 4.5-3 for a summary of the cumulative effects on BSAI Pacific cod under PA.1.

GOA Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stock is insignificant under PA.1 (see GOA Pacific cod PA.1 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska bait fisheries are identified for the GOA Pacific cod stocks. Additionally, the State of Alaska groundfish fishery contributed to past removals in the GOA. Large removals of Pacific cod did occur in the past and could have a lingering effect on the present-day stock, the biomass of which is below $B_{40\%}$ (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of Pacific cod are predicted to continue in the IPHC longline fishery, State of Alaska crab fishery, subsistence/personal use fishery, and in the State of Alaska groundfish fisheries, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels for pollock and do not add additional fishing mortality. Marine pollution is identified as having a reasonably foreseeable potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not considered contributors to Pacific cod mortality.

- **Cumulative Effects.** A cumulative effect under PA.1 is identified for mortality of GOA Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stocks is expected to be insignificant under the PA.1 (see GOA Pacific cod PA.1 direct/indirect effects discussion).

- **Persistent Past Effects.** While past large removals of Pacific cod and other past effects on biomass have been identified (see Section 3.5.1.2), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to bycatch in the IPHC longline and State of Alaska crab fisheries, and bycatch and removals in the subsistence/personal use fishery and in the State of Alaska groundfish fisheries. However, these removals are not expected to affect the ability of the stock to maintain MSST. Marine pollution is identified as having a reasonably foreseeable potentially adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not considered contributors to Pacific cod mortality, thereby would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified for PA.1; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure since the past large removals of Pacific cod and other past effects (see Section 3.5.1.2) have not had a lingering effect on the ability of the stock to sustain itself above MSST. However, since past fisheries could have had an adverse effect on Pacific cod recruitment particularly in the GOA where the state groundfish fishery is very localized, lingering effects are identified for change in reproductive success. Lingering past effects (either beneficial or adverse depending on the regime) are also identified due to climate changes and regime shifts (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska crab fisheries, subsistence use, and the State of Alaska groundfish fisheries all have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration under PA.1; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.1 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.1 would have insignificant effects on Pacific cod prey availability (see the GOA Pacific cod PA.1 direct/indirect effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of Pacific cod prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific cod prey species (see Section 3.5.1.2).

- **Reasonably Foreseeable Future External Effects.** As described for the Bering Sea, the effects of climate changes and regime shifts on Pacific cod prey species could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a reasonably foreseeable external contributing factor, and the other fisheries shown on Table 4.5-4 are determined to be potential adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability under the PA.1; however, the effects are insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, the effect is rated as insignificant (see the GOA Pacific cod PA.1 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for GOA Pacific cod stocks include past foreign, JV, and domestic fisheries, the state crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.2). Additionally, the State of Alaska groundfish fishery contributed to habitat impacts in the GOA. Past fishing for Pacific cod in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, subsistence, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear as described for the Bering Sea, impacts on habitat from climate changes and regime shifts on GOA Pacific cod stocks could be either beneficial or adverse and marine pollution could be a potential adverse contributing factor.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under PA.1 and are considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the Pacific cod stock such that it is unable to sustain itself at or above MSST and the effect is judged insignificant.

See Table 4.5-4 for a summary of the cumulative effects on GOA Pacific cod under PA.1.

Direct/Indirect Effects of PA.2

Total Biomass

Total (ages 1 through 12+) biomass of BSAI Pacific cod at the start of 2002 is estimated to be 1,933,000 mt. Model projections of future total BSAI biomasses are shown in Table H.4-44 of Appendix H. Under PA.2, model projections indicate that total BSAI biomass is expected to increase steadily to a value of 2,167,000 mt in 2007, with a 2003-2007 average value of 2,113,000 mt.

Total (ages 1 through 12+) biomass of GOA Pacific cod at the start of 2002 is estimated to be 568,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-65 of Appendix H. Under PA.2, model projections indicate that total GOA biomass is expected to increase steadily to a value of 688,000 mt in 2007, with a 2003-2007 average value of 631,000 mt. The GOA Pacific cod total biomass values are nearly identical to those projected for FMP 3.2.

Spawning Biomass

Spawning biomass of female BSAI Pacific cod at the start of 2002 was estimated to be 404,500 mt. Model projections of future BSAI spawning biomasses are shown in Table H.4-44 of Appendix H. Under PA.2, model projections indicate that BSAI spawning biomass is expected to decrease to a value of 403,800 mt in 2003, then increase to a value of 461,500 mt in 2007, with a 2003-2007 average value of 440,900 mt. Projected spawning biomass never dips below the B_{MSY} proxy value for the years 2003-2007.

Spawning biomass of female GOA Pacific cod at the start of 2002 was estimated to be 97,900 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-65 of Appendix H. Under PA.2, model projections indicate that GOA spawning biomass is expected to decrease to a value of 82,400 mt in 2005, then increase to a value of 90,100 mt in 2007, with a 2003-2007 average value of 85,900 mt. Projected spawning biomass never dips below the B_{MSY} proxy value of 79,000 mt for the years 2003-2007. The GOA Pacific cod spawning biomass values are nearly identical as those projected for FMP 3.2.

Fishing Mortality

The fishing mortality rate imposed on the BSAI Pacific cod stock in 2002 was estimated to be 0.228. Model projections of future BSAI fishing mortality rates are shown in Table H.4-44 of Appendix H. Under PA.2, model projections indicate that BSAI fishing mortality will increase to a value of 0.268 in 2003, then decrease to a value of 0.245 in 2005, then increase to a value of 0.252 in 2006 and decrease to a value of 0.250 in 2007, with a 2003-2007 average of 0.254. These values are well below the F_{MSY} proxy value of 0.409, which is the rate associated with the OFL for stocks above $B_{40\%}$.

The fishing mortality rate imposed on the GOA Pacific cod stock in 2002 was estimated to be 0.255. Model projections of future GOA fishing mortality rates are shown in Table H.4-65 of Appendix H. Under PA.2, model projections indicate that GOA fishing mortality is expected to increase to a value of 0.282 in 2003, then decrease to a value of 0.260 in 2005, then increase to a value of 0.281 in 2007, with a 2003-2007 average of 0.271. These values are well below the F_{MSY} proxy value of 0.421, which is the rate associated with the OFL for stocks above $B_{40\%}$.

Spatial/Temporal Concentration of Fishing Mortality

Current closures would remain under PA.2, although these closures would be reviewed to see if some areas may qualify as MPAs. Some areas may also be redesignated as gear- or fishery-specific regions. The BSAI and GOA Pacific cod fisheries may be limited by Pacific halibut PSC limits which are projected to be reduced by 0-20 percent in the BSAI and 0-10 percent in the GOA. Inseason bycatch closures will be reevaluated in the BSAI and developed in the GOA, and has the potential to further restrict the Pacific cod fishery from areas where Pacific halibut bycatch is high.

Under PA.2, catches of Pacific cod are projected to increase in both the BSAI and GOA, meaning that the imposition of Pacific cod fishery closed areas will tend to increase the amount of catch taken from the remaining open areas. Under PA.2, it is likely that fishing for BSAI and GOA Pacific cod would tend, to some extent, to be concentrated in space and time so as to coincide with concentrations of spawning fish. Evaluating the effects of such concentrations of fishing mortality is difficult for two reasons: 1) Such concentrations of fishing mortality have already been in place for many years. Although the stocks currently appear to be healthy despite such concentrations, the absence of a "control" treatment makes it difficult to determine which population characteristics are attributable specifically to the existing spatial/temporal concentrations of fishing mortality. 2) Pacific cod undergo large migrations and a large degree of genetic mixing appears to exist. Compared to a sedentary species with readily identifiable genetic subunits, this means that the effects of spatial/temporal concentrations of fishing effort are probably diluted to some extent, but also that their evaluation involves a larger number of difficult-to-estimate parameters.

Status Determination

Model projections of future catches of BSAI and GOA Pacific cod are below their respective OFLs in all years under PA.2. The BSAI and GOA Pacific cod stocks are projected to be above $B_{35\%}$ and therefore above their respective MSSTs in every year throughout the period 2003-2007 (Tables H.4-44 and H.4-65 of Appendix H).

Under PA.2, OY cap calculations would be revisited to determine their relevancy to current environmental conditions and knowledge of existing stock levels. Procedures to account for the uncertainty in estimating ABC for BSAI and GOA Pacific cod under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. These changes may increase or reduce catch limits for BSAI and GOA Pacific cod in the future. TAC values must be set at levels equal to or less than the ABC for all target species under PA.2.

Age and Size Composition

Under PA.2, the projected mean age of the BSAI Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished BSAI stock of 3.2 years.

Under PA.2, the projected mean age of the GOA Pacific cod stock in 2008 is 2.8 years. This compares with a mean age in the equilibrium unfished GOA stock of 3.2 years.

Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Pacific cod in both the BSAI and GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under PA.2.

Under PA.2, NPFMC and NOAA Fisheries would consider adopting 0-20 percent of the Bering Sea, Aleutian Islands and GOA as MPAs and no-take reserves across a range of different habitat types (similar to FMP 3.2). Existing closures would be reviewed to see if areas may qualify for MPAs under established criteria. Existing areas may be redefined as gear- or fishery-specific. EFH and HAPC designation would continue under PA.2, as would investigations as to whether fishing has adverse impacts on habitats; mitigation measures would be implemented as necessary. An Aleutian Islands management area would be established under PA.2 to protect coral and live bottom habitats. The 2002 Steller sea lion closures and Aleutian Islands critical habitat designations would be reviewed and modified as is called for by new scientific information. Pollock bottom trawling would be prohibited in the BSAI and GOA under PA.2. Please see the FMP 3.2 maps (Figure 4.2-5) described in Section 4.2 for more information. All of these measures may reduce the adverse impacts of fishing gear on important Pacific cod habitat.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.2 on Pacific cod would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under this FMP. Forage fish commercial fisheries would continue to be banned under PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI and GOA Pacific cod under PA.2.

Cumulative Effects of PA.2 – BSAI Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific cod stocks is insignificant under PA.2 (see Section 4.9.1.2 direct/indirect effects discussion).

- **Persistent Past Effects**. Past effects on Pacific cod mortality are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects**. Future external effects on Pacific cod mortality are the same as those described under PA.1.

- **Cumulative Effects**. Cumulative effects under PA.2 are identified for mortality of BSAI Pacific cod, but the effects are judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific cod stocks is expected to be insignificant under PA.2 (see the BSAI Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the BSAI Pacific cod change in biomass are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the BSAI Pacific cod change in biomass are the same as those described under PA.1.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified under PA.2; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.2, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the BSAI Pacific cod population (see the BSAI Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the spatial and temporal characteristics of BSAI Pacific cod are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of BSAI Pacific cod are the same as those indicated under PA.1.

- **Cumulative Effects.** Cumulative effects are possible for the spatial/temporal concentration under PA.2; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.2 would have insignificant effects on Pacific cod prey availability (see the Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the BSAI Pacific cod change in prey availability are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the BSAI Pacific cod change in prey availability are the same as those described under PA.1.

- **Cumulative Effects**. Cumulative effects are identified for prey availability; however, the effects are insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the BSAI Pacific cod stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.2 would have insignificant effects on Pacific cod habitat suitability (see the BSAI Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for BSAI Pacific cod habitat suitability are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for BSAI Pacific cod habitat suitability are the same as those indicated under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability under the PA.2 and are considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the BSAI Pacific cod stock such that it is unable to sustain itself at or above MSST.

See Table 4.5-3 for a summary of the cumulative effects on BSAI Pacific cod under PA.2.

GOA Pacific Cod

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific cod stocks is insignificant under PA.2 (see the GOA Pacific cod direct/indirect effects section).

- **Persistent Past Effects.** Past effects on GOA Pacific cod mortality are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on GOA Pacific cod mortality are the same as those indicated under PA.1.

- **Cumulative Effects.** A cumulative effect under PA.2 is identified for mortality of GOA Pacific cod, but the effect is judged to be insignificant. Pacific cod are fished at less than the OFL and all catch and bycatch are accounted for in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific cod stocks is expected to be insignificant under PA.2 (see the GOA Pacific cod PA.2 direct/indirect effects section).

- **Persistent Past Effects.** Past effects on the GOA Pacific cod change in biomass are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the GOA Pacific cod change in biomass are the same as those indicated under PA.1.

- **Cumulative Effects**. A cumulative effect for the GOA Pacific cod change in biomass is identified for the FMP; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Pacific cod biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.2, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the spatial and temporal characteristics of GOA Pacific cod are the identical to those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of GOA Pacific cod are the identical to those described under PA.1.

- **Cumulative Effects**. A cumulative effect is possible for the spatial/temporal concentration under PA.2; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the GOA Pacific cod population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.2 would have insignificant effects on Pacific cod prey availability (see the GOA Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on GOA Pacific cod prey availability are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on GOA Pacific cod prey availability are the same as those indicated under PA.1.

- **Cumulative Effects**. Cumulative effects are identified for prey availability under PA.2; however, they are insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the GOA Pacific cod stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.2 would have insignificant effects on GOA Pacific cod habitat suitability (see the GOA Pacific cod PA.2 direct/indirect effects discussion).

- **Persistent Past Effects**. Past effects on GOA Pacific cod habitat suitability are the same as those considered under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on GOA Pacific cod habitat suitability are the same as those considered under PA.1.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability under PA.2 and is considered insignificant. The combination of internal and external impacts on habitat is not expected to jeopardize the GOA Pacific cod stock such that it is unable to sustain itself at or above MSST.

See Table 4.5-4 for a summary of the cumulative effects on GOA Pacific cod under PA.2.

4.9.1.3 Sablefish

This section provides the direct, indirect and cumulative effects analysis for sablefish for each of the bookends under the preferred alternative. Sablefish are managed as one stock in the BSAI and GOA; therefore, BSAI and GOA areas are discussed together in this section. For further information regarding persistent past effects listed below in the text and in the table (see Section 3.5.1.3).

Direct/Indirect Effects of PA.1 and PA.2

<u>Catch/ABC</u>

PA.1 is projected to have an insignificant impact on average sablefish yield compared to the baseline. Similar yields are projected because PA.1 assumptions mostly replicate baseline conditions.

PA.2 is projected to significantly decrease sablefish yield compared to the baseline. Similar to FMP 3.2, PA.2 applies a risk-averse adjustment to F_{ABC}. The amount of adjustment is affected by recruitment variability and uncertainty in abundance estimation. Sablefish abundance is estimated with reasonable certainty, but recruitment is highly variable, so that the adjustment is substantial. As a result, projected yield is significantly reduced for PA.2 (Tables H.4-52 and H.4-71 of Appendix H).

<u>Total Biomass</u>

PA.1 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. Total biomass increases from 2002-2007 under PA.1 because long-term average recruitment (1977-present) is used to project biomass and is higher than most recent recruitments (Tables H.4-52 and H.4-71 of Appendix H).

PA.2 is projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline. Fishing mortality is lower for this alternative compared to baseline, but not enough to significantly increase total biomass (Tables H.4-52 and H.4-71 of Appendix H).

<u>Spawning Biomass</u>

PA.1 is projected to have an insignificant impact on spawning biomass compared to the baseline. PA.1 assumptions mostly replicate baseline conditions. Spawning biomass increases from 2002-2007 under PA.1 because long-term average recruitment (1977-present) is used to project biomass and is higher than recent recruitment (Table H.4-52 of BSAI sablefish and H.4-71 of GOA sablefish found in Appendix H).

PA.2 is projected to have an insignificant impact on spawning biomass compared to the baseline. Fishing mortality is lower for this alternative compared to baseline, but not enough to significantly increase spawning biomass (Table H.4-52 for BSAI sablefish and Table H.4-71 for GOA sablefish found in Appendix H).

Spawning biomass is projected to decrease from 2002-2007 while total biomass is projected to increase during the same interval. Total biomass includes ages 2-30+ while spawning biomass includes ages 6.5-30+ (initial age is average age of first spawning for females) so that spawning biomass trends due to changing recruitment lag total biomass trends. Spawning biomass will likely increase for a longer projection.

Fishing Mortality

Under PA.1 and PA.2, the fishing mortalities imposed on the sablefish stock are well below the F_{MSY} proxy value of 0.14 which is the rate associated with the OFL (Tables H.4-52 and H.4-71 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Sablefish fishing is concentrated along the upper continental slope and deepwater gullies. PA.1 is projected to have an insignificant impact on the spatial/temporal concentration of fishing mortality compared to the baseline. PA.1 closed areas are the same as baseline. Similarly, existing gear and fishing restrictions would remain under PA.1, including the GOA sablefish pot ban. Sablefish catch limits will continue to be allocated by gear in the BSAI and GOA.

Under PA.2, NPFMC and NOAA Fisheries would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands and GOA as MPAs and no-take reserves across a range of different habitat types (similar to FMP 3.2). Inseason bycatch closures will be reevaluated in the BSAI and developed in the GOA. The proposed closed areas for this alternative may cover some of the areas where the sablefish fishery, both longline and trawl, currently operate, and could thus restrict the fishery to the remaining open areas. Sablefish undergo large migrations (e.g. Heifetz and Fujioka 1991) and substantial genetic mixing is expected for this stock. The degree of spatial and temporal concentration of the fishery is not likely to result in depletion of sub-populations of sablefish if they exist. For this reason, it is not likely that the amount of spatial and temporal concentration of fishing effort would inhibit the stock's ability to remain above the MSST.

Status Determination

Under PA.1, sablefish is not overfished nor approaching an overfished condition. Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI and between 116,000 and 800,000 mt in the GOA. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI sablefish under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Under PA.2, sablefish is not overfished nor approaching an overfished condition. The OY caps would be revisited to determine relevancy to current environmental conditions and our knowledge of current stocks. Procedures to account for the uncertainty in estimating ABC for BSAI and GOA sablefish under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. These changes may increase or reduce catch limits for BSAI and GOA sablefish in the future. TAC values must be set at levels equal to or less than the ABC for all target species under both bookends.

Age and Size Composition

PA.1 and PA.2 are projected to have an insignificant impact on mean age compared to the baseline. The mean ages actually observed in 2008 (as opposed to projections of mean ages) will be driven largely by incoming recruitment strengths during the intervening years.

BSAI mean age likely is overestimated. The model assumes that the lower exploitation rate for the BSAI compared to the GOA will translate into greater mean age for the BSAI. However sablefish migration is substantial enough to erase the effects of differential exploitation rates between the GOA and BSAI. The mean age for the GOA best represents the mean age for the BSAI/GOA because sablefish abundance is much greater for the GOA.

Sex Ratio

The sex ratio of the adult population is 40 males:60 females, based on sex ratio data collected during sablefish longline surveys. PA.1 and PA.2 probably would have no significant effect on the sex ratio compared to the baseline.

Habitat Suitability

PA.1 would have no significant effect on habitat suitability compared to the baseline because exploitation rates for PA.1 are similar to baseline.

Current closure areas would remain under this preferred alternative bookend, including the eastern GOA trawl closure, the ban on bottom trawling for pollock in the BSAI and the ban on sablefish pot fishing in the GOA. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. These implemented measures may help reduce adverse impacts to important sablefish habitat when overlap occurs.

PA.2 would decrease exploitation rates overall, but could also significantly increase the spatial/temporal concentration of fishing mortality compared to the baseline if sablefish fishery areas are further restricted (similar to FMP 3.2). This could eliminate the local fishing mortality rates on sablefish in the closed areas, but effort also would increase in some areas or times as a result of area closures, thus concentrating the fishery at certain fishing locations and increasing fishing mortality rates on sablefish at these locations. Under PA.2, average catch is projected to decrease by about 1/3 compared to baseline. As long as at least 2/3 of the areas remain open, the remaining catch should not decrease habitat suitability in the open areas and the habitat suitability of closed areas should improve, to the extent that fishing affects habitat suitability.

Existing closures under PA.2 would be reviewed to see if areas may qualify for MPAs under established criteria. Existing areas may be redefined as gear- or fishery-specific. EFH and HAPC designation would continue under PA.2, as would investigations as to whether fishing has adverse impacts on habitats; mitigation measures would be implemented as necessary. An Aleutian Islands management area would be established under PA.2 to protect coral and live bottom habitats. The 2002 Steller sea lion closures and Aleutian Islands critical habitat designations would be reviewed and modified as is called for by new scientific information. Pollock bottom trawling would be prohibited in the BSAI and GOA under PA.2.

Please see the FMP 3.2 map (Figure 4.2-5) described in Section 4.2 for more information. All of these measures may reduce the adverse impacts of fishing gear on important sablefish habitat where overlap occurs.

Predator-Prey Relationships

PA.1 and PA.2 are projected to have an insignificant impact on total biomass (age 2-31+) compared to the baseline, so PA.1 and PA.2 should have an insignificant effect on the amount of sablefish biomass available to the ecosystem and the amount of predation due to sablefish (Table 4.9-1). A directed forage fish fishery would continue to be banned under each of these bookends.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the sablefish stock is insignificant under PA.1 and PA.2 (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, domestic, and State of Alaska groundfish fisheries are identified for sablefish. Large removals of sablefish occurred, particularly in the JV and domestic fisheries. Catches that were under reported during the late 1980s may have contributed to abundance declines in the 1990s (see Section 3.5.1.3).

- **Reasonably Foreseeable Future External Effects.** While bycatch and removals of sablefish are predicted to continue in the IPHC longline fishery, and State of Alaska groundfish fishery, these are not expected to be contributing factors to fishing mortality in the cumulative case. Removals in these fisheries are accounted for when setting annual harvest levels and do not add additional fishing mortality. Due the highly migratory nature of sablefish, Canadian fisheries fishing within Canadian waters could be harvesting sablefish considered to be part of the GOA population. These removals are not accounted for in the TAC setting process and can be considered as having a potentially adverse contribution to the cumulative case. Likewise, marine pollution is identified as having a reasonably foreseeable, potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not considered contributors to direct sablefish mortality.

- **Cumulative Effects.** Cumulative effects under PA.1 and PA.2 are identified for mortality of sablefish, but the effects are judged to be insignificant. Sablefish are fished at less than the OFL and all catch and bycatch are accounted for (with the exception of any fish taken in Canadian waters) in the management of the stock. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the sablefish stock is expected to be insignificant under PA.1 and PA.2 (see direct/indirect effects discussion).

- **Persistent Past Effects.** While past large removals of sablefish and other past effects on biomass have been identified (see Section 3.5.1.3), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Future external effects on biomass are indicated due to catch and bycatch in the IPHC longline and State of Alaska groundfish fisheries, and in the Canadian fisheries. Marine pollution is identified as having a reasonably foreseeable, potentially adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not considered contributors to sablefish mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** Cumulative effects for change in biomass are identified; however, the effects are insignificant since the combination of internal and external factors is not expected to sufficiently reduce the sablefish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the spatial and temporal distribution of catch should have an insignificant effect on the genetic structure and reproductive success of the population (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure or reproductive success. While spatial/temporal concentration of catch occurred in the state directed sablefish fisheries, there are no lingering effects due to the migratory nature of the fish (see Section 3.5.1.3).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline and State of Alaska groundfish fisheries, and Canadian fisheries all have the potential to cause adverse effects. However, the removals are not expected to be sufficiently concentrated to alter the genetic structure of the population or affect recruitment. Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, it is determined that PA.1 and PA.2 would have insignificant effects on sablefish prey availability (see the direct/indirect effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic and state fisheries catch and bycatch of sablefish prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on sablefish prey species (see Section 3.5.1.3).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on sablefish prey species could be either beneficial or adverse since strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Likewise, a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Section 3.5.1.3). Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The other fisheries shown on Table 4.5-5 are determined to be potentially adverse contributors since catch and bycatch of prey species are likely to continue.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effects are insignificant since the combination of internal and external removals of prey is not expected to decrease prey availability such that the sablefish stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, any habitat-mediated impacts would be governed by a complex web of direct and indirect interactions which are difficult to quantify. PA.1 is not expected to impact habitat compared to baseline. Therefore, it is determined that PA.1 and PA.2 would have insignificant effects on sablefish habitat suitability (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for sablefish include past foreign, JV, and domestic fisheries, the State of Alaska crab and bait fisheries, IPHC longline, and climate changes and regime shifts (see Section 3.5.1.3). Past fishing for sablefish in the past fisheries likely disrupted habitat in areas of the GOA and possibly the BSAI. It is possible that some of these areas have not recovered (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Future external effects are possible from the State of Alaska fisheries, and the IPHC fishery since any of these may impact bottom habitat through use of fishing gear. As described above for prey availability, impacts on habitat from climate changes and regime shifts on the sablefish stock could be either beneficial or adverse depending on water temperature. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, the effects on the sablefish stock are insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the sablefish stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-5 for a summary of the cumulative effects on BSAI and GOA sablefish under PA.1.

4.9.1.4 Atka Mackerel

This section provides the direct, indirect and cumulative effects analysis for Aleutian Islands and GOA Atka mackerel for each of the bookends under the preferred alternative. For further information regarding persistent past effects listed below in the text and in the tables see Section 3.5.1.4.

External effects and the resultant cumulative effects associated with PA.1 and PA.2 are depicted on Tables 4.5-6 and 4.5-7. For further information regarding persistent past effects listed below in the text and in the tables see Section 3.5.1.4.

Direct/Indirect Effects of PA.1

Model projections of future Aleutian Islands Atka mackerel catch and biomass levels under PA.1 assume the maximum permissible fishing mortality rate according to Amendment 56 ABC/OFL definitions.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA; therefore, model projections of future biomass levels were not produced.

Catch and Fishing Mortality

The average expected yield for Aleutian Islands Atka mackerel for the period 2003-2007 is 62,700 mt (Table H.4-58 of Appendix H). The catch and ABC values, which are nearly equivalent in the projections, are expected to decrease through 2006. The average fishing mortality imposed on the Aleutian Islands Atka mackerel stock in 2002 is 0.251. Model projections show this value will increase to 0.436 in 2004, then decrease in 2005 and increase to 0.401 in 2007. Overall, the projections show a 60 percent increase in the average fishing mortality from 2002 to 2007. These values are well below the F_{MSY} proxy ($F_{35\%}$) value of 0.564 which is the rate associated with the OFL.

Projections of GOA Atka mackerel under PA.1 indicate that catches will likely average about 350 mt through 2007 (Table H.4-79 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g. Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

Total Biomass

Total (ages 1-15+) biomass of Aleutian Islands Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total Aleutian Islands total biomasses are shown in Table H.4-58 of Appendix H. Under PA.1, model projections indicate that total Aleutian Islands Atka mackerel is expected to decline to a value of 415,000 mt by 2005, then increase to a value of 442,000 mt by 2007, with a 2003-2007 average value of 435,000 mt. Overall, the projections show an 8 percent decrease in total biomass from 2002 to 2007 under PA.1. These values for Aleutian Islands Atka mackerel total biomass are nearly identical to those projected under FMP 3.1.

Spawning Biomass

Spawning biomass of female Aleutian Islands Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future Aleutian Islands spawning biomasses are shown in Table H.4-58 of Appendix H. Under PA.1, model projections indicate that Aleutian Islands spawning biomass is expected to decline to a value of 78,500 mt by 2005, then increase to a value of 88,000 mt by 2007, with a 2003-2007 average value of 88,900 mt. Overall, the projections show about a 26 percent decrease in female spawning biomass from 2002 to 2007 under PA.1. Projected spawning biomass exceeds the proxy B_{MSY} value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007). These values for Aleutian Islands Atka mackerel spawning biomass are nearly identical to those projected under FMP 3.1.

Spatial/Temporal Concentration of Fishing Mortality

Under PA.1, the current network of spatial and temporal closed areas is in place. The closures designated in the Steller sea lion protection measures probably have the largest impact relative to Atka mackerel. The 2002 Steller sea lion closures implemented under PA.1 include no fishing in Seguam Pass, 3 nm no transit zones around rookeries, and trawl and fixed gear closures in nearshore and Steller sea lion critical habitats.

The directed fishery for Atka mackerel is prosecuted by catcher processor bottom trawlers. The patterns of the fishery generally reflect the behavior of the species in that the fishery is highly localized, occurring in the same few locations each year, at depths that typically range between 100 and 200 m. The localized pattern of fishing for Atka mackerel apparently does not affect fishing success from one year to the next since local populations in the Aleutian Islands appear to be replenished by immigration and recruitment. In addition, management measures are in place which have the effect of spreading out the harvest in time and space. The overall Aleutian Islands TAC is allocated to three management areas (western, central, and Bering Sea/eastern Aleutians). The regional TACs are further allocated to two seasons and there are limits to the amount of catch that can be taken inside of Steller sea lion critical habitat. Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, these measures provide protection to Atka mackerel by reducing the risk of localized depletion through effort limitations and reductions. The temporal/spatial concentration of the catch under PA.1 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself about its MSST.

Status Determination

Model projections of future catches of Aleutian Islands Atka mackerel are below the OFL in all years under PA.1 (Table H.4-58 of Appendix H). Female spawning biomass in each of the projection years (2003-2007), is above $B_{35\%}$ (B_{MSY} proxy), thus the Aleutian Islands Atka mackerel stock is not overfished and is determined to be above its MSST under PA.1.

GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI and between 116,000 and 800,000 mt in the GOA. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for Aleutian Islands Atka mackerel under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Age and Size Composition

Under PA.1, the mean age of Aleutian Islands Atka mackerel in 2007, as computed in model projections, is 2.73 years. This compares with a mean age in the equilibrium unfished Aleutian Islands stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term, however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level; therefore, it is unlikely that the age and size compositions would change in the future under PA.1. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than due to the effects of fishing.

Sex Ratio

A 50:50 sex ratio is assumed for the Aleutian Islands Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future is unknown.

Habitat Suitability

Because Steller sea lion critical habitat overlaps significantly with Atka mackerel habitat, Steller sea lion protection measures may provide habitat protection for Atka mackerel through effort limitations and reductions. The level of habitat disturbance caused by the fishery under PA.1 does not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Current area closures would remain under PA.1, including the eastern GOA trawl closures. Programs to identify EFH and HAPC would continue and a process for establishing MPAs would be developed.

Predator-Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that PA.1 will not impact prey availability for Aleutian Islands and GOA Atka mackerel. The $B_{20\%}$ rule will remain under PA.1 since Akta mackerel are an important prey species for many members of the Aleutian Islands and GOA ecosystem (same as FMP 1 and FMP 3.1).

See Table 4.9-1 for a summary of the direct/indirect effects on Aleutian Islands and GOA Atka mackerel under PA.1.

Cumulative Effects of PA.1 – Aleutian Islands Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the Aleutian Islands Atka mackerel stock is insignificant under PA.1 (see the direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects of the foreign, JV, and domestic fisheries are not expected for the Aleutian Islands Atka mackerel stock. While large removals of Atka mackerel did occur in the past, there does not appear to be a lingering effect on the Aleutian Islands Atka mackerel populations (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as the only external event that could cause effects on the Aleutian Islands Atka mackerel population. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not considered contributors to Atka mackerel mortality.

- **Cumulative Effects.** Cumulative effects under PA.1 are identified for mortality of Aleutian Islands Atka mackerel, but the effects are judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the Aleutian Islands Atka mackerel stock is expected to be insignificant under PA.1 (see the Atka mackerel PA.1 direct/indirect effects discussion).

- **Persistent Past Effects.** While past large removals of Atka mackerel and other past effects on biomass have been identified (see Section 3.5.1.4), these do not appear to have had a lingering effect on the ability of the stock to sustain itself above the MSST.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a reasonably foreseeable, potentially adverse contribution to change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are not considered contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects**. A cumulative effect for change in biomass is identified; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently reduce the Atka mackerel biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** The temporal/spatial concentration of the catch under PA.1 does not appear to affect the sustainability of the stock either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself about its MSST and the effect is judged insignificant (see the Atka mackerel PA.1 direct/indirect effects section above).

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. Past commercial whaling and sealing removed large predators of Atka mackerel adding to the potential for reproductive success of the stock. Lingering past effects are also identified due to climate changes and regime shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts could have potentially beneficial or potentially adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the effect is insignificant since the combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that PA.1 will have an insignificant effect on prey availability for Aleutian Islands Atka mackerel (see the Atka mackerel PA.1 direct/indirect effects discussion).

- **Persistent Past Effects.** While lingering population level effects from past foreign and domestic fisheries catch and bycatch of Atka mackerel prey species are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Climate changes and regime shifts could have potentially beneficial or potentially adverse effects on Atka mackerel reproductive success. A shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effect is insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the Atka mackerel stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Habitat disturbances caused by the fishery under PA.1 do not appear to affect the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST ,and the effect is judged insignificant (see the Atka mackerel PA.1 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for Aleutian Islands Atka mackerel stocks include past foreign, JV, and domestic fisheries, and climate changes and regime shifts (see Section 3.5.1.4). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the Aleutian Islands. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from the climate changes and regime shifts could be either beneficial or adverse. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability; however, the effect on the Aleutian Islands Atka mackerel stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Atka mackerel stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-6 for a summary of cumulative effects on Aleutian Islands Atka mackerel under PA.1.

GOA Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Atka mackerel stock is unknown under PA.1. The fishing mortality rate and the MSST for GOA Atka mackerel is unknown, thus the effect of fishing mortality is unknown under PA.1.

- **Persistent Past Effects**. Past effects of the past foreign, JV, and domestic, fisheries are likely for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, domestic, JV, and fisheries, have had a lingering effect on the GOA Atka mackerel population that has not yet recovered (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the population is jeopardized. Climate changes and regime shifts are not considered contributors to Atka mackerel mortality.

- **Cumulative Effects.** A cumulative effect under PA.1 is identified for mortality of GOA Atka mackerel, but the significance of the effect is unknown. GOA Atka mackerel are in Tier 6 and their MSST is unknown; therefore a status determination cannot be made.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Atka mackerel stock is unknown PA.1. Current reliable estimates of total and spawning biomass are unknown for GOA Atka mackerel.

- **Persistent Past Effects**. Past effects of the past foreign, JV, and domestic fisheries are identified for the GOA Atka mackerel stock. Large, concentrated removals of Atka mackerel occurred in the foreign, JV, domestic fisheries and are determined to have had a lingering effect on the GOA Atka mackerel population, which has not yet recovered (see Section 3.5.1.4)

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as having a potentially adverse contribution to the change in biomass since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the population is affected. Climate changes and regime shifts are not considered contributors to Atka mackerel mortality, and therefore would not directly affect biomass.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass; however, the significance of the effect is unknown.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the spatial temporal concentration effects are also unknown under PA.1.

- **Persistent Past Effects.** Since the Atka mackerel fishery was highly localized, past foreign, JV, and domestic fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. However, the effect of this change in distribution on genetic structure is unknown. The past highly localized fisheries are found to have had lingering effects on the spatial/temporal distribution of the fish. Also, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Marine pollution could contribute adversely to genetic changes and reduced recruitment since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Also, climate changes and regime shifts are could impact spawning success since a shift toward colder waters favors recruitment and survival of Atka mackerel. Conversely, warmer waters are potentially adverse.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; however, the significance of the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** Due to the low proportion of fish found in the diet of Atka mackerel, it is presumed that PA.1 will not impact prey availability for GOA Atka mackerel and the impact to the prey availability effect is determined to be insignificant.

- **Persistent Past Effects.** While lingering population level effects on the invertebrate prey of Atka mackerel from past foreign, state, and domestic fisheries, and EVOS are not expected, past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Atka mackerel prey species (see Section 3.5.1.4).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Atka mackerel prey species could be either beneficial or adverse depending on the direction of change. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself.

- **Cumulative Effects.** A cumulative effect is identified for prey availability; however, the significant effects are unknown since the direction of external effects is unknown.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As the MSST cannot be estimated for GOA Atka mackerel which are in Tier 6, the significance of the habitat suitability effects are also unknown under PA.1.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA Atka mackerel stocks include past foreign, JV, and domestic fisheries, EVOS, and climate changes and regime shifts (see Section 3.5.1.4). Intense bottom trawling for Atka mackerel in the past fisheries likely disrupted habitat in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts (see Section 3.6 for additional information on the effects of trawling on benthic habitat).

- **Reasonably Foreseeable Future External Effects.** Impacts on habitat from the climate changes and regime shifts on the GOA Atka mackerel could be either favorable or unfavorable depending on the direction of change. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** Cumulative effects are identified for habitat suitability; however, the significance of the effects on the Aleutian Islands Atka mackerel stock are unknown.

See Table 4.5-7 for a summary of the cumulative effects on GOA Atka mackerel under PA.1.

Direct/Indirect Effects of PA.2

Model projections of future Aleutian Islands Atka mackerel catch and biomass levels under PA.2 assume an uncertainty correction applied to the maximum permissible fishing mortality rate according to Amendment 56 ABC/OFL definitions.

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced.

Catch and Fishing Mortality

The average expected yield for Aleutian Islands Atka mackerel for the period 2003-2007 is 52,390 mt. The catch and ABC values (which are nearly equivalent after 2004) are expected to decrease through 2006. The average fishing mortality imposed on the Aleutian Islands Atka mackerel stock in 2002 is 0.251 (Table H.4-58 of Appendix H). Model projections show this value will increase to 0.309 in 2005, then decrease to 0.304 in 2007. Overall, the projections show a 21 percent increase in the average fishing mortality from 2002 to 2007. These values are well below the F_{MSY} proxy ($F_{35\%}$) value, which is the rate associated with the OFL.

Projections of GOA Atka mackerel under PA.2 indicate that catches will likely average a little over 150 mt through 2007 (Table H.4-79 of Appendix H). Annual changes in the GOA Atka mackerel catches reflect shifts in catches of other species which catch Atka mackerel as bycatch (e.g. Pacific ocean perch, pollock, northern rockfish, and Pacific cod).

Total Biomass

Total (ages 1-15+) biomass of Aleutian Islands Atka mackerel at the start of 2002 is estimated to be 480,000 mt. Model projections of future total Aleutian Islands total biomasses are shown in Table H.4-58 of Appendix H. Under PA.2, model projections indicate that total Aleutian Islands Atka mackerel biomass is expected to decline to a value of 451,000 mt by 2004, then increase to a value of 470,000 mt by 2007, with a 2003-2007 average value of 459,000 mt. Overall, the projections show a 2 percent decrease in total biomass from 2002 to 2007 under PA.2. These values for Aleutian Islands Atka mackerel total biomass are nearly identical to those projected for FMP 3.2.

Spawning Biomass

Spawning biomass of female Aleutian Islands Atka mackerel at the start of 2002 is estimated at 118,500 mt. Model projections of future Aleutian Islands spawning biomasses are shown in Table H.4-58 of Appendix H. Under PA.2, model projections indicate that Aleutian Islands spawning biomass is expected to decline to a value of 93,500 mt by 2005, then increase to a value of 100,700 mt by 2007, with a 2003-2007 average value of 101,700 mt. Overall, the projections show a 15 percent decrease in spawning biomass from 2002 to 2007 under PA.2. Projected spawning biomass exceeds the B_{MSY} proxy value ($B_{35\%}$) of 77,800 mt for the projection years (2003-2007). These values for Aleutian Islands Atka mackerel spawning biomass are nearly identical to those projected for FMP 3.2.

Spatial/Temporal Concentration of Fishing Mortality

Under PA.2, NPFMC and NOAA Fisheries would consider establishing 0-20 percent of the Bering Sea, Aleutian Islands and GOA as MPAs and no-take marine reserves across a range of habitat types (similar to FMP 3.2). The spatial closures illustrated in the FMP 3.2 map (Figure 4.2-5, Section 4.2) in the Aleutian Islands under PA.2 would likely impact the directed fishery for Atka mackerel. Based on locations of historical Atka mackerel fishing effort, some catches of Atka mackerel are likely to be displaced under PA.2, but it is assumed that these catches could be taken (at least in the short-term) in the remaining open areas. As such, the temporal/spatial concentration of the catch will likely increase under PA.2. Because Atka mackerel are a patchily distributed fish and the harvest is concentrated in specific locations, there is an increased risk of localized depletion that may occur under this preferred alternative bookend. However, PA.2 is not likely to adversely affect the sustainability of the stock (at least in the short-term) either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST.

Status Determination

Model projections of future catches of Aleutian Islands Atka mackerel are below the OFL in all years under PA.2 (Table H.4-58 of Appendix H). Estimates of female spawning biomass in each of the projection years (2003-2007), are above $B_{35\%}$ (B_{MSY} proxy), thus the Aleutian Islands Atka mackerel stock is not overfished and is determined to be above its MSST under PA.2.

GOA Atka mackerel are in Tier 6 and its MSST is unknown; therefore a status determination cannot be made.

Calculation of the OY caps for the BSAI and GOA would be revisited to determine relevance to current environmental conditions and current stock information. Procedures to account for the uncertainty in estimating ABC for Aleutian Islands and GOA Atka mackerel under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. Programs designed to collect biological information necessary to determine spawning stock biomass estimates would be improved under PA.2, which could affect the catch limits of GOA Atka mackerel, currently a Tier 6 species with no biomass data available. These changes may increase or reduce catch limits for Aleutian Islands and GOA Atka mackerel in the future. TAC values must be set at levels equal to or less than the ABC for all target species under PA.2.

Age and Size Composition

Under PA.2, the mean age of Aleutian Islands Atka mackerel in 2007, as computed in model projections, is 2.85 years. This compares with a mean age in the equilibrium unfished Aleutian Islands stock of 3.82 years. Note that the mean ages and sizes actually observed in 2007 (as opposed to the model projections of mean age in 2007) will be driven largely by the strengths of incoming recruitments during the intervening years. The selectivity of the fishery has cumulative impacts on the age composition due to fishing mortality, and the current composition is also the result of its being a fished population with a greater than 30-year catch history. In the short-term however, the impacts of the current fishing mortality levels on the stock would be overshadowed by the magnitude of incoming year-classes, which in turn are highly dependent on environmental conditions. The cumulative long-term impacts of the fishing mortality rates could cause a shift in the age and size compositions.

The level of catch of GOA Atka mackerel is low and projected to remain at a low level; therefore, it is unlikely that the age and size compositions would change in the future under PA.2. Changes in the age and size compositions of GOA Atka mackerel are more likely driven by variation in recruitment than due to the effects of fishing.

Sex Ratio

A 50:50 sex ratio is assumed for the Aleutian Islands Atka mackerel stock assessment and model projections. It is unknown what the true population sex ratio is, and what change, if any, would occur in the future. The current population sex ratio of GOA Atka mackerel is unknown. The true GOA population sex ratio, and what changes, if any, would occur in the future is unknown.

Habitat Suitability

The spatial closures in the Aleutian Islands under PA.2 could eliminate some Atka mackerel fishery areas while increasing effort in the fewer remaining open areas (similar to FMP 3.2). The level of habitat disturbance would decrease in the closed areas, but increase in the remaining open areas. However, PA.2 is not likely to adversely affect the sustainability of the stock (at least in the short-term) as measured by the ability of the stock to maintain itself above its MSST. The removal of directed fishing in some areas may lead to habitat improvement, but whether this would translate into improved reproductive success is uncertain.

Under PA.2, the 2002 Steller sea lion closures and Aleutian Islands critical habitat designations would be modified as deemed necessary and as new scientific information becomes available. Existing fishery closures would be reviewed to determine if some areas qualify as MPAs; others may be redesignated as fishery- or gear-specific. Programs to identify and designate EFH and HAPC would continue and an Aleutian Islands management area would be established to protect coral and live bottom habitats. All these measures may help protect important Atka mackerel habitat where overlap occurs.

Predator-Prey Relationships

The trophic interactions of Atka mackerel are governed by a complex web of indirect interactions, which are currently difficult to quantify. Under PA.2, elimination of the directed fishery for Atka mackerel in some areas and increased effort in other areas could impact the amount of Atka mackerel available to the ecosystem. In a study conducted by Yang (1996), more than 90 percent of the total stomach contents weight of Atka mackerel in the study was made up of invertebrates, with less than 10 percent made up of fish. Based on the low proportion of fish found in the diet of Atka mackerel, it is presumed that PA.2 will not impact prey availability for Aleutian Islands and GOA Atka mackerel. The $B_{20\%}$ rule will remain under PA.2 since Atka mackerel is an important prey species for many members of the Aleutian Islands and GOA ecosystem.

See Table 4.9-1 for a summary of the direct/indirect effects on Aleutian Islands and GOA Atka mackerel under PA.2.

Cumulative Effects of PA.2 – Aleutian Islands Atka Mackerel

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the Aleutian Islands Atka mackerel stock is insignificant under PA.2 (see the Atka mackerel PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** on Atka mackerel mortality are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on Atka mackerel mortality are the same as those described under PA.1.

- **Cumulative Effects**. A cumulative effect under PA.2 is identified for mortality of Aleutian Islands Atka mackerel, but the effect is judged to be insignificant. Atka mackerel are fished at less than the OFL and are above the MSST. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the Aleutian Islands Atka mackerel stock is expected to be insignificant under PA.2 (see the Atka mackerel PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the change in biomass of Atka mackerel are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass of Atka mackerel are the same as those indicated under PA.1.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified. The effect is determined to be insignificant since the combination of internal and external factors is not likely to decrease the Aleutian Islands Atka mackerel biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** PA.2 is not likely to adversely affect the sustainability of the Aleutian Islands stock (at least in the short-term) either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST and the effect is judged to be insignificant (see the Atka mackerel PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the spatial and temporal characteristics of Aleutian Islands Atka mackerel are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of Atka mackerel are the same as those described under PA.1.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration; the effect is insignificant for change in the genetic structure of the population because there is no evidence of genetic sub-population structure. The cumulative effect on reproductive success is also judged insignificant.

Change in Prey Availability

- **Direct/Indirect Effects.** Any predation-mediated impacts of PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. However, the effect is judged insignificant (see the Atka mackerel PA.2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects on the change in prey availability of Atka mackerel are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of Atka mackerel are the same as those indicated under PA.1.

- **Cumulative Effects.** Cumulative effects are identified for prey availability; however, the effects are insignificant since the combination of internal and external removals of prey species is not expected to decrease prey availability such that the Aleutian Islands Atka mackerel stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The reduction of the fishery under this PA.2 may lead to habitat improvement, but the effect on the stock's ability to maintain itself above its MSST is judged insignificant (see Aleutian Islands Atka mackerel PA. 2 direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for Aleutian Islands Atka mackerel stocks are the same as those indicated under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for Aleutian Islands Atka mackerel stocks are the same as those indicated under PA.1.

- **Cumulative Effects**. A cumulative effect is identified for habitat suitability; however, the effect on the Aleutian Islands Atka mackerel stock is insignificant since the combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Atka mackerel stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-6 for a summary of the cumulative effects on Aleutian Islands Atka mackerel under PA.2.

GOA Atka Mackerel

GOA Atka mackerel are managed in Tier 6 because current estimates of total and spawning biomass are unknown for GOA Atka mackerel. Age structured models were not available for evaluation of impacts for the GOA, therefore model projections of future biomass levels were not produced. Therefore, the direct and indirect effects of the PA.2 are unknown for all categories with the exception of prey availability. In addition, the external effects and cumulative effects are the same as those described above for PA.1 in the GOA. Since all of the internal effects on mortality, biomass, spatial/temporal concentration, and habitat are unknown, the cumulative effects on GOA Atka mackerel are also unknown (see Table 4.5-14).

The internal effects of the PA.2 on change in prey availability is judged insignificant because the main prey items for Atka mackerel are invertebrates. However, the cumulative effect for this category is also judged unknown since the direction of the external effects is unknown.

As part of PA.2, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in Tier designation for GOA Atka mackerel. Procedures to account for uncertainty in estimating ABC would be revised and updated as necessary and ecosystem interactions would be considered when determining catch limits. All these measures may affect the TAC, ABC and OFL values of GOA Atka mackerel in the future under PA.2. Although, as stated above, impacts to Atka mackerel mortality and biomass levels are unknown.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. Inseason bycatch closures will be developed in the GOA under PA.2. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. 2002 SSL closures may also be modified as seen necessary under this preferred alternative bookend. These measures may help reduce adverse impacts to GOA Atka mackerel habitat where overlap occurs; although, as stated above, impacts to Atka mackerel habitat suitability are unknown.

4.9.1.5 Yellowfin Sole and Shallow Water Flatfish

Numerous fishery management actions have been implemented that affect the yellowfin sole fisheries in the BSAI. These actions are described in more detail in Section 3.5.1.5 of this Programmatic SEIS. Yellowfin sole is managed as its own stock under the Aleutian Islands Groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species by the National Standard Guidelines.

Eight flatfish species inhabit shallow waters and are managed in the shallow water flatfish assemblage in the GOA. They include: northern and southern rock sole, yellowfin sole, starry flounder, butter sole, English sole, Alaska plaice and sand sole. Survey results from 2001 indicate that over half of the estimated biomass (54 percent) of this assemblage are northern and southern rock sole. The shallow water group is managed as Tier 4 and Tier 5 species in the GOA (Turnock *et al.* 2001).

External effects associated with the preferred alternative bookends, PA.1 and PA.2, are depicted on Tables 4.5-8 and 4.5-9 for BSAI yellowfin sole and GOA shallow water flatfish, respectively. For further information regarding persistent past effects listed below in the text and in Tables 4.5-8 and 4.5-9, refer to Section 3.5.1.5.

BSAI Yellowfin Sole – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

The total biomass of yellowfin sole at the start of 2002 is estimated to be 1,552,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-45 of Appendix H. Under PA.1, model projections indicate that the total BSAI biomass is expected to decline to 1,520,000 in 2007 with a 2003-2007 average total biomass of 1,532,000 mt. Under PA.2, model projections indicate that the total BSAI biomass is expected to decline to 1,519,000 in 2007 with a 2003-2007 average value is 1,532,000 mt.

Spawning Biomass

Spawning biomass of female yellowfin sole at the start of 2002 is estimated to be 450,700 mt. Model projections of future yellowfin sole spawning biomass estimates are shown in Table H.4-45 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to decline to 408,900 mt by 2007, with a 2003-2007 average value of 433,800 mt. Under PA.2, model projections indicate that female spawning biomass is expected to decline to the 2002 value to 408,600 mt by 2007, with a 2003-2007 average value of 434,000 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 336,900 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the yellowfin sole stock in 2002 is 0.064. Under PA.1, model projections show this value will steadily increase to 0.099 in 2007. Under PA.2, model projections show this value will increase to 0.101 in 2007 with an average value of 0.084 from 2003-2007. These values are well below the F_{MSY} proxy value of 0.138, the rate associated with the OFL (Table H.4-45 of Appendix H). BSAI yellowfin sole may be limited somewhat by Pacific halibut PSC limits which could undergo a reduction between 0 and 10 percent under PA.1 and between 0 and 20 percent under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space (including high Pacific halibut bycatch areas). Existing closures would be retained under PA.1, including existing inseason bycatch closures. As stated above, BSAI yellowfin sole may be limited temporally by Pacific halibut PSC limits.

As part of PA.1, an IR/IU program would be initiated for BSAI yellowfin sole. The IR/IU program is designed to reduce discard waste of BSAI yellowfin sole by allowing the fishing industry to develop new methods for avoiding unwanted bycatch and/or through the development of new markets for the bycatch. This program was previously initiated by NOAA Fisheries on January 1, 2003 (BSAI FMP Amendment 75), but was suspended on February 7, 2003 due to the need for clarification in the regulation. Discards occur mostly in the directed yellowfin sole fishery, and also occur in the Pacific cod, rock sole, flathead sole and other flatfish fisheries (Wilderbuer and Nichol 2002).

It is unknown what goals, objectives and criteria would be developed under PA.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated then the baseline 2002 fishery. Closure areas under PA.2 are similar to those described under FMP 3.2 and are illustrated in the FMP 3.2 map (Figure 4.2-5) described in Section 4.2.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea, Aleutian Islands and GOA as MPAs and no-take marine reserves across a range of habitats (Figure 4.2-5, FMP 3.2 map). Programs to identify, designate and assess EFH and HAPC would be continue under this preferred alternative bookend. These measures, among others, may help reduce adverse impacts to BSAI yellowfin sole habitat where overlap occurs.

Status Determination

Model projections of future catches of BSAI yellowfin sole are below the OFLs in all years under PA.1 and PA.2. The yellowfin sole stock is above the MSST level in 2002.

Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI yellowfin sole under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Procedures to account for the uncertainty in estimating ABC for BSAI yellowfin sole under PA.2 would be updated as necessary, and may be modified to account for ecosystem interactions and production patterns/trends. Ecosystem indicators will also be developed and implemented as part of the TAC-setting process, as appropriate. These changes may increase or reduce catch limits for BSAI yellowfin sole in the future. TAC values must be set at levels equal to or less than the ABC for all target species under PA.2. PA.2 would reconsider OY caps in relation to existing environmental and stock status conditions.

Age and Size Composition

Under PA.1 and PA.2, the mean age of the BSAI yellowfin sole stock in 2008, as computed in model projections (Table H.4-45 of Appendix H), is 6.23 years. This compares with a mean age in the equilibrium unfished BSAI stock of 8.04 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of yellowfin sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under PA.1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. These implemented measures may help reduce adverse impacts to important yellowfin sole habitat when overlap occurs.

As stated above, NOAA Fisheries and NPFMC would consider adopting 0 to 20 percent of the Bering Sea as MPAs and no-take marine reserves under PA.2. Existing fishery closures would be reviewed to determine if some areas qualify as MPAs; others may be redesignated as fishery- or gear-specific. Programs to identify and designate EFH and HAPC would also be continued. All these measures may help protect important yellowfin habitat where overlap occurs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on yellowfin sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on EBS yellowfin sole under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the yellowfin sole is rated as insignificant under PA.1 and PA.2 (see the EBS yellowfin sole direct/indirect effects discussion). Under PA.1 and PA.2, the annual fishing mortality values are below the F_{MSY} proxy value of 0.138. Therefore, PA.1 and PA.2 are expected to have insignificant impacts on these stocks.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts are not considered as contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of yellowfin sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI yellowfin sole, but is rated as insignificant. Fishing mortality at projected levels is below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** PA.1 or PA.2 are expected to result in insignificant effects to these stocks (see the BSAI yellowfin sole direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the yellowfin sole stock.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the change in biomass are indicated due to the potentially adverse contributions of marine pollution since acute and/or chronic pollution events could cause yellowfin sole mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse contributions to the yellowfin sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, please see Sections 3.5.1.5 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI yellowfin sole, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the spawning biomass is above the B_{MSY} value. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock (see the BSAI yellowfin sole direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI yellowfin sole catch.

- **Reasonably Foreseeable Future External Effects.** As described for biomass, effects on the reproductive success of yellowfin sole due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as having a potentially adverse contribution since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of yellowfin sole.

- **Cumulative Effects**. A cumulative effect is possible for the spatial/temporal concentration of the yellowfin sole catch; the effect is ranked as insignificant. The spatial and temporal distribution of yellowfin sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in prey availability for the yellowfin sole is ranked as insignificant (see the yellowfin sole direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the yellowfin sole stock and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.1.5 and 3.10).

- **Reasonably Foreseeable Future External Effects.** As described for biomass, effect of the climate changes and regime shifts on the EBS yellowfin sole stock are potentially beneficial or adverse. Marine pollution has also been identified as having a potentially adverse contribution.

- **Cumulative Effects.** Cumulative effects are identified for change in prey availability; however, these effects are considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the yellowfin sole is ranked as insignificant (see the yellowfin sole direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for yellowfin sole include climate changes and regime shifts. In the past, when the Aleutian Low was strong and water temperatures warm, catch tended to be dominated by flatfish species, implying increased recruitment. In contrast, when the Aleutian Low was weak and water temperatures cooler, catch tended to be dominated by shrimp. Persistent past contributions of the foreign, JV, and domestic fisheries gear impacts are described in Section 3.5.1.5 and Section 3.6.

- **Reasonably Foreseeable Future External Effects.** As described above, the effects of the climate changes and regime shifts on the yellowfin sole stock are potentially beneficial or adverse.

- **Cumulative Effects.** Cumulative effects are identified for yellowfin sole habitat suitability; however, these effects are considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the yellowfin sole stock to sustain itself at or above the MSST is jeopardized.

See Table 4.5-8 for a summary of the cumulative effects on yellowfin sole under PA.1 and PA.2.

GOA Shallow Water Flatfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Estimated total and spawning biomass is not available for GOA shallow water flatfish.

Fishing Mortality

The catch of GOA shallow water flatfish in 2002 was estimated to be 6,800 mt. Model projections of future catch are shown in Table H.4-68 of Appendix H. Under PA.1, model projections indicate that the catch is expected to decrease from 5,900 mt in 2003 to 4,900 mt in 2007. The 2003-2007 average value is 5,600 mt. However, the shallow water flatfish fishery is likely to be limited by Pacific halibut PSC limits. Under PA.2, model projections indicate that the catch is expected to decrease to 5,000 in 2007 with a 2003-2007 average of 5,000 mt. GOA shallow water flatfish catch is likely to be limited by Pacific halibut PSC limits, which are projected to be reduced by 0-10 percent under PA.2

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the ‘splitting and lumping’ of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented, and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future changes in Tier designation for GOA shallow water flatfish.

The anticipated low levels of exploitation of GOA shallow water flatfish under PA.1 and PA.2 would have insignificant effects on these stocks through mortality.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA shallow water flatfish harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Existing closures would remain under PA.1, including inseason bycatch closures.

As part of PA.1, an IR/IU program for GOA shallow water flatfish would be implemented. The IR/IU program is designed to reduce discard waste by encouraging the fishing industry to develop methods to avoid high bycatch areas and/or develop markets for the bycatch. This program was previously initiated by NOAA Fisheries on January 1, 2003 (BSAI FMP Amendment 75), but was suspended on February 7, 2003 due to the need for clarification in the regulation. As mentioned above, the shallow water flatfish fishery is likely to be limited temporally due to the attainment of Pacific halibut PSC limits.

Under PA.1, the Observer Program would continue, although training programs designed to increase species identifications would not be included, and station improvements as described under FMP 3.2 would not occur in the immediate future. However, uncertainty estimates would be developed and revised.

The shallow water flatfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-20 percent in the GOA under PA.2. This in combination with the development of inseason bycatch closures (for hotspot areas) could temporally and spatially restrict the fishery. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

Status Determination

The available information for flatfish species in the shallow water complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species in the National Standard Guidelines. Therefore, it is not possible to determine their status. Under PA.1 and PA.2, the ABC must be set below the OFL; under PA.1 the sum of the TACs must be within the OY (116,000-800,000 mt for the GOA). Under PA.2, OY caps would be reconsidered in light of their relevancy to current environmental conditions and knowledge of stock levels.

Age and Size Composition

Age and size composition projections are not available for GOA shallow water flatfish.

Sex Ratio

The sex ratio of shallow water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions which are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under PA.1, including the eastern GOA trawl closure. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. These implemented measures may help reduce adverse impacts to important shallow water flatfish habitat when overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may help reduce adverse impacts to GOA shallow water flatfish habitat where overlap occurs, although, as stated above, impacts to shallow water flatfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on shallow water flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on GOA shallow water flatfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shallow water flatfish is rated as insignificant under PA.1 and PA.2 (see the direct/indirect effects discussion).

- **Persistent Past Effects**. Past JV and domestic fisheries have been identified as having lingering past negative effects on the GOA shallow water flatfish complex (see Section 3.5.1.5).

- **Reasonably Foreseeable Future External Effects**. Future external effects on mortality are indicated due to potential adverse contributions of marine pollution since acute and/or chronic pollution events could cause shallow water flatfish species mortality. Climate changes and regime shifts are considered non-contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shallow water flatfish. The State of Alaska scallop fishery is identified as a non-contributing factor since shallow water flatfish species bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA shallow water flatfish, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** Since the total and spawning biomass estimates for GOA shallow water species are unavailable, the effects of PA.1 and PA.2 on change in biomass are unknown (see the GOA shallow water flatfish direct/indirect effects discussion).

- **Persistent Past Effects.** The past JV and domestic fisheries are identified as having past lingering negative effects on the biomass levels of GOA shallow water flatfish (see Section 3.5.1.5).

- **Reasonably Foreseeable Future External Events.** As described above for mortality, effects on biomass are indicated due to the potentially adverse contributions of marine pollution. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse contributions on the shallow water flatfish species biomass level. However, the State of Alaska scallop fishery is not considered to be contributing factor since bycatch of shallow water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for change in biomass of GOA shallow water flatfish, but is rated as unknown. Fishing mortality at projected levels is well below the OFL for this stock. It is unknown if the combined effects of internal removals and removals are likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** It is unknown how the spatial and temporal distribution of the annual GOA shallow water flatfish harvest will be affected under PA.1 and PA.2 relative to the 2002 baseline year.

- **Persistent Past Effects.** Past effects have not been identified for the change in genetic structure or the change in reproductive success of GOA shallow water flatfish.

- **Reasonably Foreseeable Future External Effects**. Future external effects on the reproductive success of shallow water flatfish species due to climate changes and regime shifts are potentially beneficial or adverse as described for mortality. Marine pollution has been identified as having a potentially adverse contribution, and the State of Alaska scallop fishery is not a contributing factor.

- **Cumulative Effects**. A cumulative effect is possible for change in genetic structure and reproductive success of GOA shallow water flatfish, but the effect is rated as unknown. It is unknown if the combined effects of internal removals and removals due to reasonably foreseeable future external events are likely to jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in prey availability for GOA shallow water flatfish is determined to be unknown (see the GOA shallow water flatfish direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA shallow water flatfish stock complex and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.1.5 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potentially beneficial or adverse as described above for mortality. Marine pollution has also been identified as having a potentially adverse contribution, and the State of Alaska scallop fishery is not considered to be a contributing factor.

- **Cumulative Effects.** Cumulative effects for change in prey availability are unknown. The predation-mediated impacts of PA.1 and PA.2 on shallow water flatfish are governed by a complex web of indirect interactions which are currently difficult to quantify.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA shallow water flatfish complex is considered to be unknown (see the GOA shallow water flatfish direct/indirect effects discussion).

- **Persistent Past Effects.** Past effects identified for GOA shallow water flatfish include climate changes and regime shifts as described for prey availability. Persistent past effects of the foreign, JV, and domestic fisheries gear impacts are described in Sections 3.5.1.5 and 3.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA shallow water flatfish stock complex are potentially beneficial or adverse as discussed above for mortality. Marine pollution has also been identified as having a potentially adverse contribution. The State of Alaska scallop fishery is also identified as a potential adverse contributor to GOA shallow water flatfish habitat suitability. See Section 3.6 for information of the impacts of fishery gear on EFH.

- **Cumulative Effects.** Cumulative effects are identified for GOA shallow water flatfish habitat suitability; however, these effects are unknown. It is unknown if the combination of internal and external habitat disturbances will to lead to a detectable change in spawning or rearing success such that the ability of the GOA shallow water flatfish stock to maintain current population levels is jeopardized.

See Table 4.5-9 for a summary of the cumulative effects on GOA shallow water flatfish under PA.1 and PA.2.

4.9.1.6 Rock Sole

Rock sole is described in more detail in Section 3.5.1.6 of this Programmatic SEIS. Rock sole is managed as its own stock under the BSAI Groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species.

Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

The total biomass of rock sole at the start of 2002 is estimated to be 970,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-48 of Appendix H. Under PA.1, model projections indicate that the total BSAI biomass is expected to decline to 710,000 mt by 2007 with a 2003-2007 average total biomass of 779,000 mt. Under PA.2, model projections indicate that the total BSAI biomass is expected to decline to 690,000 in 2007, with a 2003-2007 average value of 771,000 mt.

Spawning Biomass

Spawning biomass of female rock sole at the start of 2002 is estimated to be 331,000 mt. Model projections of future rock sole spawning biomass estimates are shown in Table H.4-48 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to decline to 189,000 mt by 2007, with a 2003-2007 average value of 244,500 mt. Under PA.2, model projections indicate that female spawning biomass is expected to decline to 180,400 mt by 2007, with a 2003-2007 average value of 240,700 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 136,700 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the rock sole stock in 2002 is 0.055. Under PA.1, model projections show this value will steadily increase to 0.104 in 2007. Under PA.2, model projections show this value will steadily increase to 0.126 by 2007. These values are well below the F_{MSY} proxy value of 0.21, the rate associated with the OFL (Table H.4-48 of Appendix H). Catch rates of BSAI rock sole may be limited by Pacific halibut PSC limits, which could be reduced by 0-10 percent in the BSAI under PA.1 and by 0-20 percent in the BSAI under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI rock sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this preferred alternative bookend or what the effect of hot-spot management of PSC would have on fishing behavior. As stated above, the rock sole fishery may also be limited temporally by Pacific halibut PSC limits.

As part of PA.1, an IR/IU program would be initiated for BSAI rock sole. The IR/IU program is designed to reduce discard waste of BSAI rock sole by allowing the fishing industry to develop new methods for avoiding unwanted bycatch and/or through the development of new markets for the bycatch. This program was previously initiated by NOAA Fisheries on January 1, 2003 (BSAI FMP Amendment 75), but was suspended on February 7, 2003 due to the need for clarification in the regulation. Discards occur mostly in the directed rock sole fishery, yellowfin sole, flathead sole, Pacific cod, and bottom pollock fisheries (Wilderbuer and Walters 2002).

It is unknown what goals, objectives and criteria would be developed under this preferred alternative bookend to allocate TAC in space and time. Existing closure areas would remain and will be reviewed under PA.2 to see if these areas qualify for MPAs or can be redesignated as fishery- or gear-specific areas. NOAA Fisheries and NPFMC would also consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands as MPAs. These area closures are similar to those discussed under FMP 3.2 and are illustrated in the FMP 3.2 map (Figure 4.2-5) in Section 4.2.

Status Determination

Model projections of future catches of BSAI rock sole are below the OFLs in all years under PA.1 and PA.2, and the female spawning stock size is below the MSST. The rock sole stock is above the MSST level in 2002.

Under PA.1, the ABC must be set below the OFL values. The OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI rock sole under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Similar to PA.1, under PA.2 the ABC must be set below the OFL values, but OY caps would be revisited to determine relevancy to current environmental conditions and knowledge of stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Age and Size Composition

Under PA.1, the mean age of the BSAI rock sole stock in 2008, as computed in model projections is 4.82 years (Table H.4-48 of Appendix H). Under PA.2, the mean age of the BSAI rock sole stock in 2008, as computed in model projections is 4.74 years (Table H.4-48 of Appendix H). This compares with a mean age in the equilibrium unfished BSAI stock of 5.90 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of rock sole in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important rock sole habitat where overlap occurs.

As stated above, under PA.2 NPFMC and NOAA Fisheries would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands as MPAs and no-take reserves across a range of different habitat types (similar to FMP 3.2). Existing closures would be reviewed to see if areas may qualify for MPAs under established criteria. Existing areas may be redefined as gear- or fishery-specific. EFH and HAPC designation would continue under PA.2, as would investigations as to whether fishing has adverse impacts on habitats; mitigation measures would be implemented as necessary. An Aleutian Islands management area would be established under PA.2 to protect coral and live bottom habitats. Pollock bottom trawling would be prohibited in the BSAI under PA.2. See the FMP 3.2 maps (Figure 4.2-5) described in Section 4.2 for more information. All of these measures may reduce the adverse impacts of fishing gear on important rock sole habitat where overlap occurs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on rock sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. A directed fishery for forage fish would continue to be banned under PA.1 and PA.2.

See Table 4.9-1 for a summary of the BSAI rock sole direct/indirect effects under PA.1 and PA.2.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of fishing mortality on the BSAI rock sole is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts are not contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of rock sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI rock sole, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on the BSAI rock sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause rock sole mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the rock sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment (see Sections 3.5.1.6 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI rock sole, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch
  - Change in Genetic Structure of Population
  - Change in Reproductive Success

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the BSAI rock sole. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of BSAI rock sole. Climate changes and regime shifts and corresponding water temperature variation could effect prey availability and habitat suitability, which in combination could effect the reproductive success of the rock sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of rock sole due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI rock sole.

- **Cumulative Effects**. A cumulative effect is possible for the spatial/temporal concentration of the rock sole catch, and is ranked as insignificant. The spatial and temporal distribution of rock sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in prey availability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do effect the availability of some forage species (i.e. capelin); however, studies on benthic invertebrates have not been conducted.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the change in habitat suitability for the BSAI rock sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI rock sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.6.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI rock sole stock are potential beneficial or adverse. Marine pollution has also been identified as a potential adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI rock sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the rock sole stock to sustain itself at or above the MSST is jeopardized.

See Table 4.5-10 for a summary of the cumulative effects on BSAI rock sole under PA.1 and PA.2.

4.9.1.7 Flathead Sole

Flathead sole are described in more detail in Section 3.5.1.7 of this Programmatic SEIS. Flathead sole is managed as its own stock under the BSAI Groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2002, flathead sole were managed independent of the other flatfish complex in the GOA. Until recently, GOA flathead sole were evaluated under Tier 4; beginning in 2004 they will be managed under Tier 3. However, for the purposes of this analysis, flathead sole have been modeled as a Tier 4 species.

BSAI Flathead Sole – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total biomass of BSAI flathead sole at the start of 2003 is estimated to be 513,000 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-49 of Appendix H. Under PA.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 492,000 mt in 2006, then increase to 496,000 mt in 2007, with a 2003-2007 average value of 498,000 mt. Under PA.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 491,000 mt in 2006, then increase to 495,000 mt in 2007, with an average of 498,000 mt from 2003-2007.

Spawning Biomass

Spawning biomass of BSAI flathead sole at the start of 2003 is estimated to be 231,200 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-49 of Appendix H. Under PA.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 176,200 mt in 2007, with a 2003-2007 average value of 203,100 mt. Under PA.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 175,200 mt in 2007, with a 2003-2007 average value of 202,900 mt.

Fishing Mortality

Under PA.1, the projected fishing mortality imposed on the BSAI flathead sole stock is 0.053 in 2003, increasing to 0.061 in 2007, with an average from 2003-2007 of 0.052. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 78 percent in 2003 and decreases to 76 percent in 2007, with an average of 79 percent from 2003-2007 (Table H.4-49 of Appendix H). The flathead sole fishery is likely to be limited by Pacific halibut PSC limits which are projected to be reduced by 0-10 percent in the BSAI under PA.1.

Under PA.2, the projected fishing mortality imposed on the BSAI flathead sole stock is approximately 0.053 in 2003, increasing to 0.067 in 2007. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 81 percent in 2003 and decreases to 74 percent in 2007, with an average of 78 percent from 2003-2007 (Table H.4-49 of Appendix H). The BSAI flathead sole fishery will likely be limited by the Pacific halibut PSC limits which are projected to decline between 0-20 percent in the BSAI under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

Under PA.1, a projected average of 11,220 mt of BSAI flathead sole are caught annually from 2003 to 2007, the largest percentage of catch occurring in the EBS shelf Pacific cod fishery, followed closely by the walleye pollock fishery, and yellowfin sole fishery. The directed flathead sole fishery contributes only about 10 percent.

Under PA.1, existing closure areas would remain, including inseason bycatch hotspot closures. As stated above, the flathead sole fishery is likely to be limited temporally by Pacific halibut PSC limits.

The average annual projected harvest of flathead sole under PA.2 was 11,700 mt, of which the yellowfin sole fishery made the largest percentage, followed closely by Pacific cod, and walleye pollock. The directed flathead sole fishery contributes to only about 10 percent of the annual harvest.

Under PA.2, existing closures would remain and would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. As mentioned above, the flathead sole fishery may also be limited temporally due to reaching Pacific halibut PSC limits, or spatially, when avoiding bycatch hotspot areas.

Status Determination

Under PA.1 and PA.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI flathead sole are below ABC and OFL levels from 2003 to 2008.

Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI flathead sole under this preferred alternative. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative and may affect catch limits in the future, as well. Under PA.2 the OY calculation would be re-evaluated to determine relevancy to current environmental conditions and knowledge of stock levels. Also, under PA.2, NOAA Fisheries would develop, implement and update procedures to account for uncertainty in estimating ABC, and species-specific production patterns, as necessary.

Age and Size Composition

Under PA.1, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-49 of Appendix H), is 4.57 years. Under PA.2, the mean age of the BSAI flathead sole stock in 2008, as computed in model projections (Table H.4-49 of Appendix H), is 4.56 years. This compares with a mean age in the equilibrium unfished stock of 5.39 years.

Sex Ratio

The sex ratio of BSAI flathead sole is assumed to be 50:50. No information is available to suggest that this would change under PA.1 and PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this PA.1 or PA.2.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important flathead sole habitat where overlap occurs.

As mentioned above, the existing closures would remain under PA.2, including the BSAI pollock bottom trawling ban. These closures would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and the Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. Existing inseason bycatch closures (e.g., Pacific halibut hotspot areas) would be evaluated for effectiveness and modified as necessary.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2. Directed forage fisheries would continue to be banned under this preferred alternative.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI flathead sole under PA.1 and PA.2.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI flathead sole is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are not considered to be contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI flathead sole, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on the BSAI flathead sole biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the flathead sole biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts (see Sections 3.5.1.7 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI flathead sole, and is rated as insignificant. Projected spawning biomass is projected to be above the MSST for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal concentration of BSAI flathead sole catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI flathead sole.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch, and is ranked as insignificant. The spatial and temporal distribution of flathead sole catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects are not identified for the change in prey availability of the BSAI flathead sole stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for BSAI flathead sole is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.7.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI flathead sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI flathead sole habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at or above the MSST is jeopardized.

See Table 4.5-11 for a summary of the cumulative effects on BSAI flathead sole under PA.1 and PA.2.

GOA Flathead Sole – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Estimates of total and spawning biomass are currently unavailable for this species.

Fishing Mortality

The catch of GOA flathead sole in 2002 was estimated to be 2,000 mt. Model projections of future catch are shown in Table H.4-69 of Appendix H. Under PA.1, model projections indicate that the catch is expected to decrease to 1,500 mt in 2004-2007. The 2003-2007 average value is also 1,570 mt. Under PA.2, model projections indicate that the catch is expected to decrease to 1,500 mt in 2003-2007, with a 2003-2007 average value of 1,500 mt.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA flathead sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this preferred alternative bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Current closures would remain under PA.1, including the eastern GOA pollock bottom trawl closure.

Flathead sole catch may be limited in the GOA due to Pacific halibut PSC limits which are projected to be reduced by 0-20 percent under PA.2. This, in combination with the development of inseason bycatch closures could actually spatially and temporally restrict the fishery (see FMP 3.2 map [Figure 4.2-5] described in Section 4.2); however, the effects are unknown. Procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA flathead sole.

Status Determination

The available information for GOA flathead sole requires that they are classified into the Tier 4 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status.

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 116,000 and 800,000 mt in the GOA (same as FMP 1 and FMP 3.1). However, under PA.2, OY cap calculations would be revisited for relevancy with current environmental conditions and stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future.

Age and Size Composition

Age and size composition estimates are currently unavailable for this species.

Sex Ratio

The sex ratio of flathead sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1 and PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

As mentioned above, current closure areas would remain under this PA.1, including the ban on bottom trawling for pollock in the eastern GOA as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. The Seguam Pass area would be closed to fishing, 3 nm no transit zones would be established around rookeries, and nearshore and critical habitat areas would be closed to trawl and fixed gear as Steller sea lion protection measures. All these measures may help reduce adverse impacts to important flathead sole habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue, and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to GOA flathead sole habitat where overlap occurs, although, as stated above, impacts to flathead sole habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on flathead sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. Directed forage fisheries would continue to be banned under this preferred alternative.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA flathead sole.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA flathead sole is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Removals by these fisheries have had a lingering negative effect on GOA flathead sole (see Section 3.5.1.7).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts are not considered to be contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of flathead sole. The State of Alaska scallop fishery is also not considered to be a contributing factor since GOA flathead sole bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA flathead sole, but is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in biomass level is rated as unknown since MSST is unable to be determined at this time.

- **Persistent Past Effects**. Past effects have been identified for fishing mortality in the GOA flathead sole stock and include past JV and domestic fisheries. Large removals of flathead sole by these fisheries is determined to have had a lingering effect on the GOA flathead sole stock (see Section 3.5.1.7).

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause flathead sole mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the flathead sole biomass level. For more information on climate changes and regime shifts see Section 3.5.1.7 and 3.10. The State of Alaska scallop fishery is identified as a non-contributing factor for change in biomass level since flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA flathead sole, but its significance is unknown. The MSST is not able to be determined and the total and spawning biomass estimates are currently unavailable. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA flathead sole stock. However, climate changes and regime shifts have been identified as having a positive or negative effect on GOA flathead sole reproductive success. See Section 3.5.1.7 for more information on the effects of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of flathead sole due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA flathead sole. The State of Alaska scallop fishery is not considered to be a contributing factor to change in genetic structure and change in reproductive success since GOA flathead sole bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the flathead sole catch; however, this effect is unknown. The spatial and temporal distribution of flathead sole catch is not expected to change significantly, while it is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA flathead sole stock and include climate changes and regime shifts. For more information on the effects of climate changes and regime shifts on the GOA flathead sole stock (see Section 3.5.1.7).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery is identified as a potentially adverse contributor to GOA flathead sole prey availability. The State of Alaska scallop fishery gear could impact flathead sole benthic prey availability and/or quality.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to sustain itself at current population levels.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA flathead sole is unknown.

- **Persistent Past Effects.** Past effects identified for GOA flathead sole include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.7.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA flathead sole stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as a potentially adverse contributor to GOA flathead sole habitat suitability. For information on the effects of fishery gear on EFH, see Section 3.6.

- **Cumulative Effects.** A cumulative effect is identified for GOA flathead sole habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the flathead sole stock to sustain itself at current population levels is jeopardized.

See Table 4.5-12 for a summary of the cumulative effects on GOA flathead sole under PA.1 and PA.2.

4.9.1.8 Arrowtooth Flounder

BSAI and GOA arrowtooth flounder are described in more detail in Section 3.5.1.8 of this Programmatic SEIS. Arrowtooth flounder is managed as its own stock under the BSAI and GOA Groundfish FMPs under the Tier 3 management category, thus MSSTs are defined for these species.

BSAI Arrowtooth Flounder – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

The total biomass of BSAI arrowtooth flounder at the start of 2002 is estimated to be 811,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-47 of Appendix H. Under PA.1, model projections indicate that the total BSAI biomass is expected to decline to 598,000 mt by 2007, with a 2003-2007 average total biomass of 675,000 mt. Under PA.2, model projections indicate that the total BSAI biomass is expected to decline to 605,000 mt in 2007, with a 2003-2007 average value of 679,000 mt.

Spawning Biomass

Spawning biomass of female BSAI arrowtooth flounder at the start of 2002 is estimated to be 475,900 mt. Model projections of future BSAI arrowtooth flounder spawning biomass estimates are shown in Table H.4-47 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to decline 30 percent of the 2002 value to 330,000 mt by 2007, with a 2003-2007 average value of 388,100 mt. Under PA.2, model projections indicate that female spawning biomass is expected to decline 30 percent of the 2002 value to 334,600 mt by 2007, with a 2003-2007 average value of 390,800 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 182,900 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the BSAI arrowtooth flounder stock in 2002 is 0.015. Under PA.1, model projections show this value will steadily increase to 0.024 in 2007. Under PA.2, model projections show this value will slowly increase to 0.020 by 2007. These values are well below the F_{MSY} proxy value of 0.38, the rate associated with the OFL (Table H.4-47 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI arrowtooth flounder harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this preferred alternative bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Current closure areas would remain under PA.1.

It is unknown what goals, objectives and criteria would be developed under PA.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated than the baseline 2002 fishery. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. These closure examples are illustrated in FMP 3.2 map (Figure 4.2-5) discussed in Section 4.2.

Status Determination

Model projections of future catches of BSAI arrowtooth flounder are below the OFLs in all years under PA.1 and PA.2. The arrowtooth flounder stocks are above the MSST level throughout the five year projection, as in the 2002 baseline year.

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI arrowtooth flounder under this preferred alternative bookend (same as FMP 1 and FMP 3.1). However, under PA.2, calculation of OY caps would be reanalyzed in light of current environmental conditions and knowledge of stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well. Under PA.2, NOAA Fisheries would also develop, implement and update procedures to account for uncertainty in estimating ABC, and species-specific production patterns, as necessary.

Age and Size Composition

Under PA.1 and PA.2, the mean age of the BSAI arrowtooth flounder stock in 2008, as computed in model projections is 4.81 years (Table H.4-47 of Appendix H). This compares with a mean age in the equilibrium unfished BSAI stock of 5.43 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the BSAI have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important arrowtooth flounder habitat where overlap occurs.

As mentioned above, the existing closures would remain under PA.2, including the BSAI pollock bottom trawling ban. These closures would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the

Bering Sea and Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. Existing inseason bycatch closures (e.g., Pacific halibut hotspot areas) would be evaluated for effectiveness and modified as necessary.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on BSAI arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. A directed fishery for forage fish would continue to be banned under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on BSAI arrowtooth flounder.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of PA.1 and PA.2 on fishing mortality of BSAI arrowtooth flounder is rated as insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts are not considered contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of arrowtooth flounder. The IPHC longline fishery is identified as a potentially adverse contributor to BSAI arrowtooth flounder mortality since arrowtooth flounder are caught as bycatch in this fishery. The State of Alaska herring fishery is not considered a contributing factor to BSAI arrowtooth flounder mortality since bycatch of these fish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of BSAI arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** The effect of PA.1 and PA.2 on the change in biomass of BSAI arrowtooth flounder is insignificant (see the direct/indirect effects section above).

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause arrowtooth flounder mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the arrowtooth flounder biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, see Sections 3.5.1.8 and 3.10. The IPHC longline fishery has been identified as a potentially adverse contributor to BSAI arrowtooth flounder biomass level since bycatch is expected to occur in this fishery. The State of Alaska herring fishery is not considered to be a contributing factor since arrowtooth flounder bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

<u>Spatial/Temporal Concentration of Catch</u>
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the PA.1 and PA.2 on the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI arrowtooth flounder. Climate changes and regime shifts are identified as having had potentially adverse or beneficial effects on the reproductive success of BSAI arrowtooth flounder (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of arrowtooth flounder due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI arrowtooth flounder. The IPHC longline fishery is not considered to be a contributing factor to the genetic structure and reproductive success of BSAI arrowtooth flounder since the removals are not expected to be significant. The State of Alaska herring fishery is also not a contributing factor in the genetic structure and reproductive success of BSAI arrowtooth flounder since bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the arrowtooth flounder catch, and is ranked as insignificant. The spatial and temporal distribution of arrowtooth flounder catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified include the past foreign, JV, and domestic fisheries, State of Alaska groundfish fisheries, State of Alaska herring fisheries and climate changes and regime shifts (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potentially beneficial or adverse. Some forage species (i.e. capelin and herring), shrimp and pollock respond to variations in water temperatures which vary with the climate. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is not considered a contributing factor to prey availability since the bycatch of prey species is not expected in this fishery. However, the State of Alaska herring fishery is identified as a potentially adverse contributor to prey availability by reducing the availability of herring.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, the effect is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI arrowtooth flounder include climate changes and regime shifts. Persistent past effects of the foreign, JV, and domestic fisheries are described in Section 3.5.1.8.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI arrowtooth flounder stock are potentially beneficial or adverse. A strong Aleutian Low and high water temperatures tend to favor recruitment and cause a change in the reproductive success of the stock. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Neither the IPHC longline fishery nor the State of Alaska herring fishery are considered to be contributing factors to BSAI arrowtooth flounder habitat suitability. The impacts from the fishery gear is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for BSAI arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

See Table 4.5-13 for a summary of the cumulative effects on BSAI arrowtooth flounder under PA.1 and PA.2.

GOA Arrowtooth Flounder – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

The total biomass of GOA arrowtooth flounder at the start of 2002 is estimated to be 1,816,000 mt. Model projections of future total GOA biomass estimates are shown in Table H.4-70 of Appendix H. Under PA.1, model projections indicate that the total GOA biomass is expected to increase to 2,082,000 mt by 2007, an abundance level 15 percent more than the 2002 value. The 2003-2007 average total biomass is 1,980,000 mt. Under PA.2, model projections indicate that the total GOA biomass is expected to increase to 2,094,000 in 2007, with a 2003-2007 average value of 1,986,000 mt.

Spawning Biomass

Spawning biomass of female GOA arrowtooth flounder at the start of 2002 is estimated to be 1,113,800 mt. Model projections of future GOA arrowtooth flounder spawning biomass estimates are shown in Table H.4-70 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to increase to 1,152,800 mt by 2007, with a 2003-2007 average value of 1,140,900 mt. Under PA.2, model projections indicate that female spawning biomass is expected to increase 4 percent of the 2002 value to 1,161,600 mt by 2007, with a 2003-2007 average value of 1,145,700 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 432,700 mt throughout the five year projection.

Fishing Mortality

The average annual fishing mortality imposed on the GOA arrowtooth flounder stock in 2002 is 0.017. Under PA.1, model projections show this value will be 0.010 in 2007, with a 2003-2007 average of 0.010. Under PA.2, model projections show this value will be 0.009 the first year of the projection and 0.008 in the remaining years until 2007. These values are well below the F_{MSY} proxy value of 0.165, the rate associated with the OFL (Table H.4-70 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA arrowtooth flounder harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Existing closures would remain under this preferred alternative bookend, including the eastern GOA pollock bottom trawling closure.

It is unknown what goals, objectives and criteria would be developed under PA.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated than the baseline 2002 fishery. NOAA Fisheries and NPFMC will consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. This would be similar to closures illustrated under FMP 3.2 map (Figure 4.2-5) described in Section 4.2.

Status Determination

Model projections of future catches of GOA arrowtooth flounder are below the OFLs in all years under PA.1 and PA.2. The arrowtooth flounder stocks are above the MSST level throughout the five year projection, as in the 2002 baseline year.

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 116,000 and 800,000 mt for the GOA. However, under PA.2, OY cap calculations would be revisited for relevancy with current environmental conditions and knowledge of current stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future.

Age and Size Composition

Under PA.1, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-70 of Appendix H), is 5.02 years. Under PA.2, the mean age of the GOA arrowtooth flounder stock in 2008, as computed in model projections (Table H.4-70 of Appendix H), is 5.03 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.11 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

Fishery-independent resource assessment surveys in the GOA have found that populations of arrowtooth flounder are comprised of a higher percentage of females than males. It is believed that this is a function of a higher natural mortality rate for males than females. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under PA.1 (described under FMP 1). Definitions and methodology for establishing MPAs would be developed and inseason bycatch closures would be established. These measures may help reduce adverse impacts to important flathead sole habitat where overlap occurs.

As stated above, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. Inseason bycatch closures would also be developed in the GOA under PA.2. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may help reduce adverse impacts to GOA flathead sole habitat where overlap occurs, although, as stated above, impacts to flathead sole habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on GOA arrowtooth flounder would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. A directed forage fish fishery would continue to be banned under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA arrowtooth flounder.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of PA.1 and PA.2 on fishing mortality of the GOA arrowtooth flounder is rated as insignificant.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI arrowtooth flounder under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA arrowtooth flounder, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on biomass is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the GOA arrowtooth flounder stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI arrowtooth flounder under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA arrowtooth flounder, and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure and reproductive success of GOA arrowtooth flounder.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the arrowtooth flounder catch, and is rated as insignificant. The spatial and temporal distribution of arrowtooth flounder catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in prey availability for the GOA arrowtooth flounder is rated as insignificant.

- **Persistent Past Effects.** Past effects identified include climate changes and regime shifts (see Section 3.5.1.8).

- **Reasonably Foreseeable Future External Effects.** Future external effects on prey availability are the same as those described for BSAI arrowtooth flounder under PA.1 and PA.2.

- **Cumulative Effects**. A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA arrowtooth flounder is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for habitat suitability of GOA arrowtooth flounder are the same as those described for BSAI arrowtooth flounder under PA.1.

- **Reasonably Foreseeable Future External Effects.** Future external effects on habitat suitability are the same as those described for BSAI arrowtooth flounder under PA.1.

- **Cumulative Effects.** A cumulative effect is identified for GOA arrowtooth flounder habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the arrowtooth flounder stock to sustain itself at or above the MSST is jeopardized.

See Table 4.5-14 for a summary of the cumulative effects on GOA arrowtooth flounder under PA.1 and PA.2.

4.9.1.9 Greenland Turbot and Deep Water Flatfish

BSAI Greenland turbot and GOA deep water flatfish are described in more detail in Section 3.5.1.9 of this Programmatic SEIS. Greenland turbot is managed as its own stock under the BSAI Groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. The reference fishing mortality rate and ABC for the GOA deep water flatfish management group are determined by the amount of population information available. ABCs for Dover sole were calculated using Tier 5. Greenland turbot and deepsea sole are in Tier 6 in the GOA because no reliable biomass estimates exists.

BSAI Greenland Turbot – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

The total biomass of Greenland turbot at the start of 2002 is estimated to be 106,000 mt. Model projections of future total BSAI biomass estimates are shown in Table H.4-46 of Appendix H. Under PA.1, model projections indicate that the total BSAI biomass is expected to decline to 86,000 mt by 2007, an abundance level 19 percent less than the 2002 value. The 2003-2007 average total biomass is 92,000 mt. Under PA.2, model projections indicate that the total BSAI biomass is expected to decline to 90,000 in 2007. The 2003-2007 average value is 94,000 mt.

Spawning Biomass

Spawning biomass of female Greenland turbot at the start of 2002 is estimated to be 67,800 mt. Model projections of future Greenland turbot spawning biomass estimates are shown in Table H.4-46 of Appendix H. Under PA.1, model projections indicate that female spawning biomass is expected to decline 31 percent of the 2002 value to 46,800 mt by 2007, with a 2003-2007 average value of 54,100 mt. Under PA.2, model projections indicate that female spawning biomass is expected to decline to 50,500 mt by 2007, with a 2003-2007 average value of 56,500 mt. Projected female spawning biomass is estimated to be above the B_{MSY} proxy value of 47,600 mt from 2003-2006 and then drop below this level in 2007.

Fishing Mortality

The average annual fishing mortality imposed on the Greenland turbot stock in 2002 is 0.052. Under PA.1, model projections show this value will increase to 0.190 in 2004 before decreasing to 0.162 in 2007. Under PA.2, model projections indicate this value will steadily increase to 0.150 by 2007. These values are well below the F_{MSY} proxy value of 0.48, the rate associated with the OFL (Table H.4-46 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI yellowfin sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Existing closures would remain under PA.1. The Greenland turbot fishery may be limited by Pacific halibut PSC limits which are projected to undergo a reduction of 0-10 percent under PA.1.

It is unknown what goals, objectives and criteria would be developed under PA.2 to allocate TAC in space and time. Since PSC limits are reduced and fishing is restricted to previous areas, it is unlikely that fishing effort would expand in space and time but would rather tend to be more concentrated thaN the baseline 2002 fishery. Existing closure areas would remain and inseason bycatch closures would be evaluated for effectiveness. See FMP 3.2 map (Figure 4.2-5) for a illustration of closures which are similar to those proposed under PA.2. A description of this map can be found in Section 4.2.

Status Determination

Model projections of future catches of BSAI Greenland turbot are below the OFL in all years under PA.1 and PA.2. The Greenland turbot female spawning stock is above the MSST level in all 5 years of the projection, as in the baseline year 2002.

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI Greenland turbot under this preferred alternative (same as FMP 1 and FMP 3.1). Under PA.2, OY caps would be reanalyzed in light of existing environmental conditions and availability of stock status information. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative and may affect catch limits in the future, as well. Under PA.2, procedures to account for uncertainty in estimating ABC and species-specific patterns would be developed, implemented and updated, as necessary.

Age and Size Composition

Under PA.1, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-46 of Appendix H), is 4.56 years. Under PA.2, the mean age of the BSAI Greenland turbot stock in 2008, as computed in model projections (Table H.4-46 of Appendix H), is 4.62 years. This compares with a mean age in the equilibrium unfished BSAI stock of 5.93 years. Note that the mean ages and sizes actually observed in 2008 (as opposed to the model projections of mean age in 2008) will be driven largely by the strengths of incoming recruitments during the intervening years.

Sex Ratio

The sex ratio of Greenland turbot in the BSAI is assumed to be 50:50. No information is available to suggest that this would change under PA.1 and PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important Greenland turbot habitat where overlap occurs.

The existing closures would remain under PA.2, including the BSAI pollock bottom trawling ban. These closures would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. Existing inseason bycatch closures (e.g., Pacific halibut hotspot areas) would be evaluated for effectiveness and modified as necessary.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on Greenland turbot would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 and PA.2. Directed fisheries for forage fish will continue to be banned under this preferred alternative.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on BSAI Greenland turbot.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Greenland turbot is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts are not considered contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Greenland turbot, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** As stated in the direct/indirect effects section, the effect of the fisheries on the change in biomass level is insignificant.

- **Persistent Past Effects.** Past effects have not been identified for the change in biomass in the BSAI Greenland turbot stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause Greenland turbot mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the Greenland turbot biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.9 and 3.10.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of BSAI Greenland turbot, and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock and the female spawning biomass is above the B_{MSY} value from 2003-2006. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the spatial/temporal concentration of BSAI Greenland turbot catch. Climate changes and regime shifts are suspected of having an effect on the reproductive success of the Greenland turbot stock (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of BSAI Greenland turbot.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the Greenland turbot catch, and is rated as insignificant. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the BSAI Greenland turbot stock. Past foreign, JV, and domestic fisheries have been identified as having influenced the availability of Greenland turbot prey, mainly pollock which is their main prey item in the BSAI. Climate changes and regime shifts have also been identified as influencing Greenland turbot prey availability (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI Greenland turbot is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for BSAI Greenland turbot include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of Greenland turbot, largely through the impacts of fishing gear on benthic habitats. See Section 3.5.1.9 for more information on the persistent past effects on Greenland turbot.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI Greenland turbot stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Greenland turbot habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Greenland turbot stock to sustain itself at or above the MSST is jeopardized.

See Table 4.5-15 for a summary of the cumulative effects on BSAI Greenland turbot under PA.1 and PA.2.

GOA Deep Water Flatfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

The catch of GOA deep water flatfish in 2002 was estimated to be 100 mt. Model projections of future catch are shown in Table H.4-66 of Appendix H. Under PA.1, model projections indicate that the catch is expected to increase to 1,250 mt in 2003, and decrease down to 1,091 mt by 2007, with a 2003-2007 average value of 1,139 mt. Under PA.2, model projections increase to 967 mt by 2007, with a 2003-2007 average value of 899 mt.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future changes in Tier designation for GOA deep water flatfish.

Given the low level of exploitation under these preferred alternative bookends, the effect of PA.1 and PA.2 on GOA deep water flatfish is insignificant through mortality.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA deep water flatfish harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this preferred alternative bookend. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. Existing closures would remain under PA.1.

The shallow water flatfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-20 percent in the GOA under PA.2. This, in combination with the development of inseason bycatch closures (for hotspot areas), could temporally and spatially restrict the fishery. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

Status Determination

The available information for flatfish species in the deep water complex requires that they are classified into either the Tier 5 or Tier 6 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Under PA.1 and PA.2, the ABC must be set below the OFL values. Under PA.1, the OY range is specified to be between 116,000 and 800,000 mt in the GOA. However, under PA.2, OY caps would be recalculated in light of existing environmental conditions and knowledge of stock status. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratio of deep water flatfish in the GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the eastern GOA as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important deep water flatfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may help reduce adverse impacts to GOA shallow water flatfish habitat where overlap occurs, although, as stated above, impacts to shallow water flatfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on deep water flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA deep water flatfish.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA deep water flatfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects have not been identified for fishing mortality in the GOA deep water flatfish stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause deep water flatfish mortality. Climate changes and regime shifts are not considered as contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of deep water flatfish. The State of Alaska scallop fishery is also not considered to be a contributing factor since bycatch of deep water flatfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for mortality of GOA deep water flatfish, but it is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Total and spawning biomass estimates are unavailable for the deep water flatfish species, therefore, the effects of PA.1 and PA.2 on the change in biomass level are unknown.

- **Persistent Past Effects**. Past effects have not been identified for the change in biomass in the GOA deep water flatfish stock complex.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause deep water flatfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the deep water flatfish species biomass level. For more information on climate changes and regime shifts, please see Sections 3.5.1.9 and 3.10. The State of Alaska scallop fishery has not been considered as a contributing factor for change in biomass level since deep water flatfish species bycatch is not expected to occur.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA deep water flatfish, but it is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown for the stock since the MSST is unable to be determined.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts which are suspected of having an effect on the reproductive success of the deep water flatfish stock complex. See Section 3.5.1.9 for more information on the effects of climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of Greenland turbot due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA deep water flatfish. The State of Alaska scallop fishery is not considered to be a contributing factor to change in genetic structure and reproductive success since bycatch of GOA deep water flatfish species is not expected to occur.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the GOA deep water flatfish catch; however, this effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain current population levels is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the GOA deep water flatfish complex is unknown.

- **Persistent Past Effects.** Past effects are identified for the change in prey availability of the GOA deep water flatfish stock complex and include climate changes and regime shifts (see Section 3.5.1.9).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deep water flatfish stock complex are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The State of Alaska scallop fishery has been identified as a potentially adverse contributor to benthic prey availability. See Section 3.6 for information of the impacts of fishery gear on EFH.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown. It is unknown whether the combination of internal and external removals of prey is expected to jeopardize the ability of the stock to maintain current populations.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA deep water flatfish complex is unknown.

- **Persistent Past Effects.** Past effects identified for GOA deep water flatfish include climate changes and regime shifts. The foreign, JV, and domestic fisheries have also influenced the habitat suitability of deep water flatfish, largely through the impacts of fishing gear on benthic habitats. See Section 3.5.1.9 for more information on the persistent past effects on deep water flatfish.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA deep water flatfish stock complex are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery has been identified as a potential adverse contributor to habitat suitability. See Section 3.6 for more information on the impacts of fishery gear on EFH.

- **Cumulative Effects.** A cumulative effect is identified for GOA deep water flatfish habitat suitability; however, this effect is unknown. It is unknown whether the combination of internal and external habitat disturbances is expected to lead to a detectable change in spawning or rearing success such that the ability of the deep water flatfish stock complex to maintain current population levels is jeopardized.

See Table 4.5-16 for a summary of the cumulative effects on GOA deep water flatfish under PA.1 and PA.2.

4.9.1.10 Alaska Plaice, Other Flatfish and Rex Sole

BSAI Alaska plaice and other flatfish and GOA rex sole are described in more detail in Section 3.5.1.10 of this Programmatic SEIS.

BSAI Alaska Plaice – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 1,083,000 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4-50 of Appendix H. Under PA.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,117,000 mt in 2007, with a 2003-2007 average value of 1,100,000 mt. Under PA.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 1,118,000 mt in 2007, with a 2003-2007 average value of 1,101,000 mt.

Spawning Biomass

Spawning biomass of BSAI Alaska plaice at the start of 2003 is estimated to be 276,900 mt. Model projections of future total BSAI Alaska plaice biomass are shown in Table H.4-50 of Appendix H. Under

PA.1, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 281,500 mt in 2007, with a 2003-2007 average value of 278,100 mt. Under PA.2, model projections indicate that BSAI Alaska plaice biomass is expected to increase to a value of 282,100 mt in 2007, with a 2003-2007 average value of 278,500 mt.

Fishing Mortality

Under PA.1, the projected fishing mortality imposed on the BSAI Alaska plaice stock is 0.017 in 2003, decreasing to 0.016 in 2004, and increasing to 0.020 in 2007, with an average from 2003-2007 of 0.018. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 92 percent in 2003 and decreases to 91 percent in 2007, with an average of 92 percent from 2003-2007 (Table H.4-50 of Appendix H).

Under PA.2, the projected fishing mortality imposed on the BSAI Alaska plaice stock is approximately 0.016 in 2003, increasing to 0.019 in 2007. The proportion of spawner biomass per recruit conserved under these fishing mortality rates is 93 percent in 2003 and declines to 91 percent in 2007, with an average of 92 percent from 2003-2007 (Table H.4-50 of Appendix H). The BSAI Alaska plaice fishery may be restricted by Pacific halibut PSC limits, which are projected to decline from 0-20 percent under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

Under PA.1, a projected average of 10,040 mt of BSAI Alaska plaice are caught annually from 2003 to 2007, with the largest percentage (~73 percent) of the harvest occurring in the EBS shelf yellowfin sole fishery. The BSAI Alaska plaice fishery may be limited by Pacific halibut PSC limits, which are expected to be reduced by 0-10 percent under PA.1. Existing closure areas will remain under this preferred alternative bookend, including inseason bycatch closures.

The average annual projected harvest of Alaska plaice under PA.2 was 9,600 mt, with a majority of the harvest occurring in the EBS shelf yellowfin sole fishery. Due to the reduction in PSC limits, and proposed closures under PA.2, it is likely that the Alaska plaice fishery will become more restricted temporally and spatially (see FMP 3.2 map [Figure 4.2-5]) described in Section 4.2 for an illustration of these example closures.

Status Determination

Under PA.1 and PA.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Alaska plaice are below ABC and OFL levels from 2003 to 2008. Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI Alaska plaice under this preferred alternative bookend (same as FMP 1 and FMP 3.1). However, under PA.2, calculations of OY caps would be revisited for relevancy under existing environmental conditions and knowledge of current stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well. Under PA.2, procedures to account for uncertainty in ABC and species-specific production patterns would be developed, implemented and updated as necessary. These measures could affect the future catch limits of BSAI Alaska plaice in the future.

Age and Size Composition

Under PA.1 and PA.2, the mean age of the BSAI Alaska plaice stock in 2008, as computed in model projections (Table H.4-50 of Appendix H), is 4.40 years. This compares with a mean age in the equilibrium unfished stock of 4.51 years.

Sex Ratio

The sex ratio of BSAI Alaska plaice is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.1 or PA.2.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important Alaska plaice habitat where overlap occurs.

The existing closures would remain under PA.2, including the BSAI pollock bottom trawling ban. These closures would be reviewed to see if areas qualify for MPAs or could be redesignated as gear- or fishery-specific areas. NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. These example closure areas are illustrated in FMP 3.2 map (Figure 4.2-5) described in Section 4.2. Existing inseason bycatch closures (e.g., Pacific halibut hotspot areas) would be evaluated for effectiveness and modified as necessary.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2. A ban on a directed forage fishery would continue under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI Alaska plaice under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects**. The effect of fishing mortality on the BSAI Alaska plaice stock is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potentially adverse contributor to mortality of BSAI Alaska plaice. Acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not considered to be contributors to mortality since a change is not expected to be significant in magnitude sufficient to cause mortality.

- **Cumulative Effects.** Under PA.1 and PA.2, a cumulative effect is identified for BSAI Alaska plaice mortality, and is considered insignificant. Alaska plaice are fished above the ABC and OFL values. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Alaska plaice stock is expected to be insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** No lingering past effects on BSAI Alaska plaice have been identified.

- **Reasonably Foreseeable Future External Effects.** Marine pollution events are identified as potentially adverse contributors to BSAI Alaska plaice change in biomass level. Acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the stock is unable to maintain MSST. Climate changes and regime shifts are identified as potentially beneficial or adverse contributors to change in biomass level, since recruitment is affected by climate changes and regime shifts through a combination of prey availability and habitat suitability effects.

- **Cumulative Effects.** A cumulative effect is identified for BSAI Alaska plaice change in biomass, and it is rated as insignificant. The combination of internal and external factors are not expected to reduce Alaska plaice biomass such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

Spatial/Temporal Concentration of Catch
  – Change in Genetic Structure of Population
  – Change in Reproductive Success

- **Direct/Indirect Effects.** PA.1 and PA.2 would have an insignificant effect on BSAI Alaska plaice spatial and temporal characteristics.

- **Persistent Past Effects.** No persistent past effects have been identified for the genetic structure of the BSAI Alaska plaice population. Although, climate changes and regime shifts have been identified as having a potentially positive or negative effect on BSAI Alaska plaice reproductive success. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment tends to be favored.

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contribution to BSAI Alaska plaice genetic structure and reproductive success. Acute and/or chronic events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and could also result in reduced recruitment. Climate changes and regime shifts have been identified as potentially beneficial or adverse contributors to the reproductive success of BSAI Alaska plaice, but are not contributing factors to the genetic structure of Alaska plaice. The reproductive success is affected through a combination of climate induced changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect has been identified for the spatial and temporal concentration of BSAI Alaska plaice, and is rated as insignificant. The combined internal and external events are not expected to significantly alter the reproductive success or genetic structure such that it jeopardizes the capacity of the stock to maintain itself above MSST.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** PA.1 and PA.2 would have an insignificant effect on BSAI Alaska plaice prey availability.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having potentially negative or positive effects on BSAI Alaska plaice prey availability. Minimal research has been conducted on benthic invertebrates, the main prey species of Alaska plaice; therefore, the magnitude and direction of the effects imposed by climate changes and regime shifts are unknown.

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potentially adverse contributor to the prey availability of BSAI Alaska plaice. Acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above the MSST. Climate changes and regime shifts are identified as potentially beneficial or adverse contributors to BSAI Alaska plaice prey availability. However, as stated above, since minimal research has been conducted on the effects of climate changes on benthic invertebrates, the magnitude and direction of the changes are unknown.

- **Cumulative Effects.** A cumulative effect has been identified for the BSAI Alaska plaice change in prey availability, and is rated as insignificant. The combination of internal and external removals of prey species is not expected to decrease prey availability such that the BSAI Alaska plaice stock is unable to maintain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** PA.1 and PA.2 would have an insignificant effect on Alaska plaice habitat suitability.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries have been identified as having negative effects on BSAI Alaska plaice habitat. See Sections 3.5.1.10 and 3.6 for more information on the effects of fishing gear on flatfish habitat. Climate changes and regime shifts are also identified as having a potentially negative or positive effect on Alaska plaice habitat. See Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to BSAI Alaska plaice habitat suitability. Acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success of Alaska plaice. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse contributions to BSAI Alaska plaice habitat suitability. In general, when the Aleutian Low is strong and corresponding water temperatures are high, flatfish recruitment is favored.

- **Cumulative Effects.** A cumulative effect for BSAI Alaska plaice change in habitat suitability is identified, and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the BSAI Alaska plaice stock to maintain itself at or above the MSST is jeopardized.

See Table 4.5-17 for a summary of the cumulative effects on BSAI Alaska plaice under PA.1 and PA.2.

BSAI Other Flatfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Estimates of total and spawning biomass are not available for these species.

Fishing Mortality

The catch of BSAI other flatfish in 2002 was estimated to be 2,600 mt. Model projections of future catch are shown in Table H.4-51 of Appendix H. Under PA.1, model projections indicate that the catch is expected to decrease from the 2002 value to 2,100 mt in 2003 and then increase to 2,300 mt in 2007 (14 percent decrease from 2002). The 2003-2007 average catch is 2,200 mt. The other flatfish fishery is likely to be limited by Pacific halibut PSC limits which are expected to decrease by 0-10 percent in the BSAI under PA.1 Under PA.2, model projects indicate that the catch is expected to decrease from a 2002 value of 2,600 mt to a 2006 value of 1,900 mt, and then increase to 2,100 mt through 2007. The 2003-2007 average projected catch is 1,900 mt. The other flatfish fishery is likely to be limited by Pacific halibut PSC limits which are expected to decrease by 0-20 percent in the BSAI under PA.2.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future changes in Tier designation for BSAI other flatfish.

Given th low exploitation rates under PA.1 and PA.2, these FMPs are likely to have insignificant effects of the BSAI other flatfish species through mortality.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual BSAI other flatfish harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space. As mentioned above, the other flatfish fishery may also be restricted temporally due to reductions in PSC limits. Existing closures would remain under this preferred alternative bookend.

The other flatfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-20 percent in the BSAI under PA.2. This, in combination with the evaluation of inseason bycatch closures (for hotspot areas), could temporally and spatially restrict the fishery. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

Status Determination

The available information for flatfish species in the deep water complex requires that they are classified into either the Tier 4 or Tier 5 management category. As a result, no MSSTs are defined for these species. Therefore, it is not possible to determine their status.

Under PA.1 and PA.2, the ABC must be set below the OFL. Under PA.1, the OY range is specified to be between 1.4 and 2 million mt in the BSAI. In the BSAI, if the sum of TAC exceeds 2 million mt, then the TAC must be adjusted down. This means that the TAC, ABC and OFL values may all be reduced in the future for BSAI other flatfish under this preferred alternative bookend (same as FMP 1 and FMP 3.1). Under PA.2, OY caps would be recalculated for relevancy under existing environmental conditions and knowledge of stock levels. Ecosystem indicators would be developed and integrated into the TAC-setting system under this preferred alternative bookend and may affect catch limits in the future, as well.

Age and Size Composition

Age and size composition estimates are not available for these species.

Sex Ratio

The sex ratios of the species in the BSAI other flatfish category are assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this preferred alternative bookend.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing

MPAs would be developed. These measures may help reduce adverse impacts to important flatfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may help reduce adverse impacts to BSAI flatfish habitat where overlap occurs, although, as stated above, impacts to flatfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on other flatfish would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 and PA.2. The direct forage fishery ban would continue under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI other flatfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other flatfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects have not been identified for BSAI other flatfish mortality.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other flatfish, and is rated as insignificant. Fishing mortality rates for projected years are well below the other flatfish OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Past effects have not been identified for the BSAI other flatfish change in biomass level effect indicator.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other flatfish, but the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>
  - Change in Genetic Structure of Population
  - Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the spatial/temporal characteristics are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial/temporal characteristics are the same as those described for BSAI Alaska plaice under these bookends.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other flatfish catch; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** The effects on change in prey availability are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** The effects on change in prey availability are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI other flatfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for the habitat suitability of BSAI other flatfish are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects identified for habitat suitability are the same as those described for BSAI Alaska plaice under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for BSAI other flatfish habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

See Table 4.5-18 for a summary of the cumulative effects on BSAI other flatfish under PA.1 and PA.2.

GOA Rex Sole – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Estimates of total and spawning biomass are not available for this species.

Fishing Mortality

The catch of GOA rex sole in 2002 was estimated to be 3,000 mt. Model projections of future catch are shown in Table H.4-67 of Appendix H. Under PA.1, model projections indicate that the catch is expected to increase to 3,300 mt for each year 2003-2007. The 2003-2007 average value is 3,300 mt. Under PA.2, model projects indicate that catch is expected to decrease to 3,042 mt in 2007, with a 2003-2007 average of 3,068 mt. Rex sole catch may be limited in the GOA due to Pacific halibut PSC limits which are projected to be reduced by 0-20 percent under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

It is unknown what spatial/temporal characteristics of the annual GOA rex sole harvest would be affected under PA.1 since it is unknown what MPA efficacy methodology would be developed under this FMP. Bycatch management would include closing hot-spot areas which could disperse fishing locations in both time and space.

Pacific halibut PSC limit reductions, in combination with the development of inseason bycatch closures, could actually spatially and temporally restrict the fishery, under PA.2 (see FMP 3.2 map [Figure 4.2-5] described in Section 4.2); however, the effects are unknown. Procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA rex sole.

Status Determination

The available information for GOA rex sole requires that they are classified into the Tier 5 management category. As a result, no MSSTs are defined for this species. Therefore, it is not possible to determine their status. Under PA.1 and PA.2, the ABC must be set below the OFL. Under PA.1, the OY range for the GOA will be established between 116,000 and 800,000 mt and ecosystem indicators will be developed and used as part of the TAC-setting process. Under PA.2, OY caps would be revisited in light of existing environmental conditions and knowledge of stock levels. These measures may affect the catch limits for rex sole in the future under PA.1 and PA.2.

Age and Size Composition

Age and size composition estimates are not available for this species.

Sex Ratio

The sex ratio of rex sole in the GOA is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under these FMPs.

Current closure areas will remain under PA.1, including the eastern GOA trawl closure. A methodology for developing and adopting MPAs will be established and the program for identifying and designating EFH and HAPC will continue.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to GOA rex sole habitat where overlap occurs, although, as stated above, impacts to rex sole habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 on rex sole would be governed by a complex web of indirect interactions which are currently difficult to quantify. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 or PA.2. The directed forage fish ban will continue under this preferred alternative.

See Table 4.9-1 for a summary of the direct/indirect effects on GOA rex sole under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA rex sole is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Large removals of rex sole by the past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA rex sole stocks (see Section 3.5.1.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts are not considered to be contributing factors since the change in water temperatures would not likely be of sufficient magnitude to result in mortality of rex sole. Also the State of Alaska scallop fishery is not considered a contributing factor since it is not expected to contribute to direct mortality of rex sole.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA rex sole, and is rated as insignificant. Fishing mortality rates for projected years are well below the rex sole OFL. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock is not possible to be determined.

- **Persistent Past Effects.** Large removals of rex sole by past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA rex sole stocks (see Section 3.5.1.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause rex sole mortality. Climate changes and regime shifts have also been identified as having an indirect potentially beneficial or adverse effect on the rex sole biomass level. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and the temperatures cooler, recruitment tends to be weak. The State of Alaska Scallop Fishery is not considered to be a contributing factor since it is not expected to contribute to direct mortality of rex sole. For more information on climate changes and regime shifts see Sections 3.5.1.10 and 3.10.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA rex sole, but the effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine MSST.

- **Persistent Past Effects**. Past effects are not identified for genetic structure of the population; however, climate changes and regime shifts are identified as having persistent past effects on the reproductive success of the GOA rex sole stock (see Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the genetic structure of rex sole include the potentially adverse effects of marine pollution since an acute and/or chronic pollution event could alter the genetic structure of the population by causing localized mortality. Neither the State of Alaska scallop fishery nor climate changes and regime shifts are considered to be contributing factors to the change in genetic structure of rex sole stocks. These events are not expected to cause localized depletions that would alter the genetic sub-population structure of rex sole stock. Change in reproductive success of rex sole due to climate changes and regime shifts are identified as having a potentially beneficial or adverse effect. Marine pollution has been identified as a potentially adverse effect since acute and/or chronic pollution events could also the reproductive success of GOA rex sole. Again, the State of Alaska scallop fishery is not a contributing factor since the scallop fishery is not expected to contribute to rex sole removals.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the rex sole catch; however, this effect is unknown since it is not possible to determine MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had affected the prey availability of the GOA rex sole stock. The actual effect of climate changes and regime shifts on rex sole prey availability is unknown, but could have had a potential positive or negative effect (see Sections 3.5.1.10 and 3.10).

- **Reasonably Foreseeable Future External Effects**. Future external effects of climate changes and regime shifts on the GOA rex sole stock are potentially beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The State of Alaska scallop fishery has been identified as having a potentially adverse effect on rex sole prey availability since the habitat disturbances caused by dredging could influence the availability of benthic prey.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability; however, this effect is unknown since it is not possible to determine the MSST. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA rex sole is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for GOA rex sole include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. Habitat disturbances caused by the past foreign, JV, and domestic fisheries have also been identified as having persistent past effects on the GOA rex sole stock. See Sections 3.5.1.10 and 3.10). regarding the past fisheries and climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA rex sole stock are potentially beneficial or adverse. When the Aleutian Low is strong and water temperatures warm, flatfish recruitment is favored, likewise when the Aleutian Low is weak and water temperatures cooler, flatfish recruitment is reduced. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The State of Alaska scallop fishery is identified as having potentially adverse effects on rex sole habitat suitability that may cause changes in the spawning or rearing success of the stock.

- **Cumulative Effects.** A cumulative effect is identified for GOA rex sole habitat suitability; however, this effect is unknown. The combined effect of internal removals and removals due to reasonably foreseeable future external events may or may not jeopardize the capacity of the stock to maintain current population levels.

See Table 4.5-19 for a summary of the cumulative effects on GOA rex sole under PA.1 and PA.2.

4.9.1.11 Pacific Ocean Perch

Pacific ocean perch (*Sebastes alutus*) are managed under Tier 3 in the BSAI and GOA.

BSAI Pacific Ocean Perch – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 374,000 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-53 of Appendix H.

Under PA.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 392,000 mt in 2007 with a 2003-2007 average value of 383,000 mt. Under PA.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 402,000 mt in 2007, with a 2003-2007 average value of 388,000 mt.

Spawning Biomass

Spawning biomass of BSAI Pacific ocean perch at the start of 2003 is estimated to be 135,500 mt. Model projections of future total BSAI Pacific ocean perch biomass are shown in Table H.4-53 of Appendix H. Under PA.1, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 137,500 mt in 2007, with a 2003-2007 average value of 136,200 mt. Under PA.2, model projections indicate that BSAI Pacific ocean perch biomass is expected to increase to a value of 142,300 mt in 2007, with a 2003-2007 average value of 138,600 mt.

Fishing Mortality

Under PA.1, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is 0.033 in 2003, decreasing to 0.029 in 2005, and increasing 0.035 in 2007, with an average from 2003-2007 of 0.032 (Table H.4-53 of Appendix H).

Under PA.2, the projected fishing mortality imposed on the BSAI Pacific ocean perch stock is approximately 0.023 in each year from 2003 to 2007. The proportion of spawner biomass per recruit conserved under this fishing mortality rate is 60 percent (Table H.4-53 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Under PA.1, a projected average of 10,600 mt of BSAI Pacific ocean perch are caught annually from 2003 to 2007, with about half of the harvest occurring in the eastern Aleutian Islands. The harvest in this area occurs largely from the directed fishery, although the Atka mackerel fishery is projected to harvest approximately 1,000 mt annually from 2003-2007.

As with PA.1, the eastern Aleutians Islands contributes the largest proportion of the BSAI Pacific ocean perch catch. The average annual projected catch from 2003-2007 was 7,830 mt, of which approximately half is expected to occur in the eastern Aleutian Islands. The directed Pacific ocean perch fishery accounted entirely for the Pacific ocean perch harvest in this area in 2003 and 2004, but from 2005-2006 the Atka mackerel fishery was projected to harvest approximately 1,000 mt of Pacific ocean perch annually from this region. A series of no-take reserves is also specified under PA.2, but comparison with the recent spatial distribution of the fishery indicates that substantial areas would remain open for Pacific ocean perch fisheries. The Pacific halibut PSC limits, which are projected to be reduced by 0-20 percent under this FMP, could restrict the Pacific ocean perch fishery if large amounts of bycatch were to occur.

Status Determination

Under PA.1 and PA.2, the ABC is set lower than the OFL, creating a buffer between these two harvest regulations. Model projections of future catches of BSAI Pacific ocean perch are below ABC and OFL levels from 2003 to 2008. The projected spawning stock biomass is projected to be greater than the B_{MSY} ($B_{35\%}$)

level of 120,200 mt in each year of the projection, so BSAI Pacific ocean perch are above the MSST level under PA.1 and PA.2. Under PA.1, the BSAI OY is specified between 1.4 and 2.0 million mt. This means that if the sum of the TACs in the BSAI exceeds 2.0 million mt, TACs must be reduced. However, under PA.2, OY caps would be revisited for relevance under existing environmental conditions and stock levels. Ecosystem indicators will also be built into the TAC-setting process under these preferred alternative bookend. These measures could affect the future catch limits of BSAI Pacific ocean perch.

Age and Size Composition

Under PA.1, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-53 of Appendix H), is 10.37 years. Under PA.2, the mean age of the BSAI Pacific ocean perch stock in 2008, as computed in model projections (Table H.4-53 of Appendix H), is 10.53 years. This compares with a mean age in the equilibrium unfished stock of 14.01 years.

Sex Ratio

The sex ratio of BSAI Pacific ocean perch is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under this PA.1 or PA.2.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important Pacific ocean perch habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs or redesignating current closure areas as fishery- or gear-specific. A management area in the Aleutian Islands would be developed to protect coral and live bottom habitats and the EFH and HAPC identification and mitigation process would also be continued under PA.2. These measures could help to reduce the adverse impacts to BSAI Pacific ocean perch habitat where overlap occurs.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on BSAI Pacific ocean perch.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI Pacific ocean perch stock is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had negative effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to BSAI Pacific ocean perch mortality since no bycatch is expected in this fishery. Marine pollution is identified as a potentially adverse contributor since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not expected to contribute to Pacific ocean perch mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI Pacific ocean perch, and it is rated as insignificant. Pacific ocean perch are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the BSAI Pacific ocean perch stock is expected to be insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** The past foreign, JV, and domestic fisheries are identified as having had negative effects on the BSAI Pacific ocean perch stock. Large removals of Pacific ocean perch occurred in the past and there appears to be a lingering effect on the BSAI populations (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute significantly to BSAI Pacific ocean perch mortality since no bycatch is expected in this fishery. Therefore, the IPHC longline fishery is not expected to cause significant changes in biomass levels. Marine pollution is identified as a potentially adverse contributor since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as beneficial or adverse contributors to Pacific ocean perch change in biomass levels as a function of reproductive success.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified and rated as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial and temporal changes should have an insignificant effect on the genetic structure and reproductive success of the BSAI Pacific ocean perch population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure. However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is not expected to contribute to changes in genetic structure or reproductive success of BSAI Pacific ocean perch since no bycatch of BSAI Pacific ocean perch is expected in this fishery. Marine pollution is identified as a potentially adverse contributor since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potentially beneficial or adverse contributors to reproductive success since changes in climate can affect prey availability and/or habitat suitability which in turn can affect recruitment. Generally, changes in climate changes that lead to increased advection of the Alaska current are believed to increase euphausiid production, a major prey item of BSAI Pacific ocean perch. Climate changes and regime shifts are not considered contributors to changes in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration, and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** PA.1 and PA.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on Pacific ocean perch prey species (see Section 3.5.1.11).

- **Reasonably Foreseeable Future External Effects.** Future external effects of climate changes and regime shifts on Pacific ocean perch prey species are identified as potential beneficial or adverse contributors. In general, it is believed that climate changes and regime shifts that lead to the increased advection of the Alaska current also increase production of euphausiids, a major prey item of BSAI Pacific ocean perch. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect identified for prey availability is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** PA.1 and PA.2 would have an insignificant effect on Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for BSAI Pacific ocean perch stocks include past foreign, JV, and domestic fisheries, IPHC longline fisheries, climate changes and regime shifts (see Section 3.5.1.11). Intense bottom trawling on Pacific ocean perch habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the BSAI. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries are also identified as having negative effects on Pacific ocean perch habitat, although these fishing gear impacts are considered to be less significant than those associated with trawl gear (see Section 3.6 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both positive and negative effects on Pacific ocean perch habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery is identified as having an adverse effect on Pacific ocean perch habitat through fishing gear impacts. As stated above, these impacts are expected to be of lesser magnitude than those effects associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the BSAI Pacific ocean perch stock are identified as potentially beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-20 for a summary of the cumulative effects on BSAI Pacific ocean perch under PA.1 and PA.2.

GOA Pacific Ocean Perch – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total biomass of GOA Pacific ocean perch at the start of 2003 is estimated to be 338,000 mt. Model projections of future total GOA Pacific ocean perch biomass are shown in Table H.4-77 of Appendix H. Under PA.1, model projections indicate that GOA Pacific ocean perch biomass is expected to increase to a value of 361,000 mt in 2007 with a 2003-2007 average value of 349,000 mt. Under PA.2, model projections indicate that GOA Pacific ocean perch biomass is expected to increase to a value of 376,000 mt in 2007 with a 2003-2007 average value of 358,000 mt.

Spawning Biomass

Spawning biomass of GOA Pacific ocean perch at the start of 2003 is estimated to be 112,700 mt. Model projections of future total GOA Pacific ocean perch biomass are shown in Table H.4-77 of Appendix H. Under PA.1, model projections indicate that GOA Pacific ocean perch biomass is expected to increase to a value of 115,500 mt in 2007, with a 2003-2007 average value of 113,200 mt. Under PA.2, model projections indicate that GOA Pacific ocean perch biomass is expected to increase to a value of 122,500 mt in 2007, with a 2003-2007 average value of 117,300 mt.

Fishing Mortality

Bycatch model results for PA.1 show catches comparable to FMP 1 for GOA Pacific ocean perch and therefore appear reasonable. Average fishing mortality during the years 2003 - 2007 is expected to be less than F_{OFL} (0.060) (Table H.4-77 of Appendix H).

PA.2 requires that appropriate harvest strategies be developed for rockfish. If these strategies were to use F_{60} as the basis for determining ABCs, then the catch of GOA Pacific ocean perch would be reduced because they are included in the slope rockfish assemblage. Under PA.2 the PSC limits for Pacific halibut could also be reduced by 0-10 percent. If the GOA Pacific ocean perch are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could also reduce catch of GOA Pacific ocean perch. Bycatch model results using F_{60} as a harvest strategy for PA.2 show catches reduced from FMP 1 for GOA Pacific ocean perch and therefore, appear reasonable. Average fishing mortality during the years 2003-2008 is expected to be less than F_{OFL} (0.060) (Table H.4-77 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effects that PA.1 has on the spatial and temporal concentration of Pacific ocean perch catch depends on the decisions made by NPFMC. The spatial distribution of catch would not be affected by proposed closures, and the apportionment of catch among management areas should provide some protection against localized depletion. Concentrating fishery effort into a short season would likely continue unless NPFMC implemented some “rights-based” management scheme.

The effects of PA.2 on the spatial and temporal concentration of Pacific ocean perch catch depends on the decisions made by NPFMC. The spatial distribution of catch would not be affected by proposed closures and apportionment of catch among management areas should provide some protection against localized depletion (see FMP 3.2 map [Figure 4.2-5] which illustrates the closures, similar to those proposed for PA.2; FMP 3.2 map is discussed in Section 4.2). The implementation of fishery rationalization should also spread out the fishery in time and space. PA.2 may also potentially have a large effect on the spatial concentration of Pacific ocean perch catch if 20 percent of the GOA is set aside as no-take reserves or as MPAs. Pacific ocean perch catches are taken in directed fisheries where the effort is highly localized and concentrated in slope areas. Much of this effort occurs in proposed closed areas. Therefore, if the proposed MPAs are closed to all bottom trawling, the spatial concentration of fishing effort would likely shift from the closure areas to the remaining open areas. The effect of shifting effort away from the closed areas is unclear.

Under PA.2 the spatial and temporal concentration of fishing effort may also be affected by Pacific halibut bycatch considerations if they substantially change the distribution of fishing effort.

Status Determination

Under PA.1 and PA.2, the projected 2003 biomass of 112,700 mt under PA.1, and 113,500 mt under PA.2, is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected 2005 biomass of 116,700 mt is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition.

Age and Size Composition

Under PA.1 and PA.2, the age composition of GOA Pacific ocean perch may be changed under fishing pressure as in FMP 1. Size composition of GOA Pacific ocean perch might change in proportion to the change in age composition. Age and size composition could also change if Pacific halibut bycatch considerations substantially change the distribution of fishing effort. The projected average age at the end of 2007 for GOA Pacific ocean perch is 10.61 years under PA.1 and 10.85 years under PA.2, compared to a projected unfished population age of 14.33 years (Table H.4-77 of Appendix H).

Sex Ratio

No information is available to suggest that the sex ratio would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Under PA.1 damage to epifauna by bottom trawls may negatively impact juvenile Pacific ocean perch habitat. PA.1 may also positively affect habitat for GOA Pacific ocean perch because it maintains the eastern GOA closure to trawling. This provides a de facto no-take zone or refugium for Pacific ocean perch in this area and provides protection from the potential effects of trawling on adult and or juvenile rockfish habitat.

Under PA.2, bottom trawl damage to epifauna would likely be reduced due to less fishing pressure and would likely result in less impact to juvenile Pacific ocean perch habitat. PA.2 may also have a positive effect on the habitat of GOA Pacific ocean perch because it maintains the eastern GOA closure to trawling and proposes to set aside 0-20 percent of the GOA as no-take reserves or as marine protected areas (MPAs). If the proposed MPAs are closed to all bottom trawling, then additional refuges for Pacific ocean perch and/or protection of juvenile rockfish habitat from the potential effects of trawling could be provided in these zones.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA Pacific ocean perch.

Cumulative Effects Analysis of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA Pacific ocean perch stock is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those described for GOA Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA Pacific ocean perch is rated as insignificant. Pacific ocean perch are fished below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA Pacific ocean perch stock is expected to be insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect for change in biomass is identified and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the Pacific ocean perch biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch
– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Impacts of the spatial and temporal changes should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects on the spatial and temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the spatial and temporal characteristics of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of GOA Pacific ocean perch, and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects.** PA.1 and PA.2 would have insignificant effects on Pacific ocean perch prey availability.

- **Persistent Past Effects**. Past effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is identified for prey availability, and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the Pacific ocean perch stock is unable to sustain itself at or above MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** PA.1 and PA.2 would have insignificant effects on GOA Pacific ocean perch habitat suitability.

- **Persistent Past Effects.** Past effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability of GOA Pacific ocean perch are the same as those described for BSAI Pacific ocean perch under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect identified for habitat suitability is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the Pacific ocean perch stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-21 for a summary of the cumulative effects on GOA Pacific ocean perch under PA.1 and PA.2.

4.9.1.12 Thornyhead Rockfish

GOA thornyhead rockfish are described in more detail in Section 3.5.1.12 of this Programmatic SEIS. Until recently, thornyhead rockfish is managed as its own stock under the GOA Groundfish FMP under the Tier 3 management category, thus MSSTs are defined for these species. Beginning in 2004, thornyhead rockfish will be managed under Tier 5; however, for the purposes of this analysis, thornyhead rockfish were modeled as a Tier 3 species.

Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total (ages 5 through 55+) biomass of GOA thornyheads at the beginning of 2002 is estimated to be 54,000 mt. Model projections of future total GOA biomasses are shown in Table H.4-78 of Appendix H. Under PA.1, model projections indicate that total GOA biomass is expected to remain at 54,000 mt until 2003, then slowly increase to 55,000 mt by 2006, with a 2003-2007 average value of 55,000 mt. Under PA.2, model projections indicate that total GOA biomass is expected to remain at 54,000 mt in 2003, then slowly increase to 57,000 mt by 2007, with a 2003-2007 average value of 56,000 mt.

Spawning Biomass

Spawning biomass of female GOA thornyheads at the start of 2002 is estimated to be 23,500 mt. Model projections of future GOA spawning biomasses are shown in Table H.4-78 of Appendix H. Under PA.1, model projections indicate that GOA spawning biomass is expected to increase to 23,600 mt by 2003, then slowly increase to 24,300 mt by 2007, with a 2002-2007 average value of 23,900 mt. Under PA.2, model projections indicate that GOA spawning biomass is expected to increase to 23,600 mt by 2004, and continue increasing to 25,200 mt by 2007, with a 2002-2007 average value of 24,400 mt.

Fishing Mortality

The average fishing mortality imposed on the GOA thornyhead stock in 2002 is projected to be 0.032 under current management. Under PA.1, fishing mortality is projected to decrease to 0.025 in 2003 and further decrease to 0.020 in 2007. PA.2 appropriate harvest strategies are to be developed for rockfish. Should these strategies use F_{60} as the harvest rule, then fishing mortality is projected to decrease to 0.013 in 2003 and further decrease to 0.012 in 2007. These values are well below the F_{MSY} proxy value of 0.102 which is the rate associated with the OFL (Table H.4-78 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

Thornyhead catch is approximately evenly divided between longliners and trawlers under status quo management. There is nothing about PA.1 or PA.2 that is expected to change this. Longline catches are spatially dispersed along the continental shelf break throughout the GOA (Figure 4.5-1), and temporally dispersed due to the nature of the IFQ sablefish fishery. For example, longline thornyhead catches in 2000 occurred year-round, with peaks in April and September, that did not exceed 60 mt per week. Trawler catch has been more concentrated in time, with some catches of 20-40 mt per week occurring in late spring, with a single large peak of 160 mt per week in July of 2000, coinciding with the rockfish trawl fishery.

Between 1997 and 1999, thornyhead trawl catches appear to have become more concentrated in space (Figure 4.5-2). According to surveys, during 1997-1999, the distribution of thornyheads did not appear to change (Figure 4.5-3). This apparent concentration may be the indirect result of changes in the trawl fisheries for deepwater flatfish and rockfish since thornyheads are not a primary target of trawl fisheries. However, it should be noted that the overall catch of thornyheads is low relative to both the estimated biomass and the ABC, such that this apparent concentration of catch is unlikely to have any negative population effects.

Status Determination

The GOA thornyhead stock is not currently overfished. At 23,500 mt, spawning stock biomass is expected to remain well above both the $B_{35\%}$ level (14,681 mt) and the $B_{40\%}$ level (16,045 mt) during the year 2002 and will remain above $B_{40\%}$ in all projection years under PA.1 and PA.2. Under PA.1 and PA.2, the ABC must be set below the OFL and the GOA OY cap has been set between 116,000 and 800,000 mt. Ecosystem considerations will be implemented into the TAC-setting process under this bookend, which may result in changes to catch limits in the future.

Age and Size Composition

Under PA.1, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-78 of Appendix H), is 10.15 years. Under PA.2, the mean age of the GOA thornyhead stock in 2007, as computed in model projections (Table H.4-78 of Appendix H), is 10.35 years. This compares with a mean age in the equilibrium unfished GOA stock of 12.67 years.

Sex Ratio

The sex ratio of GOA thornyheads is assumed to be 50:50. No information is available to suggest that this would change under PA.1 and PA.2.

Habitat-Mediated Impacts

Under PA.1, all current management measures would be maintained. The level of habitat disturbance under PA.1 (and FMP 1) does not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this FMPs.

Under PA.2, all current management measures would be maintained. Furthermore, an Aleutian Islands management area would be established to protect coral and live bottom habitats. Pollock bottom trawling would be prohibited throughout the entire GOA and 0-20 percent of the GOA would be established as MPAs and no-take reserves. EFH and HAPC programs that identify, designate and implement mitigation measures would continue under PA.2. The level of habitat disturbance under FMP 1 (and PA.2) does not appear to affect the sustainability of thornyheads either through changes in the genetic structure of the population or changes in reproductive success, as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude whether or not existing habitat-mediated impacts would undergo significant qualitative change during the next 5 years under this FMP.

Predation-Mediated Impacts

In the GOA, shortspine thornyheads prey on benthic invertebrates; according to the AFSC food habits database, much of their diet in the 1990s has been composed of shrimp. Thornyheads are rare in the diets of other groundfish, birds, or marine mammals in the GOA according to the present limited information. Therefore, the effects of status quo federal groundfish fisheries on trophic interactions involving GOA thornyheads are expected to be minor. The current levels and distribution of groundfish harvest do not appear to impact prey availability for thornyheads such that it affects the sustainability of the stock as measured by the ability of the stock to maintain itself above its MSST. Information is insufficient to conclude that existing trophic interactions would undergo significant qualitative change during the next 5 years under PA.1 and PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects of PA.1 and PA.2 on GOA thornyhead rockfish.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA thornyhead rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. The removals of thornyhead rockfish that occurred in these fisheries have had a lingering negative effect on the populations (see Section 3.5.1.12 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts are not considered contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of thornyhead rockfish. The IPHC longline fishery is identified as a potentially adverse contributor to thornyhead rockfish mortality since they are caught as bycatch in this fishery. However, the State of Alaska shrimp fishery is not considered a contributing factor since thornyhead rockfish bycatch is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA thornyhead rockfish and is rated as insignificant. Fishing mortality at projected levels is well below the OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass Level

- **Direct/Indirect Effects.** PA.1 and PA.2 are expected to have insignificant effects on these stocks.

- **Persistent Past Effects.** Past effects include past foreign, JV, and domestic groundfish fisheries. Past removals by these fisheries have had a lingering negative effect on the GOA thornyhead rockfish populations (see Section 3.5.1.12 for more information.

- **Reasonably Foreseeable Future External Effects.** Future external effects on change in biomass level are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause thornyhead rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the thornyhead rockfish biomass level. A strong Aleutian Low and high water temperatures tend to favor recruitment whereas a weak Aleutian Low and cooler water temperatures tend to result in weak recruitment. For more information on climate changes and regime shifts, please see Sections 3.5.1.12 and 3.10. The IPHC longline fishery is identified as a potentially adverse contributor to the thornyhead rockfish biomass level since they are caught as bycatch in this fishery. The State of Alaska shrimp fishery is not considered to be a contributing factor since thornyhead rockfish bycatch is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the change in biomass level of GOA thornyhead rockfish and is rated as insignificant. The spawning biomass is above the B_{MSY} value for all years. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock to sustain itself above the MSST.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is considered insignificant for the stock.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of the GOA thornyhead rockfish. Climate changes and regime shifts have been identified as having a persistent past effect on the reproductive success of GOA thornyhead rockfish. Climate changes and regime shifts and corresponding water temperature variation could affect prey availability and habitat suitability, which in combination could affect the reproductive success of the thornyhead rockfish stock.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of thornyhead rockfish include contributions from climate changes and regime shifts which may be potentially beneficial or adverse. Marine pollution has also been identified as having a potentially adverse effect since acute and/or chronic pollution events could alter the genetic structure and/or the reproductive success of GOA thornyhead rockfish. The IPHC longline fishery removals of thornyheads could be sufficiently concentrated as to alter the genetic structure and reproductive success of GOA thornyhead rockfish populations and are therefore identified as potentially adverse contributors. The State of Alaska shrimp fishery is not considered to be a contributing factor since bycatch of thornyhead rockfish is not expected in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal concentration of the thornyhead rockfish catch, and is ranked as insignificant. The spatial and temporal distribution of thornyhead rockfish catch is not expected to change significantly. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above the MSST is jeopardized.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the GOA thornyhead rockfish is expected to be insignificant.

- **Persistent Past Effects.** Past effects include climate changes and regime shifts. Climate changes and regime shifts and corresponding water temperature variation do affect the availability of some prey species (i.e. shrimp); however, this has not been confirmed by scientific studies in the GOA.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock may be potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST. The IPHC longline fishery is not considered to be a contributing factor since bycatch of GOA thornyhead rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potentially adverse contributor to prey availability since removal of shrimp, the main prey species of GOA thornyhead rockfish, occurs in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability, and is considered insignificant. The combination of internal and external removals of prey is not expected to jeopardize the ability of the stock to sustain itself above the MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the GOA thornyhead rockfish is ranked as insignificant.

- **Persistent Past Effects.** Past effects identified for GOA thornyhead rockfish include climate changes and regime shifts.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the GOA thornyhead rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fishery has been identified as a potential adverse contributor to GOA thornyhead rockfish habitat suitability. See Section 3.6 for information on the impacts of fishery gear on EFH. The State of Alaska shrimp fishery is not considered to be a contributing factor since habitat degradation by the shrimp fishery gear is not expected to occur.

- **Cumulative Effects.** A cumulative effect is identified for GOA thornyhead rockfish habitat suitability, and is considered insignificant. The combination of internal and external habitat disturbances is not expected to lead to a detectable change in spawning or rearing success such that the ability of the thornyhead rockfish stock to sustain itself at or above the MSST is jeopardized.

See Table 4.5-22 for a summary of the cumulative effects on GOA thornyhead rockfish under PA.1 and PA.2.

4.9.1.13 Rockfish

Rockfish are considered in more detail in Section 3.5.1.13.

BSAI Northern Rockfish

Until recently, BSAI northern rockfish were a part of the BSAI red rockfish assemblage and evaluated under Tier 5. As of 2004, northern rockfish will be evaluated under Tier 3 with their own age-structured model, and the red rockfish group will no longer exist. However, for the purposes of this analysis, BSAI northern rockfish were modeled as a Tier 5 species.

Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for this species.

Fishing Mortality

The catch of BSAI northern rockfish in 2003 was estimated as 4,600 mt. Projected catches from 2003-2007 are shown in Table H.4-56 of Appendix H. Under PA.1, model projections indicate that the catch is expected to increase to 6,390 mt in 2003, then decrease to 5,510 mt in 2007. The 2003-2007 average catch is 5,790 mt. The northern rockfish fisheries may be limited by Pacific halibut PSC limits which are projected to decrease between 0-10 percent under PA.1. Under PA.2, appropriate harvest strategies for rockfish are to be developed. Should these strategies use F_{60}, then the projected catch is expected to decrease to 2,942 mt in 2003 and then increase through 2007 to 3,717 mt. The 2003-2007 average catch is 3,442 mt. The northern rockfish fisheries may be limited by Pacific halibut PSC limits which are projected to decrease between 0-20 percent under PA.2.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on BSAI northern rockfish through mortality.

Spatial/Temporal Concentration of Fishing Mortality

Model projections indicate that the average harvest of 5,790 mt from 2003-2007 occurs largely in the eastern Aleutian Islands (approximately 55 percent), with 1,200 mt (22 percent) occurring in the central Aleutian Islands and 1,100 mt (19 percent) coming from the western Aleutian Islands. The harvest of northern rockfish in the each of these areas is taken largely in the Atka mackerel fishery. As stated above, the northern rockfish fisheries may be limited by Pacific halibut PSC limits under PA.1.

BSAI northern rockfish catch may be limited due to Pacific halibut PSC limits which are projected to be reduced by 0-25 percent under PA.2. Procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for BSAI rockfish.

Status Determination

The catch rates are below the ABC and OFL values for all years. The MSST for northern rockfish cannot be determined. Under PA.1, the BSAI OY cap is established between 1.4 and 2.0 million mt. Under PA.2, OY caps would be revisited for relevancy with existing environmental conditions and knowledge of stock status. If the sum of the TACs for the BSAI target fish exceeds 2.0 million mt, than TACs must be reduced. As part of PA.1 and PA.2, ecosystem indicators would be implemented into the TAC setting process.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for this species. The sex ratio of BSAI northern rockfish is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.1 or PA.2.

Current closure areas would remain under this preferred alternative bookend, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important northern rockfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and an Aleutian Islands management area would be established to protect live bottom and coral habitat. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to BSAI rockfish habitat where overlap occurs, although, as stated above, impacts to rockfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI northern rockfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI northern rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on BSAI northern rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts are not considered to be contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of northern rockfish. The IPHC longline fishery is not considered a contributing factor since bycatch of BSAI northern rockfish is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI northern rockfish, and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on BSAI northern rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the change in biomass level are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause northern rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the northern rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery is not considered to be a contributing factor since bycatch of BSAI northern rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI northern rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI northern rockfish. Climate changes and regime shifts are identified as having a potentially beneficial/negative effect on BSAI northern rockfish (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success of northern rockfish due to climate changes and regime shifts are potentially beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of northern rockfish. Marine pollution has been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI northern rockfish. The IPHC longline fishery is not considered to be a contributing factor to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in this fishery.

- **Cumulative Effects**. A cumulative effect is possible for the spatial/temporal concentration of the northern rockfish catch; however, this effect is unknown since it is not possible to determine the MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI northern rockfish stock. The actual effect of climate changes and regime shifts on northern rockfish prey availability is unknown, but could have had a potentially positive or negative effect (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery is not considered to be a contributing factor since it is unlikely that bycatch of northern rockfish prey species occurs in this fishery see Section 3.5.1.13 for more information on the trophic interactions of BSAI northern rockfish species.

- **Cumulative Effects.** A cumulative effect is possible for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI northern rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI northern rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in northern rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on northern rockfish species habitat suitability, possibly having disrupted northern rockfish species spawning and/or rearing habitats. See Section 3.5.1.13 for more information on the past events that have effected northern rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI northern rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potentially adverse effect on the northern rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt northern rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, the effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the northern rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

See Table 4.5-23 for a summary of the cumulative effects on BSAI northern rockfish under PA.1 and PA.2.

BSAI Shortraker/Rougheye Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these stocks.

Fishing Mortality

The catch of BSAI shortraker/rougheye rockfish in 2003 was estimated as 570 mt. Projected catches from 2003-2007 are shown in Table H.4-57 of Appendix H. Under PA.1, model projections indicate that the catch is expected to range between 700 and 900 mt from 2003-2007, with an average of 800 mt. As stated above, the shortraker/rougheye rockfish fishery may be limited by Pacific halibut PSC limits. PA.2 requires that appropriate harvest strategies be developed for rockfish. Should these strategies use F_{60} to determine ABCs, then the projected catch is expected to decrease to 419 mt through 2007 with a 2003-2007 average catch is 419 mt. The rockfish fisheries may be limited by Pacific halibut PSC limits which are projected to decrease between 0-20 percent under PA.2.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on BSAI shortraker/rougheye rockfish through mortality.

Spatial/Temporal Concentration of Fishing Mortality

Model projections indicate that the average harvest of 800 mt from 2003-2007 is relatively evenly spread among the three Aleutian Islands subareas, with between 26 percent and 32 percent of the harvest occurring in each subarea. The harvest in the western and eastern Aleutian Islands occurs largely in the Pacific ocean perch trawl fishery, whereas the harvest in the central Aleutian Islands occurs largely in the Pacific cod longline fishery. The shortraker/rougheye rockfish fishery may be limited by Pacific halibut PSC limits which are expected to decrease by 0-10 percent under PA.1.

BSAI shortraker/rougheye rockfish catch may be limited due to Pacific halibut PSC limits which are projected to be reduced by 0-25 percent under PA.2. Procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for BSAI rockfish.

Status Determination

The catch rates are below the ABC and OFL values for all years. The MSST for this stock cannot be determined. Under PA.1, the BSAI OY cap is established between 1.4 and 2.0 million mt. If the sum of the TACs for the BSAI target fish exceeds 2.0 million mt, than TACs must be reduced. Under PA.2, calculations of OY caps would be revisited for relevance with existing environmental conditions and knowledge of stock status. As part of PA.1 and PA.2, ecosystem indicators would be implemented into the TAC setting process.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. The sex ratio of BSAI shortraker/rougheye rockfish is assumed to be 50:50. No information is available to suggest that this would change under PA.1 or PA.2.

Habitat-Mediated Impacts

Any habitat-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that existing habitat-mediated impacts would undergo significant qualitative change under PA.1 or PA.2.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important shortraker/rougheye rockfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and an Aleutian

Islands management area would be established to protect live bottom and coral habitat. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to BSAI rockfish habitat where overlap occurs, although, as stated above, impacts to rockfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat-mediated impacts, any predation-mediated impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that trophic interactions would undergo significant qualitative change under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI shortraker/rougheye rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are not considered to be contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and the State of Alaska shrimp fishery are not considered to be contributing factors since bycatch of BSAI shortraker/rougheye rockfish is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI shortraker/rougheye rockfish, and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the fishery on biomass level is rated as unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on BSAI shortraker/rougheye rockfish (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery and the State of Alaska shrimp fishery are not considered to be contributing factors since bycatch of BSAI shortraker/rougheye rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

<u>Spatial/Temporal Concentration of Catch</u>

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is unknown since it is not possible to determine the MSST.

- **Persistent Past Effects.** Past effects are not identified for the change in genetic structure of BSAI shortraker/rougheye rockfish. Climate changes and regime shifts are identified as having a potentially beneficial/negative effect on BSAI shortraker/rougheye rockfish (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects**. Future external effects on the reproductive success of shortraker/ rougheye rockfish due to climate changes and regime shifts are potentially beneficial or adverse. However, climate changes and regime shifts are not expected to be sufficient to alter the genetic sub-population structure of shortraker/rougheye rockfish. Marine pollution has been identified as a potentially adverse effect since acute and/or chronic pollution events could alter the genetic sub-population structure and/or the reproductive success of BSAI shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery are not considered to be contributing factors to the genetic structure and reproductive success of the other rockfish species since bycatch of this species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the shortraker/rougheye rockfish catch; however, this effect is unknown since is not possible to determine the MSST.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as persistent past effects for the change in prey availability of the BSAI shortraker/rougheye rockfish stock. The actual effect of climate changes and regime shifts on shortraker/rougheye rockfish prey availability is unknown, but could have had a potential positive or negative effect (see Sections 3.5.1.13 and 3.10).

- **Reasonable Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to maintain current population levels. The IPHC longline fishery is not considered a contributing factor since it is unlikely that bycatch of shortraker/rougheye rockfish prey species occurs in this fishery. The State of Alaska shrimp fishery is identified as a potentially adverse contributor to BSAI shortraker/rougheye prey availability since shrimp is on e of the main prey species of rougheye rockfish. See Section 3.5.1.13 for more information on the trophic interactions of BSAI shortraker/rougheye rockfish species.

- **Cumulative Effects.** A cumulative effect is identified for change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI shortraker/rougheye rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects identified for BSAI shortraker/rougheye rockfish include climate changes and regime shifts. The actual effects of climate changes and regime shifts on habitat suitability are unknown, but could have a potentially beneficial or adverse effect. The past foreign, JV, and domestic groundfish fisheries are identified as having a past adverse effect on habitat suitability, largely due to the intense bottom trawling that has occurred in shortraker/rougheye rockfish species habitat. The IPHC longline fishery has also been identified as having had an adverse effect on shortraker/ rougheye rockfish species habitat suitability, possibly having disrupted shortraker/rougheye rockfish species spawning and/or rearing habitats. The State of Alaska shrimp fishery is not considered a contributing factor to shortraker/rougheye rockfish habitat suitability since habitat degradation by shrimp fishery gear is not expected to occur. See Section 3.5.1.13 for more information on the past events that have effected shortraker/rougheye rockfish habitat suitability.

- **Reasonably Foreseeable Future External Effects.** Future external effects of the climate changes and regime shifts on the BSAI shortraker/rougheye rockfish stock are potentially beneficial or adverse. Marine pollution has also been identified as a potentially adverse effect since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. The IPHC longline fisheries have also been identified as having a potentially adverse effect on the shortraker/rougheye rockfish habitat suitability. These fisheries are expected to continue into the future and could disrupt shortraker/rougheye rockfish species spawning and/or rearing habitats.

- **Cumulative Effects.** A cumulative effect is possible for the change in habitat suitability; however, this effect is unknown since the MSST is unable to be determined. It is unknown whether the combined effects will make the shortraker/rougheye rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

See Table 4.5-24 for a summary of the cumulative effects on BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

BSAI Other Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Reliable estimates of total and spawning biomass are not available for these species.

Fishing Mortality

Under PA.1, the projected catch of Aleutian Islands other rockfish in 2003 to 2007 ranged from 200 mt to 300 mt, with and average of 260 mt. The projected harvest of EBS other rockfish from 2003 to 2007 was about 100 mt in each year. Projected catches from 2003-2007 are shown in Tables H.4-54 and H.4-55 of Appendix H. Under PA.2, appropriate harvest strategies for rockfish are to be developed. Should these strategies use F_{60} as the harvest rule, then the projected catch of EBS other rockfish is expected to decrease to 72 mt in 2003 and continue to decrease through 2007 to 66 mt. The 2003-2007 average catch is 69 mt. The projected catch of Aleutian Islands other rockfish is expected to decrease to 151 mt in 2003 and continue to decrease through 2007 to 130 mt. The 2003-2007 average catch is 140 mt. These projections suggest that direct fishing mortality on other rockfish stocks will be very low relative to the OFL and that such harvest levels will not present any significant impact to the species ability to maintain current population levels. Other rockfish fisheries may be limited by Pacific halibut PSC limits which are expected to decrease by 0-10 percent under PA.1. The rockfish fisheries may be limited by Pacific halibut PSC limits which are projected to decrease between 0-20 percent under PA.2.

Spatial/Temporal Concentration of Fishing Mortality

In the Aleutian Islands, 89 percent of the average harvest of 300 mt occurs in the cental and western Aleutian Islands, taken largely in the Atka mackerel and Pacific cod trawl fisheries and the Pacific cod and sablefish longline fisheries. In the EBS, the average catch of 100 mt is taken largely in the Pacific cod and Greenland turbot bottom trawl fisheries and the sablefish and Greenland turbot longline fisheries. No significant changes are expected in the spatial and temporal concentration of catch as a result of reduced other rockfish TACs.

BSAI rockfish catch may be limited due to Pacific halibut PSC limits which are projected to be reduced by 0-25 percent under PA.2. Procedures to account of uncertainty when establishing ABC values would be developed, implemented, and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for BSAI rockfish.

Status Determination

The fishing mortality rate is below the ABC and OFL for all years. The MSST is unable to be determined. Under PA.1, the BSAI OY cap is established between 1.4 and 2.0 million mt. If the sum of the TACs for the BSAI target fish exceeds 2.0 million mt, than TACs must be reduced. Under PA.2, OY caps would be recalculated in light of existing environmental conditions and current knowledge of stock levels. As part of PA.1 and PA.2, ecosystem indicators would be implemented into the TAC setting process.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. Estimated sex ratios are not available for these species.

Habitat-Mediated Impacts

Any habitat related impacts of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude whether existing habitat conditions would undergo any significant change under PA.1 or PA.2.

Current closure areas would remain under PA.1, including the ban on bottom trawling for pollock in the BSAI as described under FMP 1. Definitions and methodology for establishing MPAs would be developed. These measures may help reduce adverse impacts to important rockfish habitat where overlap occurs.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the Bering Sea and Aleutian Islands as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and an Aleutian Islands management area would be established to protect live bottom and coral habitat. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may help reduce adverse impacts to BSAI rockfish habitat where overlap occurs, although, as stated above, impacts to rockfish habitat suitability are unknown.

Predation-Mediated Impacts

As with habitat suitability impacts, any effect on predator-prey relationships of PA.1 and PA.2 would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude whether trophic interactions would undergo any significant change as a result of the PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on Aleutian Islands and EBS other rockfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the BSAI other rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects on mortality are the same as those considered for BSAI shortraker/rougheye rockfish under bookends.

- **Reasonably Foreseeable Future External Effects**. Future external effects on mortality are the same as those considered for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI other rockfish, and is rated as insignificant. Fishing mortality at projected levels is below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Past effects on the change in biomass level are the same as those indicated for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are the same as those indicated for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI other rockfish, but is the effect is unknown. It is unknown whether the combined effect of internal external and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the spatial/temporal concentration of catch is rated as unknown.

- **Persistent Past Effects.** Past effects are not identified for spatial/temporal characteristics of BSAI other rockfish catch.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the reproductive success and genetic structure of other rockfish are the same as those considered for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is possible for the spatial/temporal concentration of the other rockfish catch, but this effect is unknown since it is not possible to calculate the MSST. However, the spatial and temporal concentration of the fishery is not expected to change significantly.

Change in Prey Availability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in prey availability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in prey availability are the same as those described for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in prey availability are the same as those described for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Cumulative Effects.** A cumulative effect is identified for the change in prey availability; however, this effect is unknown since it is not possible to determine the MSST.

Change in Habitat Suitability

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the change in habitat suitability for the BSAI other rockfish is unknown since it is not possible to determine MSST.

- **Persistent Past Effects.** Past effects on the change in habitat suitability are the same as those considered for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in habitat suitability are the same as those considered for BSAI shortraker/rougheye rockfish under PA.1 and PA.2.

- **Cumulative Effects.** The cumulative effect of habitat suitability is unknown. It is unknown whether the combined effect will make the other rockfish species vulnerable to spawning and rearing habitat disturbances due to fishing gear.

See Table 4.5-25 for a summary of the cumulative effects on BSAI other rockfish under PA.1 and PA.2.

GOA Northern Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total Biomass

Total biomass of GOA northern rockfish at the start of 2003 is estimated to be 112,000 mt. Model projections of future total GOA northern rockfish biomass are shown in Table H.4-76 of Appendix H. Under PA.1, model projections indicate that GOA northern rockfish biomass is expected to decrease to a value of 101,000 mt in 2007, with a 2003-2007 average value of 104,000 mt. Under PA.2, model projections indicate that GOA northern rockfish biomass is expected to decrease to a value of 103,000 mt in 2007, with a 2003-2007 average value of 105,000 mt.

Spawning Biomass

Spawning biomass of GOA northern rockfish at the start of 2003 is estimated to be 42,700 mt. Model projections of future total BSAI flathead sole biomass are shown in Table H.4-76 of Appendix H. Under PA.1, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 37,600 mt in 2007, with a 2003-2007 average value of 40,200 mt. Under PA.2, model projections indicate that BSAI flathead sole biomass is expected to decrease to a value of 38,400 mt in 2007, with a 2003-2007 average value of 40,700 mt.

Fishing Mortality

Under PA.1 the PSC limits for Pacific halibut are reduced by ten percent. If the GOA northern rockfish are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could reduce catch of GOA northern rockfish as well. Average fishing mortality during the years 2003 - 2008 is expected to be less than F_{OFL} (0.066) (Table H.4-76 of Appendix H).

PA.2 requires that appropriate harvest strategies be developed for rockfish. If these strategies were to use F_{60} as the basis for determining ABCs, then catch of GOA northern rockfish would be reduced. Under PA.2 the PSC limits for Pacific halibut are also reduced by 30 percent. If the GOA northern rockfish are caught in bottom trawl gear with a high bycatch of Pacific halibut, then a reduction in Pacific halibut bycatch could reduce catch of GOA northern rockfish as well. Average fishing mortality during the years 2003-2008 is expected to be less than F_{OFL} (0.066) (Table H.4-76 of Appendix H).

Spatial/Temporal Concentration of Fishing Mortality

The effects that PA.1 and PA.2 has on the spatial and temporal concentration of northern rockfish catch depends on the decisions made by NPFMC. The spatial distribution of catch would not be affected by proposed closures, and apportionment of catch among management areas should provide some protection against localized depletion. Concentrating fishery effort into a short season would likely continue unless NPFMC implemented some rights-based management scheme. Under PA.1 and PA.2 the spatial and temporal concentration of fishing effort may also be affected by Pacific halibut bycatch considerations if they substantially change the distribution of fishing effort. Under PA.1, the potential for localized depletion of the stock exists if fishing occurs year after year on localized aggregations of northern rockfish.

Under PA.2, the implementation of fishery rationalization should also spread the fishery out in time and space. PA.2 may also potentially have a large effect on the spatial concentration of northern rockfish catch if the maximum proposal of 20 percent of the GOA is set aside as no-take reserves or as MPAs. Northern rockfish catches are taken in directed fisheries where the effort is highly localized and concentrated in slope areas. Much of this effort occurs in proposed closed areas. Therefore, if the proposed MPAs are closed to all bottom trawling, the spatial concentration of fishing effort would likely shift from the closure areas to remaining open areas. The effect of shifting effort away from the closed areas is unclear, but since fishing effort is highly localized the spatial distribution of catch is likely to change.

Status Determination

Under PA.1 and PA.2, the projected 2003 biomass of 42,700 mt is greater than $B_{35\%}$ and consequently the stock is projected to be above its MSST and not projected to be in an overfished condition. The projected 2005 biomass of 40,400 mt under PA.1, and 40,800 mt under PA.2, is greater than $B_{35\%}$ and consequently the stock is not projected to be approaching an overfished condition. The ABC must be set below the OFL under both bookends. As part of PA.1, the GOA OY cap is established between 116,000 and 800,000 mt. However, under PA.2, OY caps would be recalculated for relevancy under existing environmental conditions and knowledge of stock levels.

Age and Size Composition and Sex Ratio

Under PA.1 and PA.2, the age composition of GOA northern rockfish may be affected by fishing mortality as in FMP 1. Size composition of GOA northern rockfish might change in proportion to the change in age composition. Age and size composition could also change if Pacific halibut bycatch considerations substantially change the distribution of fishing effort. No information is available to suggest that sex ratio would change under PA.1.

Habitat-Mediated Impacts

Under PA.1, damage to epifauna by bottom trawls may negatively impact juvenile northern rockfish habitat. Existing closures would remain under PA.1, including the eastern GOA trawl closure. EFH and HAPC identification and designation programs would also be continued. NPFMC and NOAA Fisheries would also develop a methodology for establishing MPAs.

Under PA.2 damage to epifauna by bottom trawls would likely be reduced under less fishing pressure and result in less impact on juvenile northern rockfish habitat. PA.2 may also have a positive effect on the habitat of GOA northern rockfish because it proposes to set aside 0-20 percent of the GOA as no-take reserves or as MPAs. If these MPAs are closed to all bottom trawling, then they may serve as refugia for northern rockfish allowing for increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. If these MPAs are closed to all bottom trawling, then they would also provide protection from the potential effects of trawling on juvenile rockfish habitat in these areas. The proposed ban on GOA pollock bottom trawling is likely to have a beneficial effect on juvenile rockfish habitat.

Predation-Mediated Impacts

There is insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under PA.1 or PA.2.

See Table 4.9-1 for the summary of direct/indirect effects of GOA northern rockfish under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA northern rockfish stock is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries are identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since bycatch is this fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are not considered contributors to northern rockfish mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA northern rockfish, and is rated as insignificant. Northern rockfish are fished at less than the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is unlikely to jeopardize the capacity of the stock to produce MSY on a continuing basis.

Change in Biomass

- **Direct/Indirect Effects.** Change in biomass of the GOA northern rockfish stock is expected to be insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Past effects of the past foreign fisheries are identified for the GOA northern rockfish stock. Large removals of northern rockfish occurred in the past and there appears to be a lingering effect on the GOA northern rockfish populations (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Bycatch in the IPHC longline fishery has already been accounted for by domestic groundfish management. Marine pollution is identified as having a potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as having beneficial or adverse contributions to northern rockfish change in biomass levels as a function of change in reproductive success.

- **Cumulative Effects.** A cumulative effect for the change in biomass is identified as insignificant. The combination of internal and external factors is not expected to sufficiently reduce the northern rockfish biomass such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects**. Impacts of the spatial and temporal characteristics of GOA northern rockfish should have an insignificant effect on the genetic structure and reproductive success of the population.

- **Persistent Past Effects.** Past effects are not identified for change in genetic structure . However, there are lingering past effects due to climate changes and regime shifts (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** As noted above, the IPHC longline fishery has already been accounted for by domestic groundfish management and is not expected to contribute to changes in genetic structure or reproductive success of northern rockfish. Marine pollution is identified as having a potentially adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock to produce MSY on a continuing basis is jeopardized. Climate changes and regime shifts are identified as potentially beneficial or adverse contributor to reproductive success since changes in climate can effect prey availability and/or habitat suitability which in turn can effect recruitment. The magnitude and direction of the change in reproductive success with water temperatures is currently unknown. Climate changes and regime shifts are not considered to be contributors to change in genetic structure.

- **Cumulative Effects.** A cumulative effect is identified for the spatial/temporal characteristics of GOA northern rockfish, and is rated as insignificant. The combination of internal and external factors is not expected to sufficiently alter the genetic structure or the reproductive success of the population such that the ability of the stock to maintain itself at or above MSST is jeopardized.

Change in Prey Availability

- **Direct/Indirect Effects**. PA.1 and PA.2 would have an insignificant effect on northern rockfish prey availability.

- **Persistent Past Effects.** Past climate changes and regime shifts are likely to have had lingering effects (both beneficial and adverse) on northern rockfish prey species (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has not been identified as a contributing factor since northern rockfish prey species bycatch is not expected to occur. Climate changes and regime shifts are identified as having potentially beneficial or adverse contributions on prey availability, although the magnitude and the direction of change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a reasonably foreseeable external contributing factor since acute and/or chronic pollution events could reduce prey availability or prey quality and thus jeopardize the stock's ability to sustain itself above its MSST.

- **Cumulative Effects.** A cumulative effect is identified for prey availability, and is rated as insignificant. The combination of internal and external removals of prey is not expected to decrease prey availability such that the northern rockfish stock is unable to sustain itself at or above MSST.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects**. PA.1 and PA.2 would have an insignificant effect on northern rockfish habitat suitability.

- **Persistent Past Effects.** Past effects on habitat suitability identified for GOA northern rockfish stocks include past foreign, JV, and domestic fisheries, IPHC longline fishery and climate changes and regime shifts (see Section 3.5.1.13). Intense bottom trawling on northern rockfish habitat in the past fisheries likely disrupted spawning and/or rearing habitats in areas of the GOA. It is possible that some of these areas have not recovered from the intense efforts. The IPHC longline fisheries have also been identified as having negative effects on northern rockfish habitat, although these effects are not expected to have been as intense as those effects associated with trawl gear. See Section 3.6 for additional information on the effects of trawling on benthic habitat). Climate changes and regime shifts have had both positive and negative effects on northern rockfish habitat.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery has been identified as an adverse contributing factor since the fishery gear could disrupt spawning and/or rearing habitats. Although, as stated above, the impacts associated with longline gear are not as significant as those associated with trawl gear. Impacts on habitat from climate changes and regime shifts on the GOA northern rockfish stock are identified as potentially beneficial or adverse contributors, although the magnitude and direction of the change in relation to strong and weak Aleutian Low systems are unknown. Marine pollution has also been identified as a potentially adverse contributing factor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success.

- **Cumulative Effects.** A cumulative effect is identified for habitat suitability, and is rated as insignificant. The combination of internal and external habitat disturbance factors is not expected to lead to a detectable change in spawning or rearing success such that the ability of the northern rockfish stock to sustain itself at or above MSST is jeopardized.

See Table 4.5-26 for a summary of the cumulative effects on GOA northern rockfish under PA.1 and PA.2.

GOA Shortraker/Rougheye Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter.

Fishing Mortality

PA.1 is more precautionary in its approach than FMPs 1, 2.1, and 2.2. However, for most measures in regards to shortraker/rougheye it remains very similar to FMP 1 and the baseline situation. One would therefore expect the catch projections for shortraker/rougheye in this bookend would be very similar to those in FMP 1. The projections, however, are consistently higher for PA.1, which does not appear reasonable (Table H.4-75 of Appendix H). Under PA.1, these projections indicate an increase from the 2002 value of 1,300 mt to 1,418 mt in 2003, and then decrease to 1,231 mt in 2007. The 2003-2007 average projected catch is 1,272 mt. PA.2 requires that appropriate harvest strategies be developed for rockfish. If those strategies were to use F_{60} to determine ABCs, then projections indicate a decrease in catch to 679 mt through 2005, and an increase through 2007 to 776. The 2003-2007 average projected catch under PA.2 is 724 mt.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA rockfish.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on GOA shortraker/rougheye rockfish through mortality.

Spatial/Temporal Concentration of Fishing Mortality

Whether PA.1 would have substantial effects on the spatial or temporal concentration of shortraker/rougheye catch would somewhat depend on decisions made by NPFMC after the bookend was implemented. ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. IFQs and fishing cooperatives may be established as needed, but since specific recommendations concerning such rights-based management are not included in the FMP, it is difficult to evaluate how they would impact shortraker/rougheye. If NPFMC decided to not establish IFQs and/or cooperatives for trawlers, the shortraker/rougheye trawl catch would continue to be concentrated into relatively short open seasons. Similar to the baseline and FMP 1, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

PA.2 would have a large effect on the spatial and temporal concentration of GOA rockfish catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because PA.2 sets aside 0-20 percent of the GOA as either no-take reserves or as MPAs. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. The rockfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-10 percent in the GOA under PA.2. Hence, if PA.2 were adopted, an indirect effect might be to reduce catches of rockfish if means were not found to control or prevent Pacific halibut bycatch. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

PA.2 would also have an important temporal effect on rockfish trawl fisheries, as all these fisheries would become "rationalized" through the establishment of IFQs or cooperatives. The existence of IFQs or fishing cooperatives would mean rockfish trawl fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called race for fish would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the trawl fishery and reduce the risk of over-harvesting slope rockfish.

Status Determination

The catch rates are below the ABC and OFL values. The MSST cannot be determined. As part of PA.1 and PA.2, the GOA OY cap is established between 116,000 and 800,000 mt. Under PA.2, OY caps would be reconsidered under existing environmental conditions and knowledge of stock levels. The ABC must be set below the OFL under these FMPs. A measure in PA.2 that would affect catch of rockfish is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of rockfish, thereby providing even greater protection against overfishing.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as shortraker/rougheye are classified as Tier 4 or Tier 5 species, with insufficient information to compute either parameter. There is no information on the sex ratio of shortraker/rougheye, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by PA.1 or PA.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, PA.1 may impact habitat for shortraker/rougheye because it closes the eastern GOA to trawling. This closure prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of shortraker/rougheye, an undamaged benthic habitat may benefit these species. For example, observations from a manned submersible in the eastern GOA have found shortraker and/or rougheye rockfish associated with boulders along steep slopes (Krieger and Ito 1999) and with colonies of Primnoa coral (Krieger and Wing 2002). The eastern GOA trawl closure presumably causes a reduction in the alteration or destruction of these habitats, which may have a positive effect on shortraker/rougheye in this region.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation would be measures instituted as needed. These measures may provide substantial habitat benefits to GOA rockfish.

Predation-Mediated Impacts

Pacific cod, and to a lesser extent walleye, pollock are species that are known to prey on shrimp, a major prey item of rougheye rockfish, so any changes in their abundance as a result of PA.1 and PA.2 hypothetically could affect the food supply of shortraker/rougheye. To protect Steller sea lions, PA.1 has two measures that could reduce the catch and increase the abundance of Pacific cod and walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for two species. Under PA.2, catch projections for walleye pollock indicate catches would be reduced compared to FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1, and abundance of walleye pollock would somewhat increase. However, whether a change in abundance of Pacific cod or walleye pollock would actually affect the food supply for shortraker/rougheye is unknown, as there is no quantitative information on trophic interactions between all these species. Moreover, shortraker and rougheye rockfish reside in deeper depths than Pacific cod or walleye pollock, so they may not be competing for the same spatial aggregations of food.

The direct/indirect effects of PA.1 and PA.2 on shortraker/rougheye in the GOA are summarized in Table 4.9-1.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA shortraker/rougheye rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts are not considered contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of shortraker/rougheye rockfish. The IPHC longline fishery and State of Alaska shrimp fishery are not considered contributing factors since bycatch of rockfish species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA shortraker/rougheye rockfish, and is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA shortraker/rougheye rockfish stocks (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on the change in biomass level are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause shortraker/rougheye rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the shortraker/rougheye rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The IPHC longline fishery and State of Alaska shrimp are not considered contributing factors to GOA slope rockfish biomass level since bycatch is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA shortraker/rougheye rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
   – Change in Genetic Structure of Population
   – Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/ temporal characteristics of GOA shortraker/rougheye rockfish under PA.1 and PA.2 are unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA shortraker/rougheye rockfish; however, climate changes and regime shifts have been identified as having had potential positive or negative effects on shortraker/rougheye rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to GOA shortraker/rougheye rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are not considered contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The IPHC longline fishery and the State of Alaska shrimp fishery are not considered contributing factors to the change in genetic structure and reproductive success of GOA shortraker/rougheye rockfish since bycatch in these fisheries is unlikely to occur.

- **Cumulative Effects.** A cumulative effect for the spatial and temporal characteristics of the GOA shortraker/rougheye rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA shortraker/rougheye rockfish complex.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had positive or negative effects on shortraker/rougheye rockfish prey availability (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to shortraker/rougheye rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability (see Sections 3.5.1.13 and 3.10). The IPHC longline fishery is not considered contributing factor to shortraker/rougheye rockfish prey availability since bycatch of shortraker/rougheye rockfish prey species is not expected to occur in this fishery. The State of Alaska shrimp fishery is identified as a potential adverse contributor to shortraker/rougheye rockfish prey availability since shrimp is a main prey item of rougheye rockfish.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA shortraker/rougheye rockfish; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under PA.1 and PA.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, and the IPHC longline fisheries have been identified as having past persistent negative effects on GOA shortraker/rougheye rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past positive or negative effects on GOA shortraker/rougheye rockfish habitat suitability (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could make a potentially beneficial or adverse contribution to shortraker/rougheye rockfish habitat suitability (see Sections 3.5.1.13 and 3.10). The IPHC longline fishery has been identified as a potentially adverse contributor to shortraker/rougheye rockfish habitat suitability due to impacts from fishery gear. The State of Alaska shrimp fishery is not considered contributing factor since habitat degradation from shrimp fishery gear is not expected to occur (see Section 3.6).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA shortraker/rougheye rockfish, the effect is currently unknown due to lack of scientific information.

See Table 4.5-27 for a summary of the cumulative effects on GOA shortraker/rougheye rockfish under PA.1 and PA.2.

GOA Slope Rockfish – Direct/Indirect Effects of PA.1 and PA.2

The average exploitable biomass for the other slope rockfish groups are placed in Tier 5 where ABC is determined by F = 0.75M. Sharpchin are assessed under Tier 4 where OFL is calculated by F = M.

Total and Spawning Biomass

No projections are possible for these two parameters, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter.

Fishing Mortality

PA.1 is more precautionary in its approach than FMPs 1, 2.1, and 2.2. However, for most measures in regards to slope rockfish it remains very similar to the baseline FMP 1. For example, the eastern GOA trawl closure is retained in this bookend, which means most of the GOA population of slope rockfish will not be vulnerable to fishing. The model projections for PA.1, however, show ABCs much less than those for FMP 1, whereas the catches for PA.1 are slightly higher than those for FMP 1. Therefore, the model results do not seem plausible (Table H.4-72 of Appendix H). Under PA.1, these projections indicate an increase from the 2002 value of 572 mt to 980 mt in 2004, and then decrease to 944 mt in 2007. The 2003-2007 average projected catch is 960 mt. PA.2 requires that appropriate harvest strategies be developed for rockfish. Should F_{60} be used as a harvest rule, then projections indicate an increase in catch to 712 mt in 2003, a decrease through 2005 to 672 mt, and then an increase through 2007 at 745 mt. The 2003-2007 average projected catch under PA.2 is 705 mt.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the ‘splitting and lumping’ of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA rockfish.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on GOA slope rockfish through mortality.

Spatial/Temporal Concentration of Fishing Mortality

The main spatial effect of PA.1 on slope rockfish would be caused by the bookend's retention of the eastern GOA trawl closure, which would mean most of the GOA population of slope rockfish would not be vulnerable to fishing. If this bookend was implemented, the only slope rockfish catch would be taken by trawl west of the closure area and by longline mostly in the eastern GOA. There have been no studies to determine stock structure for any species of slope rockfish, and it is unknown if subpopulations exist. However, because most of the biomass of slope rockfish occurs in the eastern GOA, localized depletion is unlikely under this FMP. Whether this bookend would have much effect on the temporal concentration of slope rockfish catch would depend on decisions made by NPFMC after the bookend was implemented. PA.1 states that IFQs and fishing cooperatives may be established as needed, but since specific recommendations concerning such rights-based management are not included in the FMP, it is difficult to evaluate how they would impact slope rockfish. If NPFMC decided to not establish IFQs and/or cooperatives for rockfish trawlers, most of the slope rockfish catch could continue to be concentrated into a relatively short open season. Similar to the baseline and FMP 1, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

PA.2 would have a large effect on the spatial and temporal concentration of GOA rockfish catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because PA.2 sets aside 0-20 percent of the GOA as either no-take reserves or as MPAs. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. The rockfish fishery may be restricted by Pacific halibut PSC limits, which are projected to b reduced by 0-10 percent in the GOA under PA.2. Hence, if PA.2 were adopted, an indirect effect might be to reduce catches of rockfish if means were not found to control or prevent Pacific halibut bycatch. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

PA.2 would also have an important temporal effect on rockfish trawl fisheries, as all these fisheries would become "rationalized" through the establishment of IFQs or cooperatives. The existence of IFQs or fishing cooperatives would mean rockfish trawl fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called race for fish would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the trawl fishery and reduce the risk of over-harvesting slope rockfish.

Status Determination

No projections are possible for the fishing mortality rate or MSST, as slope rockfish species are classified as Tier 4 or Tier 5 fish, with insufficient information to compute either parameter. As part of PA.1, the GOA OY cap is established between 116,000 and 800,000 mt. The ABC must be set below the OFL under PA.1. PA.2 revisits the OY caps to determine relevancy to current environmental conditions and knowledge of current stock levels. This would result in a decreased catch for rockfish and greatly reduce any risk of overfishing these species. One other measure in PA.2 that would affect catch of rockfish is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of rockfish, thereby providing even greater protection against overfishing.

Age and Size Composition and Sex Ratio

Age and size composition estimates are not available for these species. There is no information on the sex ratio of slope rockfish, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by PA.1 or PA.2 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, PA.1 greatly impacts habitat for slope rockfish because it closes the eastern GOA to trawling. This creates a de facto no-take zone or refuge for slope rockfish in this area, as trawls are generally the only effective gear for capturing most of these species. Nearly all the biomass of slope rockfish is found in the eastern GOA, which means the trawl closure in this region protects most of the GOA population from any fishing pressure.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation would be measures instituted as needed. These measures may provide substantial habitat benefits to GOA rockfish.

Predation-Mediated Impacts

No studies have been done in Alaska to determine the food habits for any of the slope rockfish species. Many of the abundant species, such as sharpchin, harlequin, and redstripe rockfish, are relatively small in size and may be plankton-feeders, but this is conjecture. There is also no documentation of predation on slope rockfish, although larger fishes such as Pacific halibut that are known to prey on other rockfish presumably also prey on slope rockfish. Because of this lack of information, the effect of PA.1 and PA.2 on predator-prey relationships for slope rockfish is unknown.

The direct/indirect effects of PA.1 and PA.2 on slope rockfish in the GOA are summarized in Table 4.9-1.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of fishing mortality on the GOA other slope rockfish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries and State of Alaska groundfish fisheries have been identified as having had a negative persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Future external effects on mortality are indicated due to the potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts are not considered to be contributing factors since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of other slope rockfish. The State of Alaska groundfish fisheries is also not considered a contributing factor since catch and bycatch of slope rockfish species is already accounted for by the domestic groundfish fishery management. In addition, the IPHC longline fishery is not considered a contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect identified for mortality of GOA other slope rockfish is rated as insignificant. Fishing mortality at projected levels is well below OFL for this stock. The combined effect of internal removals and removals due to reasonably foreseeable future external events is unlikely to jeopardize the capacity of the stock maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of changes in biomass level is unknown since the MSST for this stock cannot be determined.

- **Persistent Past Effects.** Due to large harvest rates and the longevity of rockfish, past foreign, JV, and domestic fisheries have been identified as having had a negative persistent past effect on GOA other slope rockfish stocks (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effect.** Future external effects on the change in biomass level are indicated due to potentially adverse effects of marine pollution since acute and/or chronic pollution events could cause other slope rockfish mortality. Climate changes and regime shifts have also been identified as having potentially beneficial or adverse effects on the other slope rockfish biomass level; however, it is unknown whether warmer water temperatures will favor or reduce recruitment. For more information on climate changes and regime shifts see Sections 3.5.1.13 and 3.10. The State of Alaska groundfish fisheries are not considered contributing factors to GOA slope rockfish biomass level. Although catch and bycatch do occur in these fisheries, the removals are already accounted for by the domestic groundfish fishery management.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of GOA other slope rockfish, but the effect is unknown. It is unknown whether the combined effect of internal and external removals is likely to jeopardize the capacity of the stock to maintain current population levels.

Spatial/Temporal Concentration of Catch
- – Change in Genetic Structure of Population
- – Change in Reproductive Success

- **Direct/Indirect Effects.** The spatial/temporal characteristics of GOA slope rockfish under PA.1 and PA.2 are unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA slope rockfish; however, climate changes and regime shifts have been identified as having had potential positive or negative effects on slope rockfish reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination effect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to GOA slope rockfish genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are not considered contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability. The State of Alaska groundfish fishery is not considered a contributing factor to the change in genetic structure and reproductive success of GOA slope rockfish. Although catch and bycatch of slope rockfish species occurs in these fisheries, they are not expected to contribute to localized depletion such that it leads to a detectable reduction in genetic diversity or reproductive success. The IPHC longline fishery is also not considered a contributing factor since bycatch of slope rockfish species is not expected to occur in this fishery.

- **Cumulative Effects.** A cumulative effect for the spatial and temporal characteristics of the GOA slope rockfish complex is possible; however, the effect is unknown. It is unknown whether the combined effect of internal and external removals will occur in a localized manner such that it will lead to a detectable reduction in genetic diversity and reproductive success of the GOA slope rockfish complex.

<u>Change in Prey Availability</u>

- **Direct/Indirect Effects.** The change in prey availability under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had positive or negative effects on slope rockfish prey availability (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** Marine pollution is identified as a potentially adverse contributor to slope rockfish prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability (see Sections 3.5.1.13 and 3.10). The State of Alaska groundfish fishery and the IPHC longline fishery are not considered contributing factors to slope rockfish prey availability since bycatch of slope rockfish prey species is not expected to occur in these fisheries.

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA slope rockfish; however, the effect is unknown due to lack of scientific information.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** The change in habitat suitability is determined to be unknown under PA.1 and PA.2.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries, State of Alaska groundfish fisheries and the IPHC longline fisheries have been identified as having past persistent negative effects on GOA slope rockfish habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past positive or negative effects on GOA slope rockfish habitat suitability (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could have a potentially beneficial or adverse contribution on slope rockfish habitat suitability (see Sections 3.5.1.13 and 3.10). The State of Alaska groundfish fishery and the IPHC longline fishery have been identified as potentially adverse contributors to slope rockfish habitat suitability due to impacts from fishery gear (see Section 3.6).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA slope rockfish, the effect is currently unknown due to lack of scientific information.

See Table 4.5-27 for a summary of the cumulative effects on GOA slope rockfish under PA.1 and PA.2.

GOA Pelagic Shelf Rockfish – Direct/Indirect Effects of PA.1 and PA.2

<u>Total and Spawning Biomass</u>

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish. Until recently, an age-structured model had not been finalized for dusky rockfish. As of 2004, dusky rockfish will be evaluated under Tier 3; however, for the purposes of this analysis, dusky rockfish were modeled under Tier 4.

<u>Fishing Mortality</u>

PA.1 is more precautionary in its approach than FMPs 1, 2.1, and 2.2. However, for most measures in regards to PSR it remains very similar to FMP 1 and the baseline situation. One measure in PA.1 that could affect catch of PSR is that PSC limits for Pacific halibut are reduced 0-10 percent. In at least one instance in recent years, the PSR fishery has been closed early with substantial TAC remaining so that excessive bycatch of halibut would be prevented. Hence, if PA.1 were adopted, an indirect effect might be to reduce catches of PSR if means were not found to control or prevent Pacific halibut bycatch. The model projections for PA.1 show catches about 25 percent less than those for FMP 1, which may be plausible given the reduced PSC limits for Pacific halibut (Table H.4-73 of Appendix H).

Under PA.1, these projections indicate a decrease from the 2002 value of 3,318 mt to 1,657 mt through 2007. The 2003-2007 average projected catch is 1,735 mt. PA.2 requires that appropriate harvest strategies be developed for rockfish. If those strategies were to use F_{60} to determine ABCs, then projections indicate a decrease to 1,086 mt through 2005, and an increase through 2007 to 1,372 mt. The 2003-2007 average projected catch under PA.2 is 1,222 mt.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future change in tier designation for GOA rockfish.

Given the low levels of exploitation under PA.1 and PA.2, these FMPs are expected to have insignificant effects on GOA PSR through mortality.

Spatial/Temporal Concentration of Fishing Mortality

Whether PA.1 would have substantial effects on the spatial or temporal concentration of PSR catch would somewhat depend on decisions made by NPFMC after the bookend was implemented. ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. IFQs and fishing cooperatives may be established as needed, but since specific recommendations concerning such rights-based management are not included in the FMP, it is difficult to evaluate how they would impact PSR. If NPFMC decided to not establish IFQs and/or cooperatives for rockfish trawlers, the PSR fishery could continue to be concentrated into a relatively short open season. Similar to the baseline, this would increase the risk of possible overfishing because of the difficulty of managing a short, compressed fishery.

PA.2 would have a large effect on the spatial and temporal concentration of GOA rockfish catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because PA.2 sets aside 0-20 percent of the GOA as either no-take reserves or as MPAs. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. The rockfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-10 percent in the GOA under PA.2. Hence, if PA.2 were adopted, an indirect effect might be to reduce catches of rockfish if means were not found to control or prevent Pacific halibut bycatch. However, the effects of these measures on the spatial and temporal characteristics of the stock complex are unknown.

PA.2 would also have an important temporal effect on rockfish trawl fisheries, as all these fisheries would become "rationalized" through the establishment of IFQs or cooperatives. The existence of IFQs or fishing cooperatives would mean rockfish trawl fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called race for fish would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the trawl fishery and reduce the risk of over-harvesting slope rockfish.

Status Determination

The catch rates are below the ABC and OFL values. The MSST cannot be determined for this stock. One measure in PA.2 that would affect catch of rockfish is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of rockfish, thereby providing even greater protection against overfishing.

Age and Size Composition and Sex Ratio

No projections are possible for these two parameters, as PSR species are classified as Tier 4 or Tier 5 fish and an age-structured model has not been finalized for dusky rockfish. There is no information on the sex ratio of PSR, although sex ratio for many other species of *Sebastes* has been reported to be approximately 50:50. How the sex ratio may be affected by PA.1 or PA.1 is unknown.

Habitat-Mediated Impacts

Similar to FMP 1 and the baseline situation in past years, PA.1 impacts habitat for PSR because it retains the eastern GOA trawl closure. This creates a de facto no-take zone or refuge for PSR in this area, as trawls are generally the only effective gear for capturing these species. Although biomass estimates from trawl surveys indicate that the trawl closure area in the eastern GOA only contains about 10-15 percent of the GOA biomass of dusky biomass, this is still large enough that it may provide enhanced protection to the dusky rockfish resource. Use of refugia as a conservation measure could be particularly effective for rockfish species, as most are generally believed to be sedentary in nature and not undergo extensive migrations. The closed areas may allow increased survival of larger and older fish that produce significantly more eggs and larvae to replenish the GOA population. The trawl closure also prevents damage to the benthic environment in the eastern GOA because bottom trawls cannot be used. Although little is known about the habitat preferences of PSR, an undamaged benthic habitat likely provides a benefit to these species. For example, observations from manned submersibles in the eastern GOA have found adult dusky rockfish associated with colonies of Primnoa coral (Krieger and Wing 2002) and with large vase-type sponges. Prevention of possible damage by bottom trawls to these living substrates may increase the amount of protective cover available to dusky rockfish to escape predation and thus have a positive impact on the stocks. Juvenile dusky rockfish may also be associated with epifauna such as corals or sponges that provide structural relief on the bottom. If so, reducing the damage to this epifauna by bottom trawls may increase survival of juvenile fish.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures would be instituted as needed. These measures may provide substantial habitat benefits to GOA rockfish.

Predation-Mediated Impacts

The major prey of dusky rockfish appears to be euphausiids, based on the limited food information available for this species (Yang 1993). Euphausiids are also the major prey of walleye pollock, which means dusky rockfish and walleye pollock may be competing for the same food resource. Thus, any measures in PA.1 that affect the commercial catch of walleye pollock could have a subsequent indirect effect on dusky rockfish by increasing or decreasing the amount of euphausiids available to dusky rockfish. To protect Steller sea lions, PA.1 (similar to FMP 1 and the baseline situation in past years) has two measures that may reduce catch of walleye pollock: fishing closures around sea lion rookeries, and a $B_{20\%}$ fishing rule for walleye pollock. Catch projections for walleye pollock in PA.2 indicate catches would be reduced compared to FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1., and abundance of walleye pollock would somewhat increase. Hypothetically, these measures could increase the abundance of walleye pollock, resulting in the consumption of more euphausiids and having an adverse effect on the food supply for dusky rockfish. How adverse this effect would really be, however, is unknown, as there is little or no quantitative information on trophic interactions between dusky rockfish and walleye pollock or data on whether they even feed on the same spatial aggregations of euphausiids.

The direct/indirect effects of PA.1 and PA.2 on PSR in the GOA are summarized in Table 4.9-1.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects.** The effect of the fisheries on the mortality of the GOA PSR complex is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering negative effect on the GOA PSR population (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery is not considered to be a contributing factor to GOA PSR mortality since no bycatch is expected in this fishery. Marine pollution is identified as a potentially adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not considered to be contributors to PSR mortality.

- **Cumulative Effects**. A cumulative effect identified for mortality of GOA PSR is rated as insignificant. PSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effect of fisheries on the biomass level under PA.1 and PA.2 is unknown since the MSST cannot be determined.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering negative effect on the GOA DSR population (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery is not considered a contributing factor to GOA PSR biomass levels since no bycatch is expected in this fishery. Marine pollution is identified as a potentially adverse contributor to GOA PSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not considered contributors to PSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass; however, the effect is unknown since total and spawning biomass levels and MSST are currently unavailable.

Spatial/Temporal Concentration of Catch

- Change in Genetic Structure of Population
- Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA PSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects**. No persistent past effects have been identified for the change in genetic structure of GOA PSR; however, climate changes and regime shifts have been identified as having had potentiallyy positive or negative effects on PSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination affect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp and fishery is not considered a contributing factor to GOA PSR genetic structure and reproductive success since no bycatch is expected in this fishery to occur. Marine pollution is identified as a potentially adverse contributor to GOA PSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are not considered contributing factors to genetic structure; however, they could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect of the spatial and temporal characteristics of the GOA PSR complex is possible; however, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The change in prey availability of GOA PSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had positive or negative effects on PSR prey availability (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery has been identified as a potentially adverse contributor to GOA PSR prey availability. The catch of shrimp in the shrimp fishery is expected to continue in the future. Marine pollution is identified as a potentially adverse contributor to PSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability (see Sections 3.5.1.13 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA PSR; however, the effect is unknown due to lack of scientific information.

Change in Habitat Suitability

- **Direct/Indirect Effects.** The change in habitat suitability of GOA PSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries have been identified as having past persisting negative effects on GOA PSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past positive or negative effects on GOA PSR habitat suitability (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska shrimp fishery is not considered a contributing factor to GOA PSR habitat suitability since the gear associated with this fishery is not expected to cause a significant impact to the benthic habitat (see Sections 3.5.1.13 and 3.6). Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could have a potentially beneficial or adverse contribution on DSR habitat suitability (see Sections 3.5.1.13 and 3.10).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA PSR, the effect is currently unknown due to lack of scientific information.

See Table 4.5-29 for a summary of the cumulative effects on PSR under PA.1 and PA.2.

GOA Demersal Shelf Rockfish – Direct/Indirect Effects of PA.1 and PA.2

Total and Spawning Biomass

Reliable total and spawning biomass statistics are not available for DSR species.

Fishing Mortality

Projected catch of DSR species under PA.1 is expected to increase from the 2002 value of 182 mt to 350 mt in 2003, and is then expected to remain relatively steady throughout 2007. The 2003-2007 average projected catch is 316 mt. PA.2 requires that appropriate harvest strategies be developed for rockfish. If these strategies were to use F_{60}, then projected catch would increase from the 2002 value to 227 mt in 2003, and also remains relatively steady throughout 2007. The 2003-2007 average projected catch under PA.2 is 231 mt.

Under PA.1, there would be few effects on DSR species in the short-term, and overall this management plan would be similar to the FMP 1. As described previously for FMP 1, DSR species are managed conservatively to reduce the risk of overfishing this assemblage. The 2003 OFL has been set at 540 mt (NPFMC 2002a). The 2003 TAC was set equal to the ABC, or 390 mt; so management of DSR in the eastern GOA already complies with this PA.1 requirement. Over the long-term, this FMP would initiate the collection of scientific information necessary to specify a MSST for DSR. Currently DSR fall into Tier 4 and no MSST threshold exists for this species assemblage. Obtaining the information necessary to elevate DSR into a higher Tier and specifying MSST would certainly benefit DSR species and provide opportunities for refining management measures to more fully achieve policy objectives.

DSR species are taken in a small directed fishery with hook and line gear and as bycatch in the halibut longline fishery. Reported catch of DSR has been relatively constant over the last 5 years with landings ranging from 226 mt to 363 mt in large part due to very conservative management practices (Table H.4-74 of Appendix H). Estimated bycatch mortality of DSR in the halibut fishery has ranged about 130 mt to 355 mt annually. A DSR bycatch limit (10 percent) is established during the halibut season to limit mortality of DSR in this fishery. ADF&G requires full retention of DSR in state waters and NPFMC has also recently approved a management measure that requires full retention of DSR species. Once approved by NOAA Fisheries, the measure will improve catch statistics and reduce discards and waste. These measures would continue in PA.1.

There is a danger within stock complexes to fish one species disproportionately to the other and create localized depletions. As part of PA.2, the Observer Program would continue with improvements. These improvements include the enhancement of training programs that would increase the number of species identified by observers. Observer uncertainty estimates for target species data would also be developed. Criteria for the 'splitting and lumping' of stock complexes and procedures to account for uncertainty when establishing ABC values would be developed, implemented and updated as necessary under PA.2. Moreover, the collection of biological information necessary to designate spawning stock biomass estimates would be improved, possibly leading to a future changes in Tier designation for GOA rockfish.

Under PA.1 and PA.2, we expect both the TAC and reported landings to remain stable at present levels. A more precautionary management policy will likely have no significant impact on the ability of DSR to sustain current population levels. Fishing mortality will remain below the OFL under PA.1 and PA.2. Therefore, PA.1 and PA.2 are expected to have insignificant effects on DSR species through mortality.

Spatial/Temporal Concentration of Fishing Mortality

Although management of this assemblage has been conservative, and overall the population appears stable, a decline in the density estimates in the Fairweather Grounds under PA.1 may be an indication that localized overfishing is occurring (O'Connell *et al.* 2002). The TAC for the eastern GOA is partitioned by management district based on biomass density and known habitat. The current harvest strategy indicates that two percent of the exploitable biomass is taken per year and that this level of exploitation is sustainable. However, fishing effort on the Fairweather Grounds appears to be concentrated in areas of best habitat and high density and it may be that local overfishing occurs. The question is whether such potential for localized overfishing would continue under PA.1. The answer is that it could, but the probability is reduced due to the likelihood that TAC will be adjusted downward as better information is obtained on DSR bycatch. Improved scientific information on DSR species would result in improved management that could lead to catch restrictions or other measures designed to prevent localized overfishing. It is presumed that a more precautionary management policy would provide benefits to DSR. As a result, we conclude that PA.1 would generate no significantly adverse impact on DSR stocks.

PA.2 would have a large effect on the spatial and temporal concentration of GOA rockfish catch compared to what has occurred in past years and what is proposed in FMP 1, FMP 2.1, FMP 2.2, and FMP 3.1. The spatial distribution of the catch would change substantially because PA.2 sets aside 0-20 percent of the GOA as either no-take reserves or as MPAs. As in the other FMPs, ABCs would still be geographically apportioned amongst management areas, which would continue to provide some protection against localized depletion of the resource. The rockfish fishery may be restricted by Pacific halibut PSC limits, which are projected to be reduced by 0-10 percent in the GOA under PA.2. Hence, if PA.2 were adopted, an indirect effect might be to reduce catches of rockfish if means were not found to control or prevent Pacific halibut bycatch. However, the effects of these measures on the spatial and temporal characteristics of the stock complex is unknown.

PA.2 would also have an important temporal effect on rockfish trawl fisheries, as all these fisheries would become "rationalized" through the establishment of IFQs or cooperatives. The existence of IFQs or fishing cooperatives would mean rockfish trawl fishermen would no longer have to compete with each other to catch fish during a short-duration open fishery. The so-called race for fish would be a thing of the past, and the trawl fisheries could extend over a longer time period. This would allow better management oversight of the trawl fishery and reduce the risk of over-harvesting slope rockfish.

Status Determination

The MSST cannot be determined for this stock complex. One measure in PA.2 that would affect catch of rockfish is that procedures to account for uncertainty would be incorporated into ABC determinations. These uncertainty corrections would also act to reduce ABC and result in a further decrease in catches of rockfish, thereby providing even greater protection against overfishing. Continual reduction of TAC in the DSR fishery would be beneficial and likely place DSR as a bycatch-only fishery under PA.2.

Age and Size Composition and Sex Ratio

Age and size composition data is not available for GOA demersal shelf rockfish species. The sex ratio of GOA demersal shelf rockfish species is unknown.

Habitat-Mediated Impacts

Any habitat suitability impacts of PA.1 and PA.2, such as adverse effects to spawning habitat, nursery grounds, benthic structures, as a result of fishing, would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient at the present time to conclude that existing habitat suitability indices would undergo any significant change under PA.1. However, PA.1 would initiate a federal MPA program and it is likely that certain areas of the eastern GOA would be candidates for MPA designation. Such a program, by design, could mitigate adverse effects of fishing by protecting areas important to DSR species.

Under PA.2, NOAA Fisheries and NPFMC would consider adopting 0-20 percent of the GOA as MPAs and no-take reserves. Existing closure areas would be reviewed to see if these areas already qualify as MPAs or may be redesignated as gear- or fishery-specific areas and pollock bottom trawling would be banned in the entire GOA. EFH and HAPC identification, designation, and assessment would continue and mitigation measures instituted as needed. These measures may provide substantial habitat benefits to GOA rockfish.

Predation-Mediated Impacts

As with habitat suitability indices, any effects to predator-prey relationships of PA.1 and PA.2 management would be governed by a complex web of direct and indirect interactions that are difficult to quantify. Information is insufficient to conclude that predator-prey relationships would undergo any significant change under PA.1 or PA.2.

See Table 4.9-1 for a summary of the direct/indirect effects on DSR under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

Mortality

- **Direct/Indirect Effects**. The effect of fishing mortality on the GOA DSR complex is insignificant under PA.1 and PA.2.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering negative effect on the GOA DSR population (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery are not considered to be contributing factors to GOA DSR mortality since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potentially adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could cause mortality to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not considered to be contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for mortality of GOA DSR and is rated as insignificant. DSR are expected to be fished at levels below the OFL. The combined effect of internal removals and removals due to reasonably foreseeable external events is not expected to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass

- **Direct/Indirect Effects.** The effect of the fisheries on the change in biomass level under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Removals by past foreign, JV, and domestic fisheries are identified as having a lingering negative effect on the GOA DSR population (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and the IPHC longline fishery are not considered to be contributing factors to GOA DSR biomass levels since catch/bycatch in these fisheries is already accounted for by the domestic fishery management levels or bycatch is not expected to occur. Marine pollution is identified as a potentially adverse contributor to GOA DSR mortality since acute and/or chronic pollution events, if large enough in scale, could impact biomass to the point that the capacity of the stock complex to maintain current population levels is jeopardized. Climate changes and regime shifts are not considered contributors to DSR mortality.

- **Cumulative Effects.** A cumulative effect is identified for change in biomass; however, the effect is unknown since total and spawning biomass levels are currently unavailable.

Spatial/Temporal Concentration of Catch

– Change in Genetic Structure of Population
– Change in Reproductive Success

- **Direct/Indirect Effects.** The effect of the fisheries on the spatial/temporal characteristics of GOA DSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** No persistent past effects have been identified for the change in genetic structure of GOA DSR; however, climate changes and regime shifts have been identified as having had potentially positive or negative effects on DSR reproductive success. Climate changes and regime shifts influence prey availability and habitat suitability which in combination affect reproductive success (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring, shrimp and groundfish fisheries and IPHC longline fisheries are not considered to be contributing factors to GOA DSR genetic structure and reproductive success. Catch/bycatch of these fisheries is already accounted for by the domestic groundfish management or is not expected to occur (as in the case of the State of Alaska herring and shrimp fisheries). Marine pollution is identified as a potentially adverse contributor to GOA DSR genetic structure and reproductive success since acute and/or chronic pollution events, depending on their location and magnitude, could alter the genetic structure of the population through localized mortality events, and also could result in reduced recruitment. Climate changes and regime shifts are not considered contributing factors to genetic structure; however, could affect reproductive success by driving changes in prey availability and habitat suitability.

- **Cumulative Effects.** A cumulative effect of the spatial and temporal characteristics of the GOA DSR complex is possible; however, the effect is unknown.

Change in Prey Availability

- **Direct/Indirect Effects.** The effect of the fisheries on the change in prey availability of GOA DSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Climate changes and regime shifts have been identified as having had positive or negative effects on DSR prey availability (see Sections 3.5.1.13 and 3.10).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries have been identified as potentially adverse contributors to GOA DSR prey availability. Catch of herring in the herring fishery and the catch of shrimp in the shrimp fishery are expected to continue in the future. The State of Alaska groundfish fishery and the IPHC longline fishery are not considered to be contributing factors to GOA DSR prey availability since bycatch of DSR prey species in not expected to occur. Marine pollution is identified as a potentially adverse contributor to DSR prey availability since acute and/or chronic pollution events could reduce prey availability or prey quality such that the ability of the stock complex to maintain itself at current population levels is jeopardized. Climate changes and regimes shifts are identified as potentially beneficial or adverse contributors to prey availability (see Sections 3.5.1.13 and 3.10).

- **Cumulative Effects.** A cumulative effect is possible for the change in prey availability of the GOA DSR; however, the effect is unknown due to lack of scientific information.

<u>Change in Habitat Suitability</u>

- **Direct/Indirect Effects.** The effect of the fisheries on the change in habitat suitability of GOA DSR under PA.1 and PA.2 is unknown.

- **Persistent Past Effects.** Past foreign, JV, and domestic groundfish fisheries and the IPHC longline fisheries have been identified as having past persisting negative effects on GOA DSR habitat due to the impacts caused by fishery gear. Climate changes and regime shifts have also been identified as having past positive or negative effects on GOA DSR habitat suitability (see Section 3.5.1.13).

- **Reasonably Foreseeable Future External Effects.** The State of Alaska herring and shrimp fisheries are not considered to be contributing factors to GOA DSR habitat suitability since the gear associated with these fisheries is not expected to cause a significant impact to the benthic habitat. The State of Alaska groundfish fisheries and the IPHC longline fisheries are identified as potential adverse contributors to DSR habitat suitability. See Sections 3.5.1.13 and 3.6 for more information on the effects of fishery gear on EFH. Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could cause habitat degradation and may cause changes in spawning or rearing success. Climate changes and regime shifts could have a potentially beneficial or adverse contribution to DSR habitat suitability (see Sections 3.5.1.13 and 3.10).

- **Cumulative Effects.** Although a cumulative effect is possible for habitat suitability of GOA DSR, the effect is currently unknown due to lack of scientific information.

See Table 4.5-30 for a summary of the cumulative effects on DSR under PA.1 and PA.2.

4.9.2 Prohibited Species Preferred Alternative Analysis

4.9.2.1 Pacific Halibut

Pacific halibut are managed by the IPHC. Halibut bycatch in federal groundfish fisheries is controlled by the use of PSC limits. IPHC accounts for all removals of halibut, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery.

Direct/Indirect Effects PA.1 and PA.2 – Pacific Halibut

Direct and indirect effects for Pacific halibut include mortality, and changes in reproductive success and prey availability. These effects, which are associated with changes in catch, are considered insignificant because annual quota setting processes implemented by the IPHC account for all removals of halibut including bycatch in other fisheries. Thus, if changes to the baseline condition of the stock occur, they are reflected in the quotas set for the directed fishery. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of either PA. No evidence of fishery impact to habitat of halibut has been shown, so this effect will not be considered in the cumulative effects analysis that follows. A summary of these effects is shown in Table 4.9-2.

Under PA.1, current halibut PSC caps would be retained with the possibility of future reduction in the BSAI of 0 to 10 percent). Estimated halibut bycatch mortality under PA.1 in the BSAI and GOA combined would decrease slightly from currently observed rates. This decrease would enable a corresponding increase in halibut catch by the IPHC directed fishery. Total removals would continue to be limited by the IPHC to protect the halibut resource.

Under PA.2, current halibut PSC caps in the BSAI would be reduced between 0 and 20 percent with the possibility of also reducing GOA PSC limits by zero to ten percent. Reductions in halibut are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. Estimated bycatch mortality in the BSAI and GOA would decrease, as noted in PA.1, thus enabling directed IPHC fisheries to increase halibut catch rates. Total removals would continue to be limited by the IPHC. In addition, PA.2 proposes the development of inseason closure areas in the GOA once PSC limits have been reached. This measure may provide for additional protection of the halibut resource in areas characterized with significant halibut bycatch.

Cumulative Effects Analysis PA.1 and PA.2 – Pacific Halibut

A summary of the cumulative effects analysis associated with PA.1 and PA.2 is shown in Table 4.5-31. For further information on persistent past effects included in this analysis, see Section 3.5.2.1 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA Pacific halibut is insignificant under PA.1 and PA.2 because current management of halibut by the IPHC accounts for all removals of halibut including bycatch in other fisheries when setting quotas for the directed fishery. Thus, if changes to the baseline condition of the stock occur, quotas set by the IPHC for the directed fishery will be adjusted accordingly.

- **Persistent Past Effects.** No persistent past effects of mortality on Pacific halibut have been identified. It is inferred that halibut bycatch in past fisheries was accounted for under the IPHC management process that is still in effect today.

- **Reasonably Foreseeable Future External Effects.** The directed longline fishery for Pacific halibut remains in effect, but is closely managed by the IPHC. Although state-managed fisheries may incidentally catch halibut, the IPHC provides for all removals, including bycatch in other fisheries, when setting quotas for the directed longline fishery. Thus, changes in halibut bycatch (increase or decrease) are reflected in changes to quotas set for the directed fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in halibut mortality. Long-term climate changes and regime shifts are not considered contributing factors, as they are not expected to result in direct mortality.

- **Cumulative Effects.** The combined effects of mortality on Pacific halibut resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of changes in reproductive success on BSAI and GOA Pacific halibut is insignificant under PA.1 and PA.2. Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. No significant change from the baseline condition is expected as a result of PA.1 and PA.2.

- **Persistent Past Effects.** No persistent past effects of changes in reproductive success on Pacific halibut have been identified. Currently, halibut stocks are considered healthy and stable.

- **Reasonably Foreseeable Future External Effects.** Halibut spawn in deep waters of the continental slope in midwinter where they are not significantly affected by any fishery. The directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in reproductive success for halibut. Long-term climate change and regime shifts could have impacts to the reproductive success of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in reproductive success on Pacific halibut resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

Change in Prey Availability

- **Direct/Indirect Effects.** The potential effect of changes in prey availability on BSAI and GOA Pacific halibut is insignificant under PA.1 and PA.2. Halibut are opportunistic predators with a wide range of prey species and no significant change to prey structure is expected as a result of PA.1 and PA.2.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of halibut have been identified.

- **Reasonably Foreseeable Future External Effects.** Halibut are opportunistic predators with a wide range of prey species. An increase in prey competition between Pacific halibut and fisheries catch is not expected. Thus, the directed longline fishery and other state-managed fisheries are not considered contributing factors to changes in prey availability for halibut. Long-term climate changes and regime shifts could have impacts on certain prey species of Pacific halibut depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on the prey structure of halibut cannot be determined at this time.

- **Cumulative Effects.** The combined effects of changes in prey availability on Pacific halibut resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

4.9.2.2 Pacific Salmon or Steelhead Trout

Pacific salmon are managed by ADF&G, which also manages the salmon sport fisheries and permitted subsistence harvesting, to ensure that escapement goals are met for the spawning population in order to maintain sustained yields from the stock as a whole. Annual harvest levels are responsive to fluctuations in run sizes.

For reasons discussed in Section 4.5.2.2, ESA-listed Pacific Northwest chinook salmon and steelhead trout were not specifically considered in this cumulative effects analysis.

Management of Alaskan salmon stocks is challenging due to the lack of precise information on total returns and the inability to predict future returns to most rivers or tributaries with any degree of certainty. In most cases, total return and escapement are not known. As a result of this lack of information, estimates of significant impacts of bycatch on various runs are unreliable. Another factor to consider in salmon management is the Alaska subsistence preference law. This law requires that commercial, recreational, and personal use fisheries be restricted before subsistence use fisheries. Therefore, management of all fisheries for these stocks in state waters incorporates conservative measures.

A summary of assumptions included in the impact analysis of the proposed FMPs is presented in Section 4.5.2.2.

The cumulative effects analyses were based on two groupings of Alaska salmon in the BSAI and GOA: chinook salmon and other salmon.

Direct/Indirect Effects PA.1 and PA.2 – Chinook and Other Salmon

Direct and indirect effects for chinook salmon and other salmon in the BSAI and GOA include mortality, changes in spawning habitat, prey availability, genetic structure of population, and reproductive success. A summary of these effects is shown in Table 4.9-2.

PA.1 would maintain current PSC limits for salmon in the BSAI with the possibility for reducing them by zero to ten percent in the future. In the GOA, it is proposed that PSC limits, or other appropriate measures, be established for salmon, as well as identifying salmon savings areas to improve management of salmon stocks residing in this region. Under PA.2, BSAI PSC limits for salmon may be further reduced (0 to 20 percent) while considering reduction in GOA PSC limits by zero to ten percent. PA.2 also proposes the development of in-season closures in the GOA to ensure that once PSC limits have been reached, fishing does not continue within that region. These proposed measures may provide additional protection to Alaska salmon stocks, particularly in years of poor runs.

BSAI Chinook Salmon

Under PA.1, chinook salmon bycatch in the BSAI varies, with an average of approximately 25,000 fish over the five-year projection period. Assuming that 58 to 70 percent of BSAI chinook salmon bycatch may be of western Alaska origin, the bycatch of western Alaska chinook salmon stocks could range from 14,500 to 17,500 fish during the next 6 years. This harvest represents approximately four to six percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Such bycatch levels, which are not detectable in natal streams, would have little or no effect on commercial or subsistence harvests and escapement, and are not expected to significantly impact the sustainability of the stock.

Under PA.2, chinook salmon bycatch in the BSAI varies, with an average of about 20,000 fish over the five-year projection period. In keeping consistent with the assumption in PA.1, the bycatch of western Alaska chinook salmon stocks could range from 11,600 to 14,000 fish during the next six years. This harvest represents approximately three to five percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. Reductions in BSAI chinook salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. PA.2 results in a reduction in western Alaska chinook salmon catches; however, such bycatch levels may not be detectable in natal streams, may not exert significant effects on commercial or subsistence harvests or escapement, and may not impact the sustainability of the stock as a whole.

BSAI Other Salmon

Under PA.1, bycatch of other salmon in the BSAI varies averaging 65,000 fish over the projection period. Assuming that 96 percent of other salmon bycatch is chum salmon and 19 percent may be of western Alaska origin, the resulting bycatch of western Alaska chum salmon stocks would be about 12,000 fish over the next 6 years. This harvest represents approximately one percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. It is presumed that these bycatch levels are not detectable in natal streams, would have no detectable effect on commercial or subsistence harvests and escapement, and would not significantly impact the sustainability of the stock.

Under PA.2, bycatch of other salmon in the BSAI varies, averaging 54,000 fish over the projection period. Maintaining the distribution assumptions noted in PA.1, the bycatch of western Alaska chum salmon stocks would be approximately 10,000 fish during the next six years. This harvest represents less than one percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. Reductions in BSAI other salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. PA.2 results in bycatch reductions for western Alaska chum salmon catches. However, such bycatch levels may not be detectable in natal streams, may not exert significant effects on commercial or subsistence harvests, or escapement, or significantly impact the sustainability of the stock.

GOA Chinook Salmon

Under PA.1, predicted chinook salmon bycatch in the GOA initially decreases and then gradually increases over the 5-year projection period, reaching similar levels to those observed today (approximately 21,000 fish). Assuming that 58 percent of GOA chinook salmon bycatch is of western Alaska origin, bycatch of western Alaska chinook salmon would average approximately 12,000 fish during the next 6 years. This harvest represents approximately four percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. PA.1 results in reductions of annual western Alaska chinook salmon catch; however, these bycatch levels may not be detectable in natal streams, or exert effects on commercial or subsistence harvests and escapement resulting in significant impacts to sustainability of the stock.

Under PA.2, chinook salmon bycatch in the GOA varies, but remains below those catch rates currently observed (21,000 fish). Thus, chinook salmon bycatch of western Alaska origin is predicted at less than 7,000 fish over the 5-year projection period. This harvest represents less than one percent of the average western Alaska commercial and subsistence harvest of approximately 300,000 chinook salmon from 1998 through 2000. PA.2 results in a reduction in western Alaska chinook salmon catch. Reductions in GOA chinook salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. However, significance of these reductions on escapement, commercial or subsistence harvests, and sustainability of the stocks is difficult to determine.

GOA Other Salmon

Under PA.1, bycatch of other salmon in the GOA varies, averaging about 5,000 fish over the 5-year projection period. Assuming that 56 percent of this other salmon bycatch is chum salmon, bycatch would consist of approximately 3,000 chum salmon. The proportion of these fish from western Alaska is unknown. Assuming that all of these fish were from western Alaska, this harvest represents less than one percent of the average western Alaska commercial and subsistence harvest of approximately 1,100,000 chum salmon from 1998 through 2000. PA.1 reduces western Alaska chum salmon catches. Reductions in GOA other salmon are assumed to occur as a result of bycatch reduction incentives implemented as part of the rationalization of the groundfish fisheries. However, the significance of these reductions to escapement, commercial or subsistence harvests, and sustainability of the stock cannot be determined.

Under PA.2, bycatch of other salmon in the GOA varies, but remains similar to those trends noted above for PA.1.

Cumulative Effects Analysis PA.1 – BSAI and GOA Chinook and Other Salmon

A summary of the cumulative effects analysis associated with PA.1 is shown in Tables 4.9-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant under PA.1.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in the BSAI and GOA. Bilateral agreements between the U.S. and these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries, and foreign fisheries while allocating salmon resources to the State of Alaska fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The State of Alaska took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects.** State of Alaska commercial and subsistence fisheries exert effects on mortality of western Alaska chinook and other salmon populations. The magnitude of this effect cannot be determined; however, current stock status indicates that salmon runs in western Alaska are depressed. Taking this stock condition into consideration, impacts of catch and bycatch by state fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. State of Alaska commercial, subsistence, and sport fisheries also impact salmon populations other than western Alaska chinook. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State of Alaska hatchery enhancement programs initiated in the GOA potentially counteract the effects of mortality on salmon stocks. In addition, long-term climate changes and regime shift are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on BSAI and GOA chinook, and BSAI other salmon resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for PA.1. Combined bycatch potential in the BSAI and GOA under this FMP could impede the successful recovery of depressed stocks and impact sustainability of the stock as a whole. The combined effects of mortality on GOA other salmon resulting from internal bycatch and future events are considered insignificant under PA.1.

Change in Prey Availability

- **Direct/Indirect Effects**. The potential effects of PA.1 on prey availability for BSAI and GOA chinook and other salmon are unknown. A relationship between fisheries bycatch of salmon prey and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, a relationship between State of Alaska commercial, subsistence, and GOA sport fisheries bycatch of salmon prey and salmon prey availability has not been defined, and potential effects are unknown. Land management practices are not considered contributing factors in salmon prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. State of Alaska hatchery enhancement programs occur in GOA, but do not include prey species of salmon. Long-term climate changes and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown under PA.1.

<u>Change in Genetic Structure of Population</u>

- **Direct/Indirect Effects.** The potential effects of PA.1 on genetic structure of salmon populations in the BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, salmon bycatch composition has not been determined, so potential effects of State of Alaska commercial, subsistence, and sport fisheries on genetic structure of salmon populations are unknown. For reasons stated above, land management practices, long-term climate changes, and regime shifts are not considered contributing factors to changes in the BSAI and GOA salmon populations. State of Alaska hatchery enhancement programs in the GOA focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in the GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in the BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown under PA.1.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effects of PA.1 on reproductive success for BSAI and GOA chinook and other salmon cannot be determined.

- **Persistent Past Effects.** Given the poor stock status of salmon runs in western Alaska it may be inferred that reproductive success has been impacted in certain populations of the BSAI region. Successful reproduction of salmon depends on spawning adults' ability to reach intended spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Stocks in GOA are currently considered stable, so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** State of Alaska commercial and subsistence fisheries catch of western Alaska chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. Considering the condition of this depressed stock, impacts of catch and bycatch by State of Alaska fisheries could hinder its recovery, and are therefore considered a potential adverse contribution to the population as a whole. GOA other salmon stocks are considered stable, so potential effects of State of Alaska commercial, subsistence, and sport fisheries on reproductive success of this stock are considered insignificant for this population. Degradation of watersheds used by spawning salmon, resulting from poor land management practices, could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potential adverse contributions to possible changes in reproductive success of this population. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska, and are considered potentially beneficial to the reproductive success of salmon.

Long-term climate changes and regime shifts could have impacts on the reproductive success of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species; however, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska, and the combined bycatch potential in the BSAI and GOA fisheries, the sustainability of BSAI and GOA chinook, and BSAI other salmon stocks could be impacted. Thus, fisheries catch may remove spawning adults destined for spawning grounds, and potential combined effects from internal and external events are considered conditionally significant adverse to the reproductive success of BSAI and GOA chinook and BSAI other salmon. Although current stock status of GOA chinook and other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from internal bycatch and future external events (both human controlled and natural) cannot be determined for GOA other salmon stocks under PA.1.

Cumulative Effects Analysis PA.2 – BSAI and GOA Chinook and Other Salmon

A summary of the cumulative effects analysis associated with PA.2 is shown in Table 4.9-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.2 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA chinook and other salmon is considered insignificant under PA.2.

- **Persistent Past Effects.** Past foreign fisheries in Japan and Russia are associated with direct catch and bycatch of salmon in the BSAI and GOA. U.S. bilateral agreements between the U.S. and these countries attempted to reduce gear conflicts between State of Alaska salmon fisheries and foreign fisheries while allocating salmon resources to the State of Alaska fisheries. These bilateral agreements were considered marginal management measures for protection of salmon stocks. Before 1959, salmon fisheries in Alaska were managed federally. The State of Alaska took over salmon management after statehood in 1959. However, the domestic fleet continued to grow during the years to follow and by the 1970s, the state initiated a limited entry system upon the realization that salmon stocks were being overfished. Persistent past effects of mortality on Alaskan salmon stocks exist and are associated with past foreign, JV, and domestic groundfish fisheries.

- **Reasonably Foreseeable Future External Effects**. External effects on Alaskan salmon populations differ between the BSAI and GOA and will be discussed independently for each region.

  In the BSAI, State of Alaska commercial and subsistence fisheries exert effects on mortality of chinook and other salmon populations. The magnitude of this effect cannot be determined; however, current stock status indicates that salmon runs in western Alaska are depressed. In considering this stock condition, impacts of catch and bycatch by State of Alaska fisheries could hinder recovery of depressed stocks, and are considered a potential adverse contribution to the population as a whole. In the GOA, State of Alaska commercial, subsistence, and sport fisheries exert effects on mortality of other salmon populations due to their stability. Land management practices heavily influence the condition of watersheds used by spawning salmon, but are not considered contributing factors in direct mortality of salmon. State of Alaska commercial enhancement programs were initiated in the GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. In addition, long-term climate changes and regime shifts are not expected to result in direct mortality of salmon.

  In the GOA, State of Alaska commercial, subsistence, and sport fisheries exert effects on mortality of chinook and other salmon populations. However, they are not expected to impact salmon stocks in this region under PA.2. As mentioned in the BSAI above, land management practices are an important factor influencing spawning habitat of salmon, but are not considered contributing factors in direct mortality of salmon in the GOA. State of Alaska commercial enhancement programs were initiated in the GOA and have a potential beneficial contribution to effects of mortality on salmon stocks. Long-term climate changes and regime shifts are not expected to result in direct mortality of salmon.

- **Cumulative Effects.** Given the poor stock status of salmon runs in western Alaska, the combined effects of mortality on the BSAI and GOA chinook and BSAI other salmon resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered conditionally significant adverse for PA.2. Combined bycatch potential of the BSAI and GOA under this FMP could impede on the successful recovery of depressed stocks in the BSAI and impact sustainability of the stock as a whole. The combined effects of mortality on GOA other salmon resulting from bycatch and future events are considered insignificant under PA.2.

Change in Prey Availability

- **Direct/Indirect Effects**. The potential effects of PA.2 on prey availability for BSAI and GOA and other salmon are unknown. A relationship between fisheries bycatch of salmon prey and salmon prey availability has not been defined.

- **Persistent Past Effects.** It has not been determined if past effects are currently impacting prey availability for BSAI and GOA chinook and other salmon.

- **Reasonably Foreseeable Future External Effects.** In both the BSAI and GOA, a relationship between State of Alaska commercial, subsistence, and GOA sport fisheries bycatch of prey and salmon prey availability has not been defined, and potential effects are unknown. Land management practices are not considered contributing factors in prey availability of salmon, as it is not likely that they would impact the marine environment in which salmon forage. Long-term climate changes and regime shifts could have impacts on certain prey species of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment, while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on the prey structure of salmon cannot be determined at this time. State of Alaska hatchery enhancement programs that occur in the GOA do not include prey species of salmon.

- **Cumulative Effects.** The combined effects of potential changes in prey availability for BSAI and GOA chinook and other salmon resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown under PA.2.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of PA.2 on genetic structure of salmon populations in the BSAI and GOA are unknown.

- **Persistent Past Effects.** It has not been determined if past effects may be impacting the genetic structure of the BSAI and GOA chinook and other salmon populations.

- **Reasonably Foreseeable Future External Effects**. In both the BSAI and GOA, salmon bycatch composition has not been determined, so potential effects of State of Alaska commercial and subsistence fisheries on genetic structure of salmon populations are unknown. Significant impacts to genetic structure of salmon populations by land management practices are not expected, and are not considered contributing factors to a possible change in baseline condition. Long-term climate changes and regime shifts are not expected to result in direct mortality, which would potentially affect genetic structure of BSAI and GOA chinook and other salmon stocks. State of Alaska hatchery enhancement programs in the GOA focus on building certain salmon stocks, but because actual stock composition for all species of salmon is unknown, the potential effects of this program on genetic structure of salmon populations in the GOA are not known.

- **Cumulative Effects.** Due to the uncertainty of current stock composition for chinook and other salmon in the BSAI and GOA, the combined effects of changes in genetic structure on salmon populations in Alaska resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown under PA.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of PA.2 on reproductive success for BSAI and GOA chinook and other salmon cannot be determined.

- **Persistent Past Effects**. Given the poor stock status of salmon runs in western Alaska it may be inferred that reproductive success has been impacted in certain populations of the BSAI region.

Successful reproduction of salmon depends on spawning adults' ability to reach destined spawning habitat. Persistent past effects of mortality on salmon stocks exist, and it is likely that reproductive success of these stocks has suffered as a result. Stocks in the GOA are currently considered stable so it is inferred that any past effects on the population have been mitigated over time.

- **Reasonably Foreseeable Future External Effects.** External effects on Alaskan salmon populations differ between BSAI and GOA and will be discussed independently for each region.

  In the BSAI, State of Alaska commercial and subsistence fisheries catch of chinook and other salmon populations could cause potential adverse impacts to reproductive success of these already depressed stocks. Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. The direct take of these fish would prevent their return to spawning grounds. In considering this depressed stock condition, impacts of catch and bycatch by State of Alaska fisheries could hinder recovery of depressed stocks and are considered a potential adverse contribution to the population as a whole. Degradation of watersheds used by spawning salmon, and caused by poor land management practices, could significantly impact the reproductive success of BSAI salmon stocks. Thus, these practices are considered potential adverse contributions to possible changes in reproductive success of this population.

  Salmon stocks in the GOA are considered stable, so potential effects of State of Alaska commercial, subsistence, and sport fisheries on reproductive success of this stock are considered insignificant for this population. For reasons stated above, land management practices are considered as potential adverse contributions to the reproductive success of the GOA salmon stocks. Hatchery enhancement programs in GOA may help to restore depressed stocks and maintain stable stocks in Alaska and are considered potentially beneficial to the reproductive success of salmon.

  Long-term climate changes and regime shifts could have impacts on the reproductive success of Pacific salmon in the BSAI and GOA depending on the direction of the shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on reproductive success of BSAI and GOA salmon cannot be determined at this time.

- **Cumulative Effects.** Successful reproduction of salmon relies on spawning adults' ability to reach destined spawning habitat. Given the poor stock status of salmon runs in western Alaska and combined bycatch potential of the BSAI and GOA, the sustainability of BSAI and GOA chinook and BSAI other salmon stocks could be impacted. Thus, fisheries catch may remove spawning adults destined for spawning grounds. Potential combined effects from internal and external events is considered conditionally significant adverse to the reproductive success of BSAI and GOA chinook and BSAI other salmon. Although current stock status of GOA chinook and other salmon is stable, combined effects of changes in reproductive success in Alaskan salmon populations resulting from internal catch, internal bycatch, and reasonably foreseeable future external events (both human controlled and natural) cannot be determined for GOA other salmon stocks under PA.2.

4.9.2.3 Pacific Herring

Pacific herring are managed by ADF&G. Harvest policy and allocations among gear (user) groups are established by the Alaska Board of Fisheries. Annual harvest quotas are set by ADF&G under an exploitation rate harvest policy; herring exploitation rates are capped at a maximum level of 20 percent statewide. All directed herring fisheries occur in State of Alaska waters, and are managed by regulatory stocks.

A detailed discussion of the modeling approach used in this analysis is included in Section 4.5.2.3. Given the low herring bycatch levels that are predicted across all proposed FMPs, bycatch removals would not be expected to have significantly different impacts on herring abundance estimates between FMPs.

Direct/Indirect Effects PA.1 and PA.2 – Pacific Herring

Direct and indirect effects for Pacific herring include mortality changes in reproductive success, prey availability, and habitat. These effects, which are associated with changes in catch, are considered insignificant because annual quota setting processes implemented by ADF&G are responsive to fluctuations in herring biomass. A summary of these effects is shown in Table 4.9-2.

Under PA.1, current herring PSC caps would be retained with the possibility of future reduction in the BSAI (0 to 10 percent). Total removals would continue to be limited by ADF&G to protect the herring resource.

Under PA.2, current herring PSC caps in the BSAI would be reduced between 0 and 20 percent with the possibility of also reducing GOA PSC limits by 0 to 10 percent . Total removals would continue to be limited by ADF&G. In addition, PA.2 proposes the development of inseason closure areas in the GOA once PSC limits have been reached. This measure may provide for additional protection of the herring resource in areas characterized with significant herring bycatch.

Cumulative Effects Analysis PA.1 and PA.2 – Pacific Herring

A summary of the cumulative effects analysis associated with PA.1 and PA.2 is shown in Table 4.5-34. For further information on persistent past effects included in this analysis, see Section 3.5.2.3 of this Programmatic SEIS.

<u>Mortality</u>

- **Direct/Indirect Effects**. The potential effect of fishing mortality on BSAI and GOA herring is insignificant under PA.1 and PA.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass. The herring savings areas reduce herring bycatch potential by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Domestic herring fisheries became prominent in the early 1900s, with peak catches occurring in the 1920s and 1930s. Foreign herring harvests became prominent in the BSAI in the late 1950s, with highs in the late 1960s and early 1970s. Overexploitation of herring likely resulted during these years of high catch. By 1980, foreign harvest of herring had been eliminated; however, years of unregulated catch of herring may have had long-term impacts on impacted herring populations long-term. In addition, past federal groundfish fisheries bycatch, combined with the directed State of Alaska fisheries, have exceeded the State of Alaska's herring harvest policy and may still exert lingering effects on current herring populations in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Directed State of Alaska herring fisheries still occur, but are closely managed by ADF&G. Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. State of Alaska subsistence catch is also accounted for in ADF&G herring management plans. These fisheries are not considered contributing factors to changes in herring mortality. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring mortality, especially for those populations that are still recovering from the EVOS in the GOA. Long-term climate changes and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass. Fishing quotas are based on variable exploitation rates that account for declines in stock and are capped at a maximum rate of 20 percent. Thus, although some persistent past effects may still be present on certain herring populations in the BSAI and GOA, the combined effects of mortality on Pacific herring resulting from bycatch and reasonably foreseeable future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on reproductive success of BSAI and GOA herring is insignificant under PA.1 and PA.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in reproductive success occurs, it would most likely be reflected in corresponding changes to biomass, which are incorporated into ADF&G management plans for Pacific herring.

- **Persistent Past Effects**. As discussed in the analysis of cumulative effects on Pacific herring mortality, years of unregulated foreign harvest and past federal groundfish fisheries bycatch that exceeded the State of Alaska's herring harvest policy may still exert lingering effects on current herring populations in the BSAI and GOA. Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. It has been found that this type of contamination exposure to adult and larval herring can result in many adverse effects such as: increased rates of egg mortality, larval deformities, and immune system deficiencies. It is presumed that the effects of EVOS still exist, and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** Directed State of Alaska herring fisheries still occur, but are closely managed by the ADF&G. Fishing quotas are based on variable exploitation rates that account for declines in stock. State subsistence fisheries catch is accounted for in ADF&G herring management plans. Thus, these fisheries are not considered contributing factors to changes in herring reproductive success. Future acute and chronic marine pollution could occur and is considered potentially adverse to herring reproductive success, especially for those populations that are still recovering from the EVOS in the GOA. Long-term climate changes and regime shifts could have impacts to the reproductive success of Pacific herring depending on the direction of the shift.

It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** ADF&G Pacific herring management plans are responsive to changes in herring biomass and fishing quotas are based on variable exploitation rates that account for declines in herring stock. Although certain herring populations in the GOA have been impacted by EVOS, the stock as a whole is considered recovering. Thus, some persistent past effects may still be present on certain herring populations in the BSAI and GOA, but the combined effects on Pacific herring reproductive success resulting from bycatch and future external events (both human controlled and natural) are considered insignificant for PA.1 and PA.2.

Change in Prey Availability

- **Direct/Indirect Effects**. The potential effect of federal groundfish fisheries on prey availability for BSAI and GOA herring is insignificant under PA.1 and PA.2 because current management by ADF&G is responsive to fluctuations in herring biomass regardless of the cause associated with the change. Thus, if a change in prey availability did occur, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans for Pacific herring.

- **Persistent Past Effects.** No persistent past effects impacting prey availability of herring have been identified.

- **Reasonably Foreseeable Future External Effects**. Pacific herring feed primarily on zooplankton which are not affected by State of Alaska directed herring fisheries or State of Alaska subsistence fisheries. Thus, these fisheries are not considered contributing factors to changes in prey availability for herring. Future acute and chronic marine pollution could occur, but effects on prey such as zooplankton, are unknown. Long-term climate changes and regime shifts could have impacts too many species that contribute to the prey structure of Pacific herring. The nature of these impacts depends on the direction of the climatic shift. It has been shown that warm trends favor recruitment while cool trends weaken recruitment in most fish species. However, the effects of this type of large scale event on herring cannot be determined at this time.

- **Cumulative Effects.** Potential effects of future natural events, such as marine pollution and climatic shifts, on prey availability for Pacific herring are unknown for PA.1 and PA.2.

Change in Habitat

- **Direct/Indirect Effects.** The potential effect of federal groundfish fisheries on habitat of BSAI and GOA herring is insignificant under PA.1 and PA.2 because current management of herring by ADF&G is responsive to fluctuations in herring biomass. Thus, if a change in important habitat occurs, it would most likely be reflected in corresponding changes to biomass, which are accounted for in ADF&G management plans for Pacific herring. The herring savings areas reduce herring bycatch potential and protect important habitat by triggering closures in years when herring are abundant within fishing grounds.

- **Persistent Past Effects.** Herring spawning habitat in the GOA (specifically PWS) was contaminated with oil resulting from the EVOS in 1989. The long-term effects of this event to herring habitat are unknown. It is presumed that the effects of EVOS still exist and subsets of herring populations in the GOA are still recovering.

- **Reasonably Foreseeable Future External Effects.** No evidence of fishery impacts on habitat of herring exists. Thus, fisheries are not considered contributing factors to changes in herring habitat at this time. Future acute and chronic marine pollution could occur and is considered potentially adverse to some herring habitat, especially those that are still recovering from EVOS in the GOA. Long-term climate changes and regime shifts are not expected to significantly change physical habitat of Pacific herring.

- **Cumulative Effects.** Potential impacts of future natural events, such as marine pollution and climatic shifts, in addition to lingering contamination from EVOS on certain habitat of herring in the GOA exist, but effects are not known for PA.1 and PA.2.

4.9.2.4 Crab

Alaska king, bairdi Tanner crab, and opilio Tanner crab (also called snow crab) fisheries are managed by the State of Alaska, with federal oversight and guidelines established in the BSAI king and Tanner crab FMP (NPFMC 1989). Section 4.5.2.4 contains further information on current stock status and management of crab in Alaska.

For cumulative effects analyses, crab stocks in the BSAI and GOA will be placed in the following groups: bairdi Tanner, opilio Tanner (only BSAI), red king, blue king, and golden king.

Direct/Indirect Effects PA.1 and PA.2 – Crab

Direct and indirect effects for all species of crab in the BSAI and GOA include mortality, changes in biomass, reproductive success, prey availability, and habitat. These effects may be attributed to fishing activities (both directed fishing and bycatch), but may also be linked to natural events such as long-term climatic changes and decadal regime shifts. Significance of these effects is based on the likelihood that population-level changes will result from internal events within the groundfish fishery. An effect that is considered insignificant corresponds to a change that is not likely to result in population-level effects on crab or that lies within the range of natural variability for the species.

Under PA.1, all existing closures/restricted areas (i.e., Red King Crab Area and Pribilof Island closures) will be maintained, as will the 2002 Steller sea lion closures. In addition, identification and designation of EFH and HAPC is proposed. Current PSC limits for crab in the BSAI will be maintained under PA.1 with consideration for further reduction by zero to ten percent. PSC limits, or other appropriate measures, will be established for crab in the GOA and based on biomass estimates or other fishery data.

PA.2 includes and builds upon the proposed measures in PA.1. In addition to maintaining existing closure areas, review of these closures to determine if they qualify as MPAs, including no-take reserves, has been suggested. Other proposed measures under PA.2 include: implementation of mitigation measures for EFH and HAPC that show significantly adverse effects from fishing, establishing an Aleutian Islands management area to protect living habitat (often contained in crab habitat), possible modification to Steller sea lion closures (including Aleutian Islands) with designation of critical habitat based on scientific data, and development of inseason closure areas in the GOA triggered by PSC limits being reached. Also proposed under PA.2 is a further reduction in the BSAI crab PSC limits by 0 to 20 percent and GOA limits by zero to ten percent. Expansion of observer coverage based on scientific data and compliance needs for all vessels is also included in PA.2. This observer coverage, along with improved species identification for non-target species, may provide additional protection to crab populations throughout the BSAI and GOA regions and provide for more reliable crab bycatch composition data.

Cumulative Effects Analysis PA.1 and PA.2 – Crab

Summaries of the cumulative effects analyses associated with PA.1 and PA.2 are shown in Table 4.9-2. For further information on persistent past effects included in this analysis, see Section 3.5.2.4 of this Programmatic SEIS.

The foundation of the cumulative effects analysis is the baseline description for each species that includes population status and trends, if known, and the major human and natural influences that have affected the population in the past and that continue up to the present.

For each species, the predicted direct and indirect effects of the groundfish fishery are then analyzed for their contribution to the overall impacts from all sources, including reasonably foreseeable future events resulting from human and natural events external to the fishery. The reasonably foreseeable future events also include other U.S. and foreign fisheries, acute and chronic environmental pollution, and natural events such as climatic and oceanographic fluctuations. Cumulative effects are each rated according to the same significance criteria as the direct/indirect effects of the fishery and are based on the potential for population-level effects.

<u>Mortality</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in the BSAI

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of these crab species does not reflect large deviations from the current baseline condition, however, catch trends do vary throughout the five-year period. Although current bycatch limits and quota-setting processes are responsive to fluctuations in stock and account for crab bycatch in other state and federal fisheries, these stocks are currently considered depressed, and in some instances, overfished. Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs. Furthermore, additional protection measures could enhance habitat and possible recovery of depressed stocks, but these changes are not expected to significantly affect the crab population in the BSAI as a whole. Under PA.1 and PA.2, it is possible that bycatch of crab could decrease, and additional protection measures could enhance habitat and possible recovery of depressed stocks, but these changes are not expected to significantly affect the crab populations in the BSAI as a whole. Thus, PA.1 and PA.2 are considered to have insignificant effects on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI because no sign of recovery for these stocks has been shown to date.

- **Persistent Past Effects**. Direct catch and bycatch of crab are associated with past foreign fisheries. Crab bycatch is common in yellowfin sole and Pacific ocean perch fisheries. During the 1960s, foreign fleets in the BSAI experienced record catch of yellowfin sole and Pacific ocean perch. It is inferred that bycatch of crab during this time increased proportionally with the direct catch of these fisheries. The United States initiated bilateral agreements with Japan and Russia in the mid-1960s in order to reduce gear conflicts and allocate crab resources between State of Alaska crab fisheries and foreign fisheries. These bilateral agreements are thought to have been marginal management measures providing no benefit or protection to crab stocks overall. Thus, adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, managed by ADF&G in cooperation with NOAA Fisheries. These fisheries are considered to have a potential adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI since no signs of recovery have been shown. Formal stock rebuilding plans are in place for the BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. The BSAI red king crab stocks do not have rebuilding plans in effect, and the populations are currently considered depressed. Long-term climate changes and regime shifts are not expected to result in direct mortality of crab stocks, and are not considered contributing factors to potential changes in mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. It is unclear if additional protection measures and decreased bycatch of crab will mitigate the combined effects of mortality resulting from past events, internal bycatch, and reasonably foreseeable future external events on depressed stocks. Thus, cumulative effects of PA.1 and PA.2 on BSAI crab stocks cannot be determined at this time.

Golden King Crab in the BSAI and GOA

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of golden king crab in the BSAI and GOA were combined with predictions for blue king crab. The BSAI predictions showed increases in catch for PA.1 and decreases in catch for PA.2 over the next five years when compared to current catch rates. Model projections for GOA catch showed decreases in catch for PA.1 and PA.2 compared to current catch in this region. Crab bycatch could decrease as a result of bycatch reduction incentives built into rationalization programs. However, significance of these predicted changes in catch on mortality is unknown due to lack of survey information for determining current stock status. Thus, effects of PA.1 and PA.2 on mortality of BSAI and GOA golden king crab are unknown.

- **Persistent Past Effects**. Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist (see the previous discussion of persistent past effects on crab in the BSAI).

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab fisheries, scallop fisheries, and subsistence fisheries continue to occur, managed by ADF&G in cooperation with NOAA Fisheries. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab, but the overall stock status of golden king crab stocks in the BSAI and GOA are currently unknown. Thus, the potential effects of these fisheries on mortality are not known. Long-term climate changes and regime shifts are not expected to result in direct mortality of crab stocks, and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects**. ADF&G crab management plans are responsive to changes in stock status and quota-setting processes account for crab bycatch in other State of Alaska and federal fisheries. Under PA.1 and PA.2, it is possible that bycatch of golden king crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks. Some GOA stocks are considered depressed, but the overall stock status of golden king crab in the BSAI and GOA is unknown. Thus, potential combined effects of mortality, resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time.

Bairdi Tanner, Red King, and Blue King Crab in the GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of bairdi Tanner, red king, and blue king crab in the GOA showed decreases from current baseline for the next 5 years. Under these proposed FMPs, it is expected that bycatch of bairdi Tanner, red king, and blue king crab in the GOA crab could decrease, likely as a result of bycatch reduction incentives built into rationalization programs.

  However, significance of these predicted changes in catch on mortality is unknown for bairdi Tanner and blue king crab due to lack of survey information for determining current stock status as a whole. Thus, effects of PA.1 and PA.2 on mortality of GOA bairdi Tanner and blue king crab are unknown. GOA red king crab stocks are considered severely depressed according to ADF&G survey information, but it is unclear if possible decreases in crab catch proposed under the PA will mitigate driving factors of mortality in these stocks. PA.1 and PA.2 are considered insignificant for mortality effects on GOA red king crab populations due to the lack of recovery that has been observed in these stocks to date.

- **Persistent Past Effects**. Adverse past effects of mortality on GOA crab stocks from directed crab catch and bycatch could still exist (see previous section of persistent past effects on GOA crab).

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab fisheries, scallop fisheries, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in the GOA is currently unknown. Thus, the potential effects of these fisheries on mortality of bairdi Tanner and blue king crab stocks are not known. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with State of Alaska fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in the GOA. Long-term climate changes and regime shifts are not expected to result in direct mortality of crab stocks and are not considered contributing factors to potential changes in crab mortality.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed but their overall stock status is unknown. Thus, potential combined effects of mortality resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time. It is unclear if additional protection measures and decreased bycatch of crab put forth under the PA will mitigate the combined effects of mortality, resulting from past events, internal bycatch, and reasonably foreseeable future external events on severely depressed red king crab stocks. Cumulative effects of PA.1 and PA.2 on GOA red king crab cannot be determined at this time.

Change in Biomass

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in the BSAI

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of these crab species do not reflect large deviations from the current baseline condition, although catch trends vary throughout the five-year period. Under the PA, it is possible that bycatch of crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs, but these changes are not expected to significantly affect crab biomass in the BSAI as a whole. Thus, PA.1 and PA.2 are considered to have insignificant effects on changes in biomass of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Adverse past effects of mortality on BSAI and GOA crab stocks from directed crab catch and bycatch could still exist (see previous discussion of persistent past effects on crab).

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur and are considered to have a potential adverse effect on bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI, since no signs of recovery have been shown. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time. The BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. Potential effects of long-term climate changes and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Persistent past effects on crab populations in the BSAI may still exist, and stocks are considered depressed with no signs of recovery to date. It is unclear if additional protection measures and decreased bycatch of crab will mitigate the combined effects of mortality and subsequent changes to biomass resulting from past events, internal bycatch, and reasonably foreseeable future external events on depressed stocks. Thus, cumulative effects of PA.1 and PA.2 on BSAI crab stocks cannot be determined at this time.

Golden King Crab in the BSAI and GOA

- **Direct/Indirect Effects**. Due to lack of survey information for determining current biomass of golden king crab in the BSAI and GOA, potential effects of PA.1 and PA.2 on changes to biomass cannot be determined.

- **Persistent Past Effects**. The potential effects of past fishing mortality on biomass of golden king crab stocks in the BSAI and GOA cannot be determined because catch composition is unknown and biomass estimates over time do not exist for these stocks.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for golden king crab. However, the overall stock status of golden king crab stocks in the BSAI and GOA is unknown, and biomass estimates have not been determined. Thus, the potential effects of these fisheries on biomass are not known. Effects of long- term climate changes and regime shifts on crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other state and federal fisheries. Under the PA, it is possible that bycatch of golden king crab could decrease and additional protection measures could enhance habitat and possible recovery of depressed stocks. However, persistent past effects on these crab populations in the BSAI and GOA may still exist. Some GOA stocks are considered depressed, but the overall stock status and biomass estimates of golden king crab in the BSAI and GOA are unknown. Thus, potential combined effects of changes in biomass resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined at this time.

Bairdi Tanner, Red King, and Blue King Crab in the GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Under PA.1 and PA.2, predicted catch of bairdi Tanner, red king, and blue king crab in GOA shows decreases from currently observed catch over the next five years. Under these proposed FMPs, it is expected that bycatch of crab could decrease as a result of bycatch reduction incentives built into rationalization programs. However, significance of these predicted changes in catch on the change in biomass mortality is unknown for bairdi Tanner and blue king crab due to lack of survey information for determining current stock status as a whole. Thus, effects of PA.1 and PA.2 on biomass of GOA bairdi Tanner and blue king crab are unknown. GOA red king crab stocks are considered severely depressed according to ADF&G survey information, but it is unclear if possible decreases in crab catch proposed under these FMPs will mitigate driving factors of mortality in these stocks. PA.1 and PA.2 are considered insignificant to potential changes in biomass for GOA red king crab populations due to the lack of recovery that has been observed in these stocks to date.

- **Persistent Past Effects**. Adverse effects of past fishing mortality on biomass of bairdi Tanner, blue king, and red king crab stocks in GOA may still exist as recovery of depressed stocks has not been observed.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Survey data collected by ADF&G in specific areas of the GOA have shown depressed stock status for bairdi Tanner and blue king crab, but their overall stock status in GOA is currently unknown. Thus, the potential effects of these fisheries on biomass of bairdi Tanner and blue king crab stocks cannot be determined. GOA stocks of red king crab are considered severely depressed according to current ADF&G surveys. The depressed nature of these stocks, in addition to external mortality associated with State of Alaska fisheries (directed, subsistence, and scallop), could adversely impact recovery and sustainability of red king crab stocks in GOA. Effects of long-term climate changes and regime shifts of crab biomass have not been determined.

- **Cumulative Effects.** ADF&G crab management plans are responsive to changes in stock status, and quota-setting processes account for crab bycatch in other State of Alaska and federal fisheries. However, persistent past effects on bairdi Tanner, red king, and blue king crab stocks in the GOA may still exist. Some GOA stocks of bairdi Tanner and blue king crab are considered depressed, but their overall stock status and biomass estimates are unknown. Thus, potential combined effects of changes in biomass, resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined for bairdi Tanner and blue king crab stocks at this time. It is unclear if additional protection measures and decreased bycatch of crab put forth under the PA will mitigate the combined effects of mortality and corresponding changes to biomass resulting from past events, internal bycatch, and reasonably foreseeable future external events on severely depressed red king crab stocks. Therefore, the cumulative effects on GOA red king crab cannot be determined at this time.

<u>Change in Reproductive Success</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in the BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. Changes in reproductive success within the BSAI crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causal link between reproductive success and depressed stock status cannot be concluded at this time. Potential effects of PA.1 and PA.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects**. As discussed earlier, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set to avoid mating and molting periods therefore, these fisheries are not considered to be contributing factors to changes in reproductive success of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI. Formal stock rebuilding plans are in place for the BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on the recovery of these stocks as a whole over time. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed. The potential effects of long-term climate changes and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods; however, persistent past effects on crab populations in the BSAI may still exist. Stocks are considered depressed with no signs of recovery to date. Thus, potential effects on reproductive success, resulting from past events, internal catch and internal bycatch, and reasonably foreseeable future external events, are unknown for PA.1 and PA.2.

Golden King Crab in the BSAI and GOA

- **Direct/Indirect Effects**. Due to lack of survey information for determining current stock status of golden king crab in the BSAI and GOA, potential effects of PA.1 and PA.2 on changes to reproductive success cannot be determined.

- **Persistent Past Effects**. Current stock status of BSAI and GOA golden king crab has not been determined, so potential past effects on reproductive success are also unknown.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur. Crab seasons are set as to avoid mating and molting periods therefore, these fisheries are not considered contributing factors to changes in reproductive success of golden king crab. The potential effects of long-term climate changes and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on golden king crab populations in the BSAI and GOA are not known. Potential effects on reproductive success resulting from past events, internal bycatch, and reasonably foreseeable future external events, are unknown for PA.1 and PA.2.

Bairdi Tanner, Red King, and Blue King Crab in the GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Due to lack of survey information for determining current stock status of blue king crab in the GOA, potential effects of PA.1 and PA.2 on changes to reproductive success cannot be determined. Survey data collected by ADF&G for certain bairdi Tanner crab stocks in western GOA show signs of possible recovery, while other GOA stocks are still considered depressed. Red king crab populations in the GOA are at historic lows according to ADF&G survey information. Changes in reproductive success within the GOA crab populations may be an underlying factor in the depressed nature of these stocks. However, a direct causal link between reproductive success and depressed stock status cannot be concluded at this time. Potential effects of this PA on changes to reproductive success cannot be determined for bairdi Tanner and red king crab populations in the GOA.

- **Persistent Past Effects**. As discussed earlier, past fisheries may have indirectly impacted reproductive success of these stocks by removing vital brood stocks and/or adversely impacting spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Crab seasons are set to avoid mating and molting periods; therefore, these fisheries are not considered contributing factors to changes in the reproductive success of these stocks. The potential effects of long-term climate changes and regime shifts on reproductive traits of crab are unknown.

- **Cumulative Effects.** Crab seasons are set to avoid mating and molting periods. However, persistent past effects on crab populations in the GOA may still exist. Some stocks are considered depressed with no signs of recovery to date. Thus, potential effects on reproductive success resulting from past events, internal catch/internal bycatch, and reasonably foreseeable future external events, are unknown for PA.1 and PA.2.

Change in Prey Availability

Bairdi Tanner, Opilio Tanner, Red King, Blue King, and Golden King Crab in the BSAI and GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, only BSAI opilio Tanner crab is included in this analysis.

- **Direct/Indirect Effects.** Diet composition of crab has not been determined, but crab are known to be benthic feeders. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and it is unclear if PA.1 and PA.2 would impact prey structure and availability for all species of crab throughout BSAI and GOA. Thus, potential effects of the PA on changes in prey availability cannot be determined.

- **Persistent Past Effects**. Crab are benthic feeders and generally feed on invertebrates. Catch of crab prey in current and past groundfish fisheries is minimal. Thus, past effects on crab prey structure and availability in the BSAI and GOA have not been identified.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, and are managed by ADF&G in cooperation with NOAA Fisheries. Competition for prey species of crab resulting from groundfish fisheries' catch has not been shown, and these fisheries are not considered contributing factors to changes in prey availability. Rebuilding plans currently in effect in the BSAI do not address crab prey structure and availability and are not considered contributing factors to potential changes in prey availability. Long-term climate changes and regime shifts may impact crab prey structure depending on the direction of the change. However, it is impossible to determine the possible effects that these changes may have on crab populations throughout the BSAI and GOA.

- **Cumulative Effects.** Diet composition of crab has not been determined, and potential changes to prey structure, resulting from internal effects and reasonably foreseeable future events, cannot be determined for all species of crab in the BSAI and GOA for PA.1 and PA.2.

<u>Change in Habitat</u>

Bairdi Tanner, Opilio Tanner, Red King, and Blue King Crab in the BSAI

- **Direct/Indirect Effects.** These stocks are currently considered depressed and in some instances, overfished. However, a direct causal link between habitat and depressed stock status cannot be concluded at this time. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks, but recovery has not been shown. Under PA.1 and PA.2, it is possible that additional protection measures could enhance recovery of crab habitat, but it is impossible to realize the potential population-level effects that may result. Thus, PA.1 and PA.2 are considered to have insignificant effects on changes in habitat of bairdi Tanner, opilio Tanner, red king, and blue king crab stocks in the BSAI because no signs of recovery for these stocks have been shown to date.

- **Persistent Past Effects.** Past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist, as these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur and are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for these stocks under current management plans. Formal stock rebuilding plans are in place for BSAI bairdi and opilio Tanner crab stocks. The St. Matthew Island blue king crab stock has a rebuilding plan in effect. In the Pribilof Islands, a blue king crab rebuilding plan is currently being developed, but is not in effect at this time. These rebuilding plans may have beneficial effects on recovery of these stocks as a whole over time and offer protection of critical habitat. BSAI red king crab stocks do not have rebuilding plans in effect, and the population is currently considered depressed with possible habitat- related effects unclear. Long-term climate changes and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the BSAI may still exist and stocks are considered depressed with no signs of recovery to date. Although much of the known habitat areas of BSAI crab are currently protected by no trawl zones and conservation zones, it is possible that other critical habitat areas are not included in these measures or those proposed under the PA. Thus, potential effects on crab habitat, resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined.

Golden King Crab in the BSAI and GOA

- **Direct/Indirect Effects**. Due to lack of survey information for determining current stock status of golden king crab in the BSAI and GOA, it is difficult to identify habitat-related effects as they pertain to changes in these crab populations throughout the BSAI and GOA. Potential effects of PA.1 and PA.2 to crab habitat are unknown.

- **Persistent Past Effects**. As discussed in the analysis of cumulative effects on mortality of Bairdi tanner, Opilio tanner, red king and blue king crab, past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as many of these stocks have not shown signs of recovery to date.

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, and are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for many of the crab stocks under current management plans, and the current depressed nature of some golden king crab stocks in the GOA. Long-term climate changes and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes that may occur.

- **Cumulative Effects.** Some GOA golden king crab stocks are considered depressed, and past effects may still exist as many of these stocks have not shown signs of recovery to date. Although much of the known habitat areas of BSAI and GOA crab are currently protected by no trawl zones and conservation areas, it is possible that other critical habitat areas are not included in these measures or those proposed under the PA. Thus, potential effects on golden king crab habitat resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined without first establishing the overall population and essential habitat status of this species.

Bairdi Tanner, Red King, and Blue King Crab in the GOA

Opilio Tanner crab populations are not encountered during ADF&G surveys in the GOA. It is inferred that this crab species is not prevalent in this region. Therefore, opilio Tanner crab is not included in this analysis.

- **Direct/Indirect Effects.** Red king and bairdi Tanner stocks in the GOA are currently considered depressed, while blue king crab stock status is unknown. Data on bairdi Tanner crab is limited, but stocks are presumed to be depressed based on available survey data. The red king crab stocks are considered severely depressed according to ADF&G surveys. However, a direct causal link between habitat and depressed stock status cannot be concluded at this time. It is inferred that current crab management plans are mitigating past habitat disruption and providing protection for crab stocks, but recovery of stocks has not been shown. Under PA.1 and PA.2, it is possible that additional protection measures could enhance recovery of crab habitat, but it is impossible to realize the potential population-level effects that may result. Thus, PA.1 and PA.2 are considered to have insignificant effects on changes in habitat of red king crab stocks in the GOA because no signs of recovery for these stocks have been shown to date. Thus, the cumulative effects on habitat suitability for these stocks cannot be determined. Under the PA, it is possible that additional protection measures could enhance recovery of crab habitat, but it is impossible to realize the potential population-level effects that may result. Thus, the potential effects of PA.1 and PA.2 on changes to bairdi Tanner, red king, and blue king crab habitat in the GOA are unknown.

- **Persistent Past Effects.** Past fisheries may have directly or indirectly impacted spawning and nursery habitat as a result of bottom trawling. Past effects may still exist as some of these stocks have not shown signs of recovery to date (see previous discussions of persistent past effects).

- **Reasonably Foreseeable Future External Effects.** State of Alaska crab, scallop, and subsistence fisheries continue to occur, and are considered potential adverse factors in possible changes to crab habitat based on the lack of recovery that has been observed for some of these stocks under current management plans. Long-term climate changes and regime shifts are not expected to directly affect the physical habitat and are not considered contributing factors in possible changes to GOA crab habitat that may occur.

- **Cumulative Effects.** Persistent past effects on crab habitat in the GOA may still exist, and stocks are considered depressed with no signs of recovery to date. Although much of the known habitat areas of GOA crab are currently protected by no trawl zones and conservation areas, it is possible that other critical habitat areas are not included in these measures, nor those proposed under this PA. Thus, potential cumulative effects on GOA bairdi Tanner, red king, and blue king crab habitat resulting from past events, internal bycatch, and reasonably foreseeable future external events cannot be determined.

4.9.3 Other Species Preferred Alternative Analysis

The other species category consists of the following species:

- Squid (order Teuthoidea).

- Sculpin (family Cottidae).

- Shark (Somniosus pacificus, Squalus acanthias, Lamna ditropis).

- Skate (genera Bathyraja and Raja).

- Octopi (*Ocotopus dofleini*, *Opistholeutis california*, and *Octopus leioderma*).

Current management practices provide for the establishment of an aggregate TAC, which limits the catch of species in this category. Within the other species category, only shark are identified to the species level by fishery observers. Furthermore, accuracy of catch estimates depends on the level of coverage in each fishery. Observer coverage in the BSAI is estimated at 70-80 percent, whereas the GOA has approximately 30 percent observer coverage. Coverage can vary for certain target fisheries and vessel sizes (Gaichas 2002). Further description of this management of the Other Species category is described in detail in Section 3.5.3.

Formal stock assessments for other species are not currently conducted in the BSAI and GOA, and biomass estimates for the species included in this category are limited and often unreliable. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to the lack of information needed to establish the baseline condition. While changes in bycatch relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes in catch actually impact other species populations, or whether these impacts might be beneficial, adverse, or insignificant. There are numerous direct and indirect effects that may impact the current and future status of individual species within this group and/or this group as a whole. These effects are summarized in the section that follows.

Direct/Indirect Effects PA.1 – Other Species

Direct and indirect effects for other species include mortality, changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of the non-target species groups are unknown. In order to determine how these stocks respond to changes in catch, information on stock status is needed. For many non-target species, the differences in catch between the comparative baseline and the proposed alternatives are relatively small, such that diverse FMPs may have similar (unknown) effects on each stock. A summary of these effects is shown in Table 4.9-2.

Under PA.1, total catch of BSAI and GOA other species is predicted to increase by several thousand mt per year. This is due to predicted increases in catches in the target fisheries where other species are caught as bycatch. Most of this increase is predicted in the catch of skate and sculpin in both areas. Catch projections for specific groups within the BSAI and GOA other species are presented below.

Squid

In the BSAI, squid catch is predicted to increase and then decrease to just above the current level over the five-year projection, likely following trends in the pollock fishery. Squid catch is predicted to double over the five-year projection period in the GOA, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so doubling may not cause different population impacts than current catch levels.

Sculpin

Catches of BSAI sculpin are predicted to remain very close to currently observed catches. GOA sculpin catch is predicted to increase slightly from current catch amounts, but the significance of this change cannot be determined.

Shark

BSAI and GOA shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Catches of all of these species in the BSAI are predicted to remain stable throughout the projection period under PA.1. All shark catch in the GOA is predicted to be relatively low, and catches of other shark remain close to current catch levels. Pacific sleeper shark catch is predicted to decrease to about one-third of current catch levels and then slowly increase over the five-year projection period to levels just below those observed currently. Salmon shark catch is predicted to decrease slightly. Catch of dogfish in the GOA is predicted to gradually increase over the five-year projection period showing an average increase of more than 50 percent compared to current catch levels.

Skate

The increased catch of skate in the BSAI may reflect increased catches in both longline fisheries for Pacific cod and in bottom trawl fisheries for cod and flatfish. In the GOA, skate catch is predicted to increase by about 1,000 mt. These increases in catch rates for BSAI and GOA may warrant increased management attention if they actually were to occur.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the Target Species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined Big and Longnose skates in the Central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway, and improved collection of data is expected under this amendment.

Octopi

Octopi catch in the BSAI is predicted to remain stable at 300 to 400 mt per year. The trace amounts of octopi catch reported in the GOA are predicted to decrease over the projection period, with no discernable differences in the currently unknown population impacts.

Direct/Indirect Effects PA.2 – Other Species

A summary of the direct and indirect effects associated with PA.2 is shown in Table 4.9-2.

Under PA.2, total catch of BSAI other species is predicted to decrease by several thousand mt per year, and total catch of GOA other species is predicted to remain in a similar range to current levels,. This is due to predicted decreases in catches of target species where other species are bycatch. Most of the decrease in the BSAI is predicted in the catch of skate and sculpin. Catch projections for specific groups within the BSAI and GOA other species are presented below.

Under PA.2, it is proposed that criteria be developed for applying TAC-setting procedures to specific species groups within the other species category. Sharks and skates have been the focus of this effort, but other species may be added as population data becomes available. By implementing specific TAC-setting measures into species classes that have traditionally been included in the overall other species TAC, improved management of these individual species may minimize potential population-level impacts resulting from bycatch mortality. In addition, improved observer coverage and species identification for non-target species, as proposed in PA.2, may provide improved bycatch data further supporting the need for more comprehensive management of particular species within the other species complex.

Squid

In the BSAI, squid catch is predicted to decrease slightly below the current level over the five-year projection, likely following trends in the pollock fishery. GOA squid catch is predicted to remain within the same range as current catches over the first few years of the projection period with a gradual increase thereafter, likely reflecting increasing catches in the pollock fishery. However, observed GOA squid catch has been low historically, so this increase may not result in significant population-level impacts.

Sculpin

Catches of BSAI sculpin are predicted to decrease slightly by 1,000 mt relative to current catches. The decreased catch of sculpin are due primarily to bycatch reduction incentives included in rationalization programs under PA.2. GOA sculpin catch is predicted to increase slightly each year throughout the five-year projection period, but averages a level similar to currently observed levels over time.

Shark

BSAI and GOA shark species have been separated into Pacific sleeper shark, salmon shark, dogfish, and other shark. Under PA.2, BSAI shark catch for all species remains relatively similar to those levels currently observed. GOA salmon shark are predicted to experience a decrease in catch over the five-year projection period by approximately 40 percent of currently observed levels. On average, GOA Pacific sleeper sharks show a decrease in catch by approximately 50 percent of current catch levels throughout the five-year projection period. Projected dogfish catch levels in the GOA remain similar to current levels.

Skate

The catch of BSAI skate is predicted to decrease by nearly 3,000 mt to about 15,500 mt over the projection period under PA.2. The decreased catch of skate is due primarily to bycatch reduction incentives included in rationalization programs under PA.2. This decrease in catch of skate may reflect decreased catches in both longline fisheries for Pacific cod and in bottom trawl fisheries for cod and flatfish. In the GOA, skate catch is predicted to remain close to currently observed levels.

Adoption of Amendment 63 by NPFMC would result in the separation of GOA skate species from the other species complex. In turn, they would be added to the Target Species category with an ABC and TAC set for skates and skate complexes (NPFMC 2003a). The NPFMC has requested a separate OFL and ABC for combined Big and Longnose skates in the Central GOA due to concerns regarding a developing fishery. Efforts to address existing data gaps for skate species are underway and improved collection of data is expected under this amendment.

Octopi

Octopi catch in the BSAI is predicted to remain stable at 200 to 300 mt per year. The trace amounts of octopi catch reported in the GOA are predicted to decrease over the five-year projection period by approximately 25 percent on average.

Cumulative Effects Analysis PA.2 – Other Species

A summary of the cumulative effects analysis associated with PA.1 and PA.2 is shown in Table 4.5-81. For further information on persistent past effects included in this analysis, see Section 3.5.3 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effect of fishing mortality on BSAI and GOA other species is unknown under PA.1 and PA.2. The current baseline condition is unknown. Species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries.

- **Persistent Past Effects**. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP: other species and non-specified species. It is difficult to determine how much protection is afforded by a TAC set with the use of data-poor criteria.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to the specific-species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate changes and regime shifts are not expected to result in direct mortality.

- **Cumulative Effects**. For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Reproductive Success

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA other species are unknown under PA.1 and PA.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects**. Current reproductive status of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species, other species, and non-specified species, are within the categories receiving the least intensive management under the current FMP. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered, or if sex-specific aggregations are overfished. However, persistent past effects on the population have not been determined.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fishery continue to take other species as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown since the current baseline condition and species-specific reproductive status have not been determined. Long-term climate changes and regime shifts could have impacts to the reproductive success of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects.** For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species within this complex are unknown and persistent past effects have not been identified. The combined effects of changes to reproductive success on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Genetic Structure of Population

- **Direct/Indirect Effects.** The potential effects of changes in genetic structure of the other species population in the BSAI and GOA are unknown under PA.1 and PA.2. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects**. The current genetic composition of the other species complex is unknown. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species are within the categories receiving the least intensive management under the current FMP (i.e. other species and non- specified species). This possible overexploitation could have impacts to the genetic structure of the population if the genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fishery continue to take other species as bycatch. However, their potential impacts to the genetic structure of the specific species populations within this complex are unknown. Long-term climate changes and regime shifts are not expected to result in direct mortality and would not be considered contributing effects to changes in genetic structure of populations.

- **Cumulative Effects**. For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown, and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the other species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are, therefore, unknown.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA other species is unknown under PA.1 and PA.2. The current baseline condition is unknown and species-specific catch information is lacking for this complex, since species identification does not occur in the fisheries. Formal stock assessments are not conducted for other species, and most biomass estimates for BSAI and GOA other species are unreliable or not known.

- **Persistent Past Effects**. It is possible under current other species management in the BSAI and GOA, that a species or even a species group could be disproportionately exploited while the overall aggregate other species TAC is not reached. In addition, the highest observed catches of non-target species, other species, and non-specified species are within the categories receiving the least intensive management under the current FMP. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fisheries continue to take other species as bycatch. However, potential impacts to the specific species within this complex are unknown since the current baseline condition has not been determined. Long-term climate changes and regime shifts could have impacts on the biomass of the other species depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how the other species will respond to climatic fluctuations.

- **Cumulative Effects**. For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of changes in biomass on this species complex as a whole are unknown. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

Change in Habitat

- **Direct/Indirect Effects.** The potential effects of habitat changes to BSAI and GOA other species is unknown under PA.1 and PA.2. A current baseline condition has not been determined.

- **Persistent Past Effects**. Under current management in the BSAI and GOA, impacts to habitat could be occurring for some of the species within the other species complex. However, the species included in this complex have diverse habitat preferences and distribution patterns. Although persistent past effects potentially impacting habitat for some or all of these species could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries, IPHC halibut longline fisheries, and state sport halibut fisheries continue to take other species as bycatch. However, potential impacts to the habitat of the specific species within this complex are unknown. Long-term climate changes and regime shifts are not expected to result in significant changes to physical habitat and are not considered contributing factors to potential effects.

- **Cumulative Effects**. For all members of the other species complex, life history and distribution information are minimal in both the BSAI and the GOA. These species have diverse habitat preferences. Although persistent past effects potentially impacting habitat could exist, without a baseline condition established, they remain unknown. The combined effects of changes to habitat on other species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown.

4.9.4 Forage Fish Preferred Alternative Analysis

The BSAI and GOA FMPs were amended in 1998 to establishing a forage species category to prevent the development of directed fisheries on these ecologically important non-target species. Forage fish are described in more detail in Section 3.5.4.

Direct/Indirect Effects of PA.1 and PA.2 – BSAI and GOA Forage Fish

Total and Spawning Biomass

Total and spawning biomass of BSAI and GOA forage fish is unknown at this time. The incidental catch rates predicted for PA.1 and PA.2 are not expected to affect biomass.

Catch/Fishing Mortality

A directed fishery on forage species is prohibited by Amendments 36 and 39 in the BSAI and GOA FMPs. However, forage fish are taken in small amounts as incidental catch in several target fisheries. The bulk (>90 percent most years) of the forage fish bycatch is made up of smelt species (Osmeridae) from the pollock fishery. In the BSAI region, model projections for PA.1 and PA.2 indicate incidental catch of forage fish would remain low at a level similar to the current catch (Table H.4-63 in Appendix H). Over the next five years, pollock catch in the GOA is projected to grow rapidly under PA.1 and PA.2 (Table H.4-82 in Appendix H). The increased pollock catch under these FMPs is projected to result in greater incidental catches of forage fish.

Fishing mortality of BSAI and GOA forage fish is unknown at this time. As described above, forage fish bycatch and fishing mortality in the BSAI is predicted to remain relatively low under PA.1 and PA.2. The predicted increase in forage fish bycatch in the GOA would intuitively lead to an increase in fishing mortality. However, since the fishing mortality is currently thought to be very low, there is no evidence that this increase will lead to an adverse affect on the population.

Under PA.1, NOAA Fisheries and NPFMC will initiate a cumulative effects study to determine the impacts of reopening the Aleutian Islands pollock fishery on Steller sea lions and other members of the BSAI ecosystem. If the Aleutian Islands fishery were to be reopened at the conclusion of the study, this would likely increase the bycatch of forage fish.

Measures that may reduce forage fish mortality under PA.1 include reduced PSC limits in the BSAI (0 to 10 percent) and 2002 Steller sea lion measures, which may further restrict the target fisheries (discussed under change in habitat suitability). Under PA.2, PSC limits could be further reduced in the BSAI (0 to 20 percent) and GOA (0 to 10 percent). The 2002 Steller sea lion measures would be adopted and the Aleutian Islands closures, and critical habitat designations could be revised, as necessary. Furthermore, under PA.2, 0 to 20 percent of the Bering Sea and Aleutian Islands and GOA would be designated as MPAs or no-take reserves. In the GOA, inseason bycatch closures would be developed, and the effectiveness of current closures would be reevaluated in the BSAI. Also, the BSAI pollock bottom trawl closures would be extended throughout the GOA.

Spatial/Temporal Concentration of Fishing Mortality

Little is known about the current spatial or temporal concentration of fishing mortality in forage species. It is unknown how the spatial or temporal concentration of fishing effort is expected to change under PA.1. The existing closure areas will remain under PA.1; therefore, bycatch of forage species is unlikely to change substantially with regards to spatial concentration. Increased PSC limits for the BSAI fisheries may affect the temporal concentration of forage fish bycatch, although the impact is expected to be minimal. Under PA.2, reduced PSC limits and an increased number of closure areas may affect the spatial and temporal characteristics of forage fish bycatch; however, the impact of these changes are unknown.

Status Determination

The MSST of forage fish species is unknown at this time, but it is highly unlikely that management practices under PA.1 and PA.2 would lead to stocks declining to an unsustainable level.

Age and Size Composition and Sex Ratio

The age and size composition of species in the forage fish group is unknown. However, it is assumed that the age and size composition of forage fish would not change under PA.1. The sex ratio of forage fish is assumed to be 50:50. There is no information available that would suggest a potential change under PA.1.

Habitat-Mediated Impacts

Little is known about the relationship between forage fish and their habitat. It is unknown how any of the considered FMPs would change the habitat occupied by forage fish. The 2002 Steller sea lion closures prohibit fishing in Seguam Pass, establishes three nm no-transit zones around rookeries, and establishes trawl and fixed gear closures in nearshore and critical habitat areas. Programs to identify and designate EFH and HAPC will continue under PA.1, and mitigation measures for EFH and HAPC would be developed under PA.2. As mentioned above, under PA.2, 0 to 20 percent of the Bering Sea, Aleutian Islands and GOA could be established as MPAs and no-take reserves. These measures may reduce the potential adverse impacts to BSAI and GOA forage fish habitat where overlap with fisheries occurs.

Predation-Mediated Impacts

The predator-prey interactions of forage fish are very complex and difficult to predict. With the available data, it would be extremely difficult to accurately assess the predator-prey impacts of PA.1.

See Table 4.9-2 for a summary of the direct/indirect effects on BSAI and GOA forage fish under PA.1.

Cumulative Effects Analysis of PA.1 and PA.2 – BSAI and GOA Forage Fish

Mortality

- **Direct/Indirect Effects**. The effect of fishing mortality on BSAI and GOA forage fish is rated as insignificant under PA.1 and PA.2.

- **Persistent Past Effects** have not been identified for fishing mortality in the BSAI or GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on mortality are indicated due to potential adverse contributions of marine pollution, since acute and/or chronic pollution events could result in forage fish mortality. Climate change and regime shifts are considered non-contributing factors, since it is unlikely that the change in water temperatures would be of sufficient magnitude to result in mortality of forage fish (see Sections 3.5.4 and 3.10). Alaska subsistence and personal use fisheries are identified as potential adverse contributors to forage fish mortality, however, the removal of these fisheries is expected to be minimal.

- **Cumulative Effects.** A cumulative effect is identified for mortality of BSAI and GOA forage fish but is rated insignificant. Projected levels of removals are small and not expected to have a population-level impact. The combined effects of internal and external removals is unlikely to jeopardize the capacity of the stock to maintain current population levels.

Change in Biomass Level

- **Direct/Indirect Effects.** The total and spawning biomass for BSAI and GOA forage fish is unknown at this time.

- **Persistent Past Effects** have not been identified for changes in biomass to the BSAI and GOA forage fish stock.

- **Reasonably Foreseeable Future External Effects** on the change in biomass are indicated due to the potential adverse contributions of marine pollution since acute and/or chronic pollution events could result in forage fish mortality. Climate changes and regime shifts have been identified as having potential beneficial or adverse contributions on the forage fish biomass level. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment of some forage species (see Sections 3.5.4 and 3.10). The Alaska subsistence and personal use fisheries have been identified as potential adverse contributors to changes in biomass level of BSAI and GOA forage fish. Subsistence and personal use fisheries concentrate on smelt species, however, it is unlikely that these fisheries would have a population-level effect.

- **Cumulative Effects.** A cumulative effect is possible for the change in biomass level of BSAI and GOA forage fish, but impacts of the effect are unknown. Total and spawning biomass are unavailable for the forage fish species at this time.

Spatial/Temporal Concentration of Catch

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the effect of the fisheries on the spatial/temporal characteristics of forage fish stocks is unknown.

- **Persistent Past Effects** on the genetic structure of BSAI and GOA forage fish have not been identified. Climate changes and regime shifts may influence reproductive success of BSAI and GOA forage fish. For example, some Osmeridae species have shown a decline in recruitment since the late 1970s, coinciding with an increase in water temperature (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** on reproductive success of forage fish due to climate changes and regime shifts are potentially beneficial or adverse. Marine pollution has been identified as a potential adverse contribution since acute and/or chronic pollution events could alter genetic structure and/or reproductive success of BSAI and GOA forage fish. The Alaska subsistence and personal use fisheries are identified as potential adverse contributors to the genetic structure and reproductive success of BSAI and GOA forage species. As stated above, these fisheries target smelt species; however, it is unlikely that removals in these fisheries would jeopardize the capacity of the stocks to maintain current population levels.

- **Cumulative Effects.** A cumulative effect could result from changes to spatial/temporal characteristics of forage fish; however, this effect is unknown. Information on spatial/temporal characteristics of the BSAI and GOA forage fish stocks is currently lacking.

Change in Prey Availability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in prey availability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** on changes to prey availability of the BSAI and GOA forage fish stock exists and include climate changes and regime shifts. Crab and shrimp have shown variation in abundance associated with changes in climate and water temperatures. However, studies on most benthic invertebrates have not been conducted (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** of climate changes and regime shifts on the BSAI and GOA forage fish stock are potentially beneficial or adverse. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment in some species. Marine pollution has been identified as a potentially adverse contributor since acute and/or chronic pollution events could reduce prey availability or prey quality, thus jeopardizing the stocks' ability to maintain current population levels. Alaska subsistence and personal use fisheries are identified as potentially adverse contributors in prey availability of BSAI and GOA forage fish. However, the catch/bycatch of these species is expected to be minimal and is unlikely to have a population-level impact.

- **Cumulative Effects**. Although a cumulative effect on prey availability for forage species could exist, potential population-level impacts are not known. Information on forage fish prey interactions is insufficient.

Change in Habitat Suitability

- **Direct/Indirect Effects**. Under PA.1 and PA.2, the change in habitat suitability for the BSAI and GOA forage fish is unknown.

- **Persistent Past Effects** identified for BSAI and GOA forage fish include climate changes and regime shifts. A strong Aleutian Low and increased water temperatures tend to result in weak recruitment for some forage fish species (see Sections 3.5.4 and 3.10).

- **Reasonably Foreseeable Future External Effects** of climate change and regime shifts on the BSAI and GOA forage fish stocks are potentially beneficial or adverse. Marine pollution may be a potentially adverse contributor since acute and/or chronic pollution events could result in habitat degradation in spawning or rearing success. Alaska subsistence and personal use fisheries are identified as potentially adverse contributors to forage fish habitat suitability (see Section 3.6).

- **Cumulative Effects.** A cumulative effect is possible for BSAI and GOA forage fish habitat suitability; however, potential population-level impacts are unknown. Information on forage fish habitat and possible fishing effects on these habitats is largely unknown at this time.

See Tables 4.5-44 and 4.5-45 for a summary of the cumulative effects on BSAI and GOA forage fish, respectively.

4.9.5 Non-Specified Species Preferred Alternative Analysis

Grenadier have been chosen to illustrate potential effects to non-specified species because they are currently the major catch in this FMP category. Non-specified species is a huge and diverse category encompassing every species not listed in the current FMP as a target, prohibited, forage, or other species. Considering a single species group from this category, such as grenadier, cannot possibly represent the diverse effects to all species in the category. However, because information is lacking for nearly all non-specified species, and due to the small or unknown amounts of bycatch (due to a lack of reporting requirements in this category), only potential effects to grenadier are discussed.

Formal stock assessments are not conducted for grenadier. Thus, changes in total biomass, reproductive success, genetic structure of population, habitat, or mortality rates under any FMP alternative cannot be determined due to the lack of information needed to establish the baseline condition . Changes in bycatch of grenadier were predicted based on modeled changes in target species catches and population trajectories (sablefish target fisheries account for the highest grenadier bycatch). While changes in bycatch mortality relative to the comparative baseline are reported here, it is important to emphasize that determinations cannot be made as to how these changes actually impact grenadier populations, or whether these impacts might be adverse, beneficial, or insignificant.

Direct/Indirect Effects PA.1 and PA.2 – Grenadier

Direct and indirect effects for grenadier include mortality, changes in reproductive success, genetic structure of population, and habitat. The significance of these effects caused by changes in catch for any of these non-target species groups are unknown, because information on stock status is lacking.

Under PA.1, catch of grenadier in both the BSAI and GOA is predicted to remain within or above the currently observed range. In both areas, grenadier catch is predicted to increase initially and then decrease; however, catch rates still remain higher than those currently observed. The significance of these changes to grenadier and other species populations within the non-specified species group cannot be determined, and potential population-level impacts cannot be characterized.

Under PA.2, catch of grenadier in both the BSAI and GOA is predicted to decrease relative to the currently observed catch. In the BSAI, grenadier catch is predicted to decrease by one-half of currently observed levels. In the GOA, catch is predicted to decrease from an estimated 11,000 mt to approximately 8,000 mt per year. The decreased catch of grenadier is due primarily to bycatch reduction incentives included in rationalization programs under PA.2. As stated above, the significance of these changes to grenadier and other species populations within the non-specified species category cannot be determined.

As proposed under PA.2, development of TAC-setting criteria, allowing for a non-specified species to become a managed category, may result in improved management of individual species within the non-specified species group, and minimize potential population-level impacts resulting from bycatch mortality. In addition, improved observer coverage and species identification for non-target species, as proposed in PA.2, may provide reliable bycatch data further supporting the need for more comprehensive management of particular species within the non-specified group.

Cumulative Effects Analysis PA.1 and PA.2 – Grenadier

A summary of the cumulative effects analysis associated with PA.1 and PA.2 are shown in Table 4.9-2. For further information on persistent past effects included in this analysis, see Section 3.5.5 of this Programmatic SEIS.

Mortality

- **Direct/Indirect Effects.** The potential effects of PA.1 and PA.2 on mortality of grenadier in the BSAI and GOA is unknown. The current baseline condition is unknown and catch information is lacking for all members of the non-specified species category since species identification does not occur in the fisheries.

- **Persistent Past Effects**. No management or monitoring of any species in this category exists, and retention of any non-specified species is permitted. No reporting requirements for non-specified species exist, and there are no catch limitations or stock assessments. It is possible that grenadier, and all other species included in the non-specified species category in the BSAI and GOA, could be disproportionately exploited, but stock status remains unknown. Grenadier continue to constitute the largest portion on the non-target species bycatch in the GOA, and federal fishery-caused mortality is considered a persistent past effect.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, the state-managed commercial fisheries and IPHC halibut longline fisheries continue to take grenadier and other non-specified species as bycatch. However, potential impacts to specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate changes and regime shifts are not considered contributing factors as they are not expected to result in direct mortality.

- **Cumulative Effects**. For grenadier and other species within the non-specified complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of mortality on this species complex as a whole are unknown. The combined effects of mortality on grenadier, and other species within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for PA.1 and PA.2.

<u>Change in Reproductive Success</u>

- **Direct/Indirect Effects.** The potential effects of changes in reproductive success on BSAI and GOA grenadier, and presumably all other species within the non-specified species complex, are unknown under PA.1 and PA.2. The current baseline condition is unknown, and species-specific reproductive status has not been determined.

- **Persistent Past Effects.** The current reproductive status of grenadier is unknown. It is possible that grenadier, and all other species included in the non-specified species category, in the BSAI and GOA, could be disproportionately exploited; however, stock status remains unknown. This possible overexploitation could have impacts to reproductive success if sex-ratios of these species are significantly altered or if sex-specific aggregations are overfished. This overfishing could lead to reduced recruitment. It is unknown if persistent past effects on the population exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fisheries continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to reproductive success of the specific species within this complex are unknown, since current baseline condition and species-specific reproductive status have not been determined. Long-term climate changes and regime shifts could have impacts to the reproductive success of grenadier (and other non-specified species) depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how grenadier and all other members of the non-specified species category, will respond to climatic fluctuations.

- **Cumulative Effects**. For grenadier, and all other species within the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current reproductive status of species with this complex are unknown and persistent past effects have not been identified. The combined effects of changes to reproductive success on grenadier and other non-specified species resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for PA.1 and PA.2.

<u>Change in Genetic Structure of Population</u>

- **Direct/Indirect Effect of the Alternative.** The potential effects of changes in genetic structure of grenadier and other species within the non-specified species complex in the BSAI and GOA are unknown under PA.1 and PA.2. The current baseline condition is unknown, and the genetic structure of species-specific populations within this complex has not been determined.

- **Persistent Past Effects**. The current genetic composition of the non-specified species complex is unknown. It is possible that grenadier, and all other species included in the non-specified species category, in the BSAI and GOA, could be disproportionately exploited; however, however, stock status remains unknown. This possible overexploitation could have impacted the genetic structure of the population if genetic composition within these species groups has been significantly altered. It is unclear if persistent past effects on the populations exist.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fisheries continue to take grenadier (and other non-specified species) as bycatch. However, their potential impacts to genetic structure of the specific species populations within this complex are unknown. Long-term climate changes and regime shifts are not expected to result in direct mortality and would not be considered contributing factors in changes to genetic structure of populations.

- **Cumulative Effects**. For grenadier, and all members of the non-specified species category, life history and distribution information are minimal in both the BSAI and the GOA. Current genetic structure of species-specific populations within this complex are unknown and persistent past effects have not been identified. The combined effects of changes to genetic structure of populations within the non-specified species complex resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for PA.1 and PA.2.

Change in Biomass

- **Direct/Indirect Effects.** The potential effect of change in biomass on BSAI and GOA grenadier is unknown under PA.1 and PA.2. The current baseline condition is unknown for all members of the non- specified complex, and species-specific catch information is lacking since species identification does not occur in the fisheries. Formal stock assessments are not conducted and grenadier biomass estimates in the BSAI and GOA, other than those conducted since 1999 for the giant grenadier, are not known.

- **Persistent Past Effects.** It is possible that grenadier, and all other species included in the non-specified species category, in the BSAI and GOA, could be disproportionately exploited; however, however, stock status remains unknown. The current non-management of grenadier could mask declines in individual grenadier species and lead to overfishing of a given grenadier species. Although persistent past effects potentially impacting biomass could exist, without a baseline condition established, they remain unknown.

- **Reasonably Foreseeable Future External Effects.** In the BSAI and GOA, state-managed commercial fisheries (specifically sablefish and Greenland turbot longline) and IPHC halibut longline fisheries continue to take grenadier (and other non-specified species) as bycatch. However, potential impacts to the specific species within this complex are unknown, since the current baseline condition has not been determined. Long-term climate changes and regime shifts could have impacts on the biomass of grenadier and all other members of the non-specified species group depending on the direction of the shift. It has been shown in other aquatic species that warm trends favor recruitment while cool trends weaken recruitment, but it is currently not known how these non-specified species will respond to climatic fluctuations.

- **Cumulative Effects**. For all members of the non-specified species complex, life history and distribution information are minimal in both the BSAI and the GOA. Species identification does not occur in the fisheries and potential impacts of changes in biomass to grenadier and all other non-specified species are unknown. Although persistent past effects of changes to biomass could exist, without a baseline condition established, they remain unknown. The combined effects of these changes on BSAI and GOA grenadier and all other species in the non-specified species group, resulting from internal bycatch and reasonably foreseeable future external events (both human controlled and natural) are unknown for PA.1 and PA.2.

4.9.6 Habitat Preferred Alternative Analysis

Direct/Indirect Effects PA.1 – Habitat

Example PA.1 illustrates a management approach that accelerates precautionary management measures by increasing constraints where necessary, formalizing precautionary practices in the FMPs, and initiating scientific review of existing practices as a necessary precursor to the decision of how best to incorporate adequate precaution. Three components of the bookend are specific to habitat:

- Developing an MPA process.
- Identifying and designating EFH and HAPC pursuant to MSA rules.
- Maintaining current closed/restricted areas.

The first two components are discussed qualitatively in Appendix F-3 and summarized below. The analysis of direct and indirect effects on habitat of maintaining the current closure areas follows.

Developing an MPA Process

Specific to developing an MPA process as required by Executive Order (EO) 13158, PA.1 incorporates an initiative to develop and adopt definitions of MPAs, marine reserves, marine fishery reserves, and protected marine habitats (see Section 1.0 of Appendix F-3). PA.1 seeks to develop an MPA efficacy methodology including program goals, objectives, and criteria for establishing MPAs. Appendix F-3 discusses specific actions to achieve the objectives for MPA establishment that have been recommended by ADF&G. Section 5.1 of Appendix F-3 suggests a three-phase method for the MPA designation process that could be used under this framework. The methodology employs and expands upon EFH/HAPC considerations, the ADF&G (2002b) recommendations, and suggestions provided by the NRC (2001). As discussed in the appendix, the public, recognized ecological and socioeconomic experts (organized into teams or forums), and interested federal and state agency representatives all have the opportunity to provide input into each step of the MPA candidate selection, designation, and management process.

Identify and Designate EFH and HAPC

As described in Section 1.1 of Appendix F-3, EFH definitions for all managed species are currently being reviewed by the NPFMC and NOAA Fisheries through its EFH amendment process. A decision on the Alaska EFH definitions will be made by August 2005. The Assistant Administrator of NOAA Fisheries determined that the agency would prepare new regional EISs to include all FMPs covered by the EAs. The proposed action to be addressed in the EFH EIS is the development of the mandatory EFH provisions of all five FMPs of the NPFMC; the BSAI groundfish FMP, GOA groundfish FMP, BSAI king and Tanner crab FMP, scallop fishery off Alaska FMP, and the FMP for the salmon fisheries in the EEZ off the coast of Alaska. At present NOAA Fisheries and the NPFMC are identifying feasible alternatives for analysis in the EIS for NPFMC's eventual selection of a preferred alternative. The Alaska Groundfish Programmatic SEIS is not intended to replace or supercede the EFH EIS, but will provide overarching policy guidance for EFH and will set the stage for future FMP actions.

According to the Final Rule implementing the EFH provisions of the MSA (50 CFR Part 600), to identify EFH basic information is needed to understand the usage of various habitats by each managed species. Pertinent information includes the geographic range and habitat requirements by life stage, the distribution and characteristics of those habitats, and current and historic stock size as it affects occurrence in available habitats. Temporal and spatial distribution of each life history stage is necessary to understand each species' relationship to, or dependence on, its various habitats. Data summarizing all environmental and habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity of the managed species should be provided.

The NPFMC (1999) identified EFH information levels for groundfish, crab, scallops, and salmon in the Alaska regions. Level 2 data is available for some adult life history stages of groundfish, crabs, and shellfish. Level 2 data is available for some stocks of red and blue king crab, and Tanner and snow crab stocks in some regions, at the egg, larval, late juvenile, and adult stages. The remainder of the data for all other crab stocks is either at Level 1 or unknown. Level 1 data is available for the eggs, larvae, early juvenile, and late juvenile stages of pollock, and for the late juvenile stages of most other groundfish species. Even minimal (Level 1) data are not available for forage fish at all life stages, so distribution and habitat use are considered to be unknown. Salmon EFH data are highly variable and cross Levels 1 through 4 depending on species, stock, and life stage. The majority of the data available for adults in the freshwater stage ranges from Levels 1 to 3. The information levels for all EFH are continually being refined and updated and will be presented in the EIS currently being developed for EFH.

Maintaining Current Closed and Restricted Areas

There are no additional bottom trawl closures relative to the baseline, and there will be decreases in fishing effort. Figure 4.2-8 (bookend first appears in a previous section) illustrates the PA.1 suite of year-round closures in the BSAI and GOA management areas. Since the closure areas remain the same as in FMP 1, FMP 2.2, and FMP 3.1, impacts to habitat under PA.1 should be similar to those described previously for these FMPs. A summary of direct and indirect impacts of PA.1 is provided in Table 4.9-3.

As shown on Table 4.9-3, direct and indirect effects of the FMP on habitat are discussed for changes to living habitat through direct mortality of benthic organisms and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to their habitat type differences, the BSAI and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

The habitat impacts model predicts the following effects for PA.1 on biostructure relative to the baseline:

- **Bering Sea.** There is no predictable difference from the baseline where mean impacts are low when averaged over entire fishable EEZ. As with the baseline, impacts to biostructure ranged from 1.8 to 9.3 percent of the fishable EEZ and from 8.2 to 41.9 percent of the fished area (see Table 4.1-26). Based on these results, we conclude that there would be an insignificant change to mortality and damage to living habitat as a result of PA.1 as compared to the baseline. However, the baseline condition is considered to be already adversely impacted. Thus, the rating is based on the insignificant change between PA.1 projections and the comparative baseline.

- **Aleutian Islands.** There is no predictable difference from baseline (Table 4.1-26). Therefore, we rate the change resulting from PA.1 on the baseline as insignificant. However, the prevalence of long-lived species of coral in the bycatch is a particular concern in the Aleutian Islands under PA.1. With a recovery rate for red tree coral possibly as low as $\rho = 0.005$ (200 years) and sensitivity $q_h = .27$, the habitat impact model indicates that fishing intensity as low as $f = 0.10$ (total area swept once every ten years) results in an equilibrium level reduction of 85 percent relative to the unfished level. About 9 percent of the area is estimated to be fished at $f = 0.10$ or greater. This amounts to 3,590 square miles of area. Thus, continued bycatch and damage to living habitat at PA.1 bycatch levels may have adverse consequences on habitat quality, and PA.1 would not change this risk.

- **GOA.** There is no predictable difference from baseline where estimates of equilibrium impact on biostructure averaged over entire fishable EEZ range from 0.9 to 6.9 percent of the fishable area and 3.8 percent to 29.0 percent of the fished areas (see Table 4.1-26). Only 2 percent of the fishable EEZ is impacted to a level potentially below 32 percent of unfished levels, but amounts to about 2,418 square miles of habitat in scattered concentrations. Therefore, for PA.1, we rate this change to mortality and damage to living habitat as insignificant. However, the baseline condition is considered to be already adversely impacted.

Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection

- **Bering Sea.** Identical to the baseline and FMP 1, PA.1 closures in the Bering Sea are mostly concentrated on sand substrate (Table 4.5-47). Only 27 percent of the geographical- habitat zones have greater than or equal to 20 percent of their area closed to bottom trawling. Figure 4.1-10 shows that the amount of large contiguous areas of high fishing intensity—that is, areas that are swept at least once each year with bottom trawls—exceeds 8,000 square miles (Table 4.1-26). Table 4.5-49 shows that of the Bering Sea fishable area, 19.3 percent is closed to bottom trawling under FMP 1 and is identical to PA.1. However, very little geographic diversity of fishing impacts occurs within the closed habitats, and nearly all of the closures are not year-round. Figure 4.5-4 shows areas closed to trawling only at various times of the year under FMP 1 and PA.1, while Figure 4.5-5 depicts just those areas closed to fixed gear only.

Application of the habitat impacts model indicated that, depending on the sensitivity and recovery parameters thought plausible, fishing of this intensity could reduce the amount of biostructure in the area by 13 to 75 percent of its unfished level equilibrium level (Table 4.1-26). Such biostructure includes sponges, soft corals, tunicates, and anemones (Heifetz 2002, Malecha *et al.* 2003). In these habitat areas, no existing closure areas abut these intensely fished areas to provide a diverse level of impact. While existing closures tend to be large and cover all of the particular habitat, they provide little diversity in fishing impacts. The primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear, and they do not necessarily cross a wide range of habitat types. Some of the trawl closures are in effect year-round while others are seasonal (see Section 3.6). However, compared to the existing baseline the predicted effects of PA.1 on benthic community diversity are insignificant. Similarly, the predicted effects of PA.1 on geographic diversity of impacts are predicted to be insignificant. However, as described above for direct mortality, the baseline condition is considered to be already adversely impacted.

- **Aleutian Islands.** Identical to the baseline and FMP 1, PA.1 closures in the Aleutian Islands are concentrated in shallow water where only 4 percent of the area is closed to bottom trawling year-round for all species. However, as shown on Table 4.5-49, about 43 percent of the fishable area in the Aleutian Islands is closed to bottom trawling at one time or another during the year under FMP 1, and similarly under PA.1. These closures are associated with sea lion rookeries. As in the baseline, there is very little diversity in protection. Less than one percent of the deep area is closed to bottom trawling. Figure 4.1-10 shows that none of the closure areas extends over any blocks of significant fishing effort. Figures 4.5-4 and 4.5-5 show the closure areas under PA.1 broken down by gear type for bottom trawl and fixed gear, respectively. The Aleutian Islands bathymetry and habitat are distributed on a very fine scale, with fishing effort that is very patchy and in very small clusters. Based on comparison of these observations to the baseline, the predicted effects of PA.1 on benthic community diversity and geographic diversity of impacts are insignificant, but the baseline condition is considered to have already experienced adverse impacts.

- **GOA.** Figure 4.5-6 shows that, as in the baseline, minimal geographic diversity of impact or protection results from the current suite of closed areas. Except for the southeast trawl closure which covers several entire habitats, all other closures are inshore, and none exists on the outer shelf or slope (see Figure 4.5-6). As shown on Table 4.5-49 and Figures 4.5-4 and 4.5-5, PA.1 closes nearly 46 percent of the fishable area in the GOA to trawling at one time or another during the year. The inshore closure areas tend to be large relative to the size of bathymetric and habitat resolution scale and thus tend to encompass much of a bathymetric feature. Based on these results, the predicted effects of PA.1 on benthic community diversity and geographic diversity of impacts are insignificant, but the baseline condition is considered to be in an adversely impacted state.

Cumulative Effects PA.1 – Habitat

Cumulative effects on habitat for PA.1 are summarized on Table 4.5-50. The following discussion of the results presented on the table is broken down by geographic area.

Bering Sea

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts which include mortality due to smothering and/or reduced oxygen are expected to be more prevalent in inshore, closed bay locations. Improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use is possible at several locations in the Bering Sea area including Port Moller, Port Heiden, Dillingham, St. Paul and St. George. Again the impacts include mortality due to smothering and/or burying and would affect only nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution, since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Again, areas more likely to be impacted would be located nearer to shore. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Bering Sea benthic organisms. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue and add to the adverse consequences on benthic living habitat.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the community structure is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see Section 3.6 for discussion and references). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, all have the potential to cause changes to benthic communities. If long-term, as in the case of a change to a weather pattern, wind induced waves and surges could cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above, all of these impacts are more likely to be observed in nearshore areas. Regime shifts, and large-scale environmental fluctuations associated with ENSO and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific. These changes could have either beneficial or adverse effects on the benthic community (see Sections 3.6 and 3.10).

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Bering Sea. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, bycatch and damage to living habitat in the Bering Sea will continue and add to the adverse consequences to benthic living habitat.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 illustrate the spatial measures that were in effect before 1980 or were later established by regulations following the publication of the Final Groundfish SEIS in November of 1980. As discussed in Section 3.6, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most of the restricted areas were implemented to spatially and temporally restrict the foreign fishery to prevent conflicts with domestic fisheries through bycatch of species important to U.S. fishermen, or grounds preemption and gear conflicts. Most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that back in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. This again was due to the need to give priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 almost 9 percent of the fishable area in the Bering Sea was closed to trawling with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time.

- **Reasonably Foreseeable Future External Effects.** These include port expansion and the potential resultant changes to offal discharge and marine pollution events. As ports in the Bering Sea are expanded and new ports created, additional dock space for harboring the fishing fleet is made available. While the fleet might not necessarily expand, the opening of new ports may allow vessels of all sizes to access new or relatively unfished areas. On the other hand, depending on distribution, fishing pressure in heavily fished areas may be eased as access to other areas becomes available. Of course, closed areas proposed to continue under PA.1 would not be affected by the redistribution of home ports. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.1 would protect more benthic habitat from trawl gear in the future (19 percent) than was protected in 1980 (8.6 percent). However, the spatial distribution of the closed areas under PA.1 will not protect the full range of habitat types or provide for a diversity of impacts within fished areas. Existing closures tend to be large and cover all of particular habitat. They provide little diversity in fishing impacts since the primary focus of these past regulations has been to prevent potential damage to vulnerable crab habitat from bottom trawl gear. (See direct/indirect effects discussion and baseline description in Section 3.6). The additional external impacts do not provide any protection and could add to the lingering past mortality impacts and to impacts that are already evident. This is particularly important since FMP 1 does not require a reduction in TAC. The benefits provided by the closed areas are uncertain since previously unfished areas would likely be fished and impacts would occur in areas not previously impacted.

Aleutian Islands

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the baseline is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutian Islands. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Dredging due to scallop fisheries and/or navigation can occur in localized areas, often in conjunction with port development and can cause burial or smothering of benthic fauna. Damage to living substrates by longline and pot fisheries (see Section 3.6) has been documented and is expected to continue in those heavily fished areas. Offal discharge can occur from offshore catcher processors and onshore processors. However, impacts which include mortality due to smothering and/or reduced oxygen are expected to be more prevalent at inshore closed bay locations. However, improvements in offal pre-treatment and discharge regulations in recent years have reduced impacts and potentially improved conditions. Port expansion and increased use is possible at several locations in the Aleutian Islands including Atkutan, Adak, Unalaska, Cold Bay, Dutch Harbor, and King Cove. Again the impacts include mortality due to smothering, and/or burying and would affect only nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organisms.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Aleutian Islands benthic organisms. Long-lived species such as tree coral are more prevalent in the Aleutian Islands. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, bycatch and damage to living habitat in the Aleutians will continue and will add to the adverse consequences to benthic living habitat.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the community structure is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see Section 3.6). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** Dredging, longline and pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause changes to benthic communities. If long-term, as in the case of a change to a weather pattern, wind induced waves and surges could cause sufficient changes to the substrate such that the benthic community is impacted. As discussed above for mortality, all of these impacts are more likely to be observed in nearshore areas. Regime shifts and large-scale environmental fluctuations associated with ENSO and La Niña events have been identified as having impacts on both the physical and biological systems in the North Pacific (see Sections 3.6 and 3.10). These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Aleutian Islands. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, continued bycatch and damage to living habitat will add to the adverse consequences on the benthic community.

<u>Geographic Diversity of Impacts and Protection</u>

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the baseline is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed above for the Bering Sea, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring. Figures 3.6-6 and 3.6-7 illustrate that in 1980, there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. They gave priority to the domestic fisheries that used similar gear and fishing grounds. Table 4.5-51 shows that in 1980 about 31 percent of the fishable area in the Aleutian Islands was closed to trawling with about 6 percent closed to all fishing. There were no longline only closures in the Aleutian Islands at that time.

- **Reasonably Foreseeable Future External Effects.** These include other fisheries, port expansion, and the potential resultant changes to offal discharge and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As with the Bering Sea, ports in the Aleutian Islands will be expanded and new ports created, and additional dock space for harboring the fishing fleet will be made available. While the fleet might not necessarily expand, the distribution of fishing effort is likely to change and previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.1 would protect more benthic habitat from trawl gear in the future (43 percent) than was protected in 1980 (31 percent). However, the spatial distribution of the closed areas under the current FMPs may not protect the full range of habitat types.

GOA

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the benthic community is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas. The areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As described for the BSAI, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat. Port expansion and increased use is possible at several locations in the GOA including Kodiak, Sand Point, Chignik, Port Lions, Ouzinkie, Valdez, and Seward. The impacts include mortality due to smothering and/or burying and would likely affect only nearshore zones and bays. Marine pollution is identified as having a reasonably foreseeable potential adverse contribution since acute and/or chronic pollution events, if large enough in scale, could cause mortality to benthic organisms. Natural events such as storm surges and waves have the potential to cause direct morality through burial. These effects, like the others, would be expected in shallow waters where the wave energy is transmitted to the bottom without much attenuation through the water column. Climate changes and regime shifts are not expected to cause direct mortality of benthic organism.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of GOA benthic organisms. The additional external impacts described above will add to the lingering past mortality impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, continued bycatch and damage to living habitat in the GOA will add to the adverse consequences of fishing on the mortality of benthic organisms.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the community structure is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see Section 3.6). However, the areas historically and recently closed to fishing described in Section 3.6 may have recovered or be recovering with past mortality effects becoming less evident over time.

- **Reasonably Foreseeable Future External Effects.** As with the other regions, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to GOA benthic communities. As discussed above, these changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the GOA. The additional external impacts described above will add to the lingering past impacts and contribute to impacts that are already evident. Thus, even though the direct/indirect effect of PA.1 is rated as insignificant, bycatch and damage to living habitat will continue in the GOA and will add to the adverse consequences of fishing.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above in Section 4.9.6, this effect is judged to be insignificant; however, the baseline is considered to be already impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. As discussed for the other groups, during the late 1970s and early 1980s, there was little domestic fishing for groundfish species. Most domestic fishing effort focused on crab, salmon, and herring, and there were more restrictions placed on foreign fixed gear fisheries than trawl fisheries. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 5 percent of the fishable area in the GOA was closed to trawling, and about 7 percent was closed to all fishing. The largest closures in the GOA concerned longline fishing where almost 61 percent of the fishable area was closed to longlining. Therefore, in 1980 about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at one time throughout the year.

- **Reasonably Foreseeable Future External Effects** include other fisheries, port expansion, and the potential resultant changes to offal discharge and marine pollution episodes. Depending on changes in distribution of fishing effort, sensitive areas could either be additionally impacted or allowed to recover. As ports in the GOA are expanded and new ports are created, additional dock space for harboring the fishing fleet is made available, and changes in the distribution of fishing effort would result. Depending on the distribution of fishing effort, previously unimpacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.1 would protect much more benthic habitat from trawl gear in the future (46 percent) than was protected in 1980 (16 percent). However, the spatial distribution of the closed areas under the PA.1 may not protect the full range of habitat types. Also, in 1980 more benthic habitat was protected from fixed gear (over 60 percent of the fishable area) than would be protected under PA.1 (less than one percent of the fishable area in the GOA). While fixed gear impacts are believed to cause less of an impact on benthic communities, research has shown that considerable bycatch of coral and other large benthic structures occur with this gear type. The additional external impacts described above will add to the lingering impacts and contribute to impacts that are already evident.

Direct/Indirect Effects PA.2 – Habitat

This FMP contains a composite of several different concepts for habitat protection and mitigation. Figure 4.2-9 illustrates the suite of year-round closures in the BSAI and GOA management areas. These areas are essentially the same as those proposed for and analyzed under FMP 3.2 and can be considered a proxy for what might actually be implemented by NPFMC under this PA. The conceptual strategies for the proxy include:

- Review all existing closures to see if the areas qualify for MPAs. An MPA could include no-take marine reserves, establishing specific gear restrictions, or restrictions on specific fisheries. An example under PA.2 would be bottom trawl closures located in specific areas on the GOA upper slope that possess sensitive hard bottom habitats impacted by the rockfish fishery.

- Consider adopting 0 to 20 percent of the BSAI and GOA as MPAs and no-take marine reserves (e.g., 5 percent no take and 15 percent MPA across a range of habitat types). A proxy for this strategy would be to incorporate a band-approach where closures would be oriented perpendicular to depth contours from nearshore to deep water assuring protection of a diversity of habitat types across a range geographic areas.

- Develop a special conservation area in the Aleutian Islands to protect sensitive cold water coral communities.

- Implement rotational closures in the Bering Sea to mitigate for impacts.

In the following analysis, we examine qualitatively the relative merits of these conceptual approaches.

- **Slope Rockfish Closures.** The basis for these conceptual closures is to illustrate how the effects of fishing on EFH can be mitigated by reducing the impacts caused by a particular fishery. This concept is currently being developed for the GOA slope rockfish fishery by the NPFMC EFH committee. The GOA closure scheme selected by the EFH committee was based on a very preliminary run of the habitat impacts model. Further research may identify other fisheries and areas that would be better candidates for habitat mitigation. Note that the exact location used in the analysis presented here does not correspond to those areas being studied by the NPFMC and NOAA Fisheries in the EFH SEIS. They only serve to illustrate the concept. Independent of the habitat impacts model, it is worth noting that GOA rockfish fisheries are responsible for a considerable portion of the bycatch of living substrates, especially coral and sponges.

It must be emphasized that the NPFMC and NOAA Fisheries need to carefully consider the location of closures so that unintended consequences do not occur. Displacement of effort to new areas with more sensitive habitat may be an unintended consequence. If closures are placed primarily in areas with high fish densities and displacement of effort occurs in areas of low densities, then increased effort and potentially more habitat impacts may occur overall. For this ,reason the NRC (2002) suggests that for closures to be most effective they should be combined with some effort controls. The example PA.2 does illustrate a scenario of reduced TACs, and the use of fishery cooperatives combined with no-take reserves and MPAs. However, it is important to point out that closures alone, if they are strategically placed within historically fished areas, can provide benefits to habitat overall without necessarily requiring a reduction in TACs. The benefits to habitat can be enhanced by having areas selected for closure to be located within historically fished areas. This patchiness promotes habitat diversity (Duplisea *et al.* 2002).

- **Rotational Closures.** These closures have been suggested as a concept of protecting seafloor habitat while not permanently closing an area to fishing and illustrate how the year-round closures shown in Figure 4.2-9 could be managed. Conceptually, rotational closures are not that much different from the concept of rotating crops. The theory is that by allowing some areas (fields) to go to seed and recover to a more natural state, benefits accrue to both habitat and food production objectives. However, rotational closures are not appropriate for highly structured seafloor habitats with long-lived species. Rotational closures need to be tied to recovery times of living habitats and may only be a viable alternative in sandy energetic habitats inhabited by short-lived animals. Specific knowledge of recovery times is required because if the rotation schedule is less than the recovery time then all areas may be maintained in a disturbed state with little benefits to habitat or yield. For example, during a temporary trawl closure in the North Sea, fishing effort was displaced outside the closed area and then returned when the area was re-opened several years later (Rijnsdorp *et al.* 2001). The net result was a more homogeneous distribution of fishing effort and habitat disturbance than in years prior to the closure. From a habitat perspective it is preferable to keep fishing effort patchy (Duplisea *et al.* 2002) because repeated tows of the same area cause a diminishing mortality of benthic species and some areas remain unfished. Thus, permanently closed areas are preferred over temporary or rotating closures (Collie *et al.* in review).

- **Aleutian Island Special Management Area.** The Aleutian Islands most likely harbor the highest diversity and abundance of cold water corals and sponges in the world (Heifetz 2002). A recent expedition to the Aleutian Islands used the manned submersible DSV Delta and scuba to explore coral and sponge habitat in the Aleutian Islands near the Andreanof Islands and on Petrel Bank (NPFMC 2002b). Dive observations confirmed that coral and sponges are widely distributed in that region; corals and sponges were found at 30 of 31 submersible dive sites. Disturbance to epifauna, likely anthropogenically induced, was observed at most dive sites and may have been more evident in heavily fished areas. Percent coverage of corals ranged from approximately 5 percent on low-relief pebble substrate to 100 percent coverage on high-relief bedrock outcrops. Unique coral habitat consisting of high density gardens of corals, sponges, and other sessile invertebrates was found at five sites between 150 and 350 m deep. These gardens were similar in structural complexity to tropical coral reefs and shared several important characteristics with tropical reefs including complex vertical relief and high taxonomic diversity. The uniqueness and fragility of this habitat points to the need for the design of special management regime that protects this habitat yet allows fishing. Strategically placed closures in areas of sensitive habitat would protect such habitat as long as the displaced fishing effort does not occur to new areas with equally or more sensitive habitat. Unfortunately, there exists little information on the locations of these fragile habitats throughout the Aleutian Islands. Locating and mapping these areas is a priority for research. In the interim, one precautionary measure would be to restrict fishing to those areas that are known to have little or no sensitive habitat.

- **Band Approach.** Incorporation of a band-approach where closures are oriented perpendicular to depth contours from nearshore to deep water would assure protection of diversity of habitat types across a range of geographic areas. This concept has appeal in situations where little is known about benthic habitat types and location. Ideally these closures would be placed to ensure a diversity of habitat types are protected. However, lacking good scientific information on distribution of habitat types, alternatives would randomly or systematically place the closures equidistant apart. In theory, this strategy should promote habitat diversity and protect a wide range habitat types from the effects of fishing. Mitigation and diversity of impacts can occur if closures incorporate fished and unfished areas. One adverse aspect of such random placement is that such closures could have serious social and economic consequences. Determining where to apply this broad approach, should include consultation with the fishing industry and nearby communities.

As shown on Table 4.9-3, direct and indirect effects of the FMP on habitat are discussed for changes to living habitat through direct mortality of benthic organisms and changes to benthic community structure through benthic community diversity and geographic diversity of impacts and protection. Due to their habitat type differences the BSAI and GOA are rated and discussed separately.

Changes to Living Habitat – Direct Mortality of Benthic Organisms

In the GOA, the multi-species model results indicate that the bycatch of coral is projected to decline under PA.2. This is realistic because PA.2 has reduced TAC levels for some target species, especially rockfish. These reduced TACs should result in less fishing effort.

If the magnitude of such declines are actually realized, then this could have beneficial impacts on living substrates possibly resulting in increased abundance of some species of living substrates over baseline levels. Such abundance increases for short-lived biota with fast recovery rates may occur relatively quickly. For other species of living substrates such as long-lived corals and perhaps some sponges that have been permanently eradicated from some areas, increases over baseline levels may not occur or occur very slowly. Conceptual deductions from the habitat impacts model yield the following inferences:

- **Bering Sea.** Based on the location of the PA.2 closures relative to the distribution of fishing intensity shown in Figure 4.7-1, the change relative to the baseline in total impact to biostructure would likely be slight and insignificant. The baseline condition is considered to already be adversely impacted. However, there are some reductions in TAC which may result in some reduction in impacts. Most of the closure areas are located in sand habitat with moderate amounts of closure in sand/mud habitat and almost no closures in mud habitat. The closed areas are located in areas that have been lightly fished compared to large areas of heavy fishing that are left open. Whether mean impact increases or decreases depends on relative density of target species and habitat in the open and closed areas, and the respective impact/recovery parameters (q, q_h, and ρ) in the open and closed areas. There is little information to indicate that habitat density and the parameters would differ between the open and closed areas. One would expect target species density to be lower in areas of low fishing intensity and higher in the areas of high fishing intensity. If closed areas are of lower historical fishing density, benefits to habitat are likely minimal. If target species density is higher in the closed areas, benefits to habitat from the closure would increase.

- **Aleutian Islands.** A decrease in mean equilibrium impact would probably occur in the Aleutian Islands due to the specific closures depicted by the PA.2 bookend. Closures where fishing occurs seem to bisect the cluster of historical fishing patterns leaving the adjacent area open (Figure 4.7-1). Some reductions in TAC may result in less habitat impacts. Based on these results, we conclude that there would be a significantly beneficial change to mortality and damage to living habitat as a result of PA.2. However, as described above, the baseline condition is considered to already be adversely impacted.

- **GOA.** The mean impact will increase in the GOA, as many of the closed areas are centered on high effort areas which would be expected to have higher target fishery species densities (Figure 4.7-2). This results in a much higher effort to catch fish in lower density open areas. This much higher effort will result in enough of an increase in habitat impacts to negate impact reduction in the closed areas. It is not clear whether decreased TACs for some species will offset this increase in habitat impacts. Based on these results, we conclude that, under certain conditions, there could be significantly adverse changes to mortality and damage to living habitat as a result of PA.2. Therefore, the internal effect is rated as conditionally significant adverse, and the baseline condition is considered to already be adversely impacted.

Changes to Benthic Community Structure – Benthic Community Diversity and Geographic Diversity of Impacts and Protection

- **Bering Sea.** Closures are fairly well distributed among geographical-habitat types. Some improvement in geographic diversity would be achieved. While large expanses of high fishing intensity still remain open in this FMP, there is at least one closure area that covers a portion of high fishing intensity as shown in Figure 4.7-1. This provides some improvement in the geographic diversity of impacts. An overall improvement to geographic diversity of impacts could be realized with smaller closure areas, some of which covering a small fraction of the heavily fished areas. Some of the closures for this FMP are located where light levels of fishing occur and may provide some low-level of contrast and diversity. Table 4.5-49 shows that of the Bering Sea fishable area, nearly 33 percent is closed to bottom contact at one time or another during the year under PA.2. Figure 4.7-3 shows areas closed to trawling only at various times of the year under this FMP, while Figure 4.7-4 depicts those areas closed to fixed gear only. Based on these results, the predicted effects of PA.2 on benthic community diversity are conditionally significant beneficial. The predicted effects of PA.2 bookend on geographic diversity of impacts are significantly beneficial. However, the baseline is considered to already be adversely impacted.

- **Aleutian Islands.** Closures illustrated in PA.2 bookend are well distributed among geographical-habitat types. Improvement in geographic diversity of impacts would occur under this FMP scenario. As shown on Table 4.5-49, about 80 percent of the fishable area in the Aleutian

Islands is closed to bottom contact at one time or another during the year under this FMP, and these closures are well distributed over a range of geographical-habitat zones. Figures 4.7-3 and 4.7-4 show the closure areas under PA.2 broken down by gear type; bottom trawl and fixed gear, respectively. While the closure areas are especially large compared to the resolution of the bathymetry and fishing distribution and encompass different habitat types at a time, it may well be that a similar mix of habitat types occur adjacent to the closure areas. Also, Figure 4.7-1 shows that some closure areas happen to bisect apparent historic clusters of fishing patterns, thus providing a contrast in impact for the habitat being fished. Based on these results, the effects of PA.2 on benthic community diversity are significantly beneficial. The predicted effects of PA.2 bookends on the geographic diversity of impacts are significantly beneficial. However, the baseline is considered to already be adversely impacted.

- **GOA.** Closures illustrated by the PA.2 bookend are well distributed among geographical-habitat types. However, slight, if any, improvement in geographic diversity of impact would result. As shown on Table 4.5-49 and Figures 4.7-3 and 4.7-4, PA.2 closes over 72 percent of the fishable area in the GOA to bottom contact at one time or another during the year. The closure areas are large in relation to the GOA spatial habitat or bathymetric resolution, and thus tend to encompass much of a bathymetric feature. Figure 4.7-2 shows that closures often encompass clusters of historically high fishing intensity, leaving little diversity or contrast of fishing intensity within a bathymetric feature or habitat type. An overall improvement to geographic diversity of impacts could have been realized with smaller closure areas strategically placed to not encompass entire habitat types or clusters of fishing intensity. For example, the closure areas on the upper slope should include some portion of areas where high fishing intensity has occurred, but need not be as large in size as illustrated in this PA.2 scenario. Based on these results, the predicted effects of PA.2 bookend on benthic community diversity and geographic diversity of impacts are found to be insignificant relative to the baseline. However, the baseline is considered to already be adversely impacted.

Cumulative Effects PA.2 – Habitat

Cumulative effects of habitat for PA.2 are summarized on Table 4.9-3.

The following discussion of the results presented on the table is broken down by geographic area.

Bering Sea

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea. These effects include persistent mortality of long-lived species such as tree corals and other sessile epifauna (see the cumulative effects discussion for PA.1 in this section).

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat (see the Bering Sea PA.1 cumulative effects discussion in this section).

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Bering Sea benthic organisms. There is little information to indicate that habitat density and the parameters would differ between the open and closed areas. The baseline condition is considered to be adversely impacted. Although some benefits accrue within the proposed MPAs, impacts from fishing are not totally eliminated, and TAC effort is likely to remain high. While there is an incremental expansion of no-take MPAs, the closures analyzed under this FMP are not refined and may not be effective. We do not know for certain where future closures may be, or whether they would be no-take reserves or a form of gear-specific/species-specific MPA. Due to this uncertainty, along with the already impacted baseline, and with the addition of the external impacts on mortality described above, the cumulative effect of the FMP on mortality could be conditionally significant adverse.

  However, if the closures proposed under PA.2 were to be further defined based on additional information regarding important habitats in need of protection, and were properly designed and located to protect the sensitive habitats, future closures could provide successful mitigation of the effects of fishing. Overtime, valued habitat that has been adversely affected by fishing could recover. Therefore, under that condition, cumulative effects may have more of a conditionally significant beneficial rating rather than conditionally significant adverse.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above, this effect is judged to be conditionally significant beneficial, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Bering Sea (see the Bering Sea PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** Offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities as described for PA.1. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Bering Sea. This FMP provides some improvement in the geographic diversity of impacts. However, some of the closures for this FMP are located where light levels of fishing occur and may provide some low level of contrast and diversity. As described above for mortality, while benefits accrue due to the MPAs, the closure areas are not refined and may not be effective in protecting benthic community structure (see the discussion provided above for mortality). For these reasons, along with the already impacted state of the communities and the external adverse impacts, the FMP is rated as conditionally significant adverse in the cumulative case.

  However, as described above for mortality, if the closures proposed under PA.2 were to be further defined and designed to protect important habitats, mitigation of fishing-related impacts could occur. Cumulative effects may have more of a conditionally significant beneficial rating rather than conditionally significant adverse.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, this effect is judged to be significantly beneficial, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 almost 9 percent of the fishable area in the Bering Sea was closed to trawling, with 2.2 percent closed to all fishing. There were no longline-only closures in the Bering Sea at that time. The cumulative effects section for PA.1 provides additional discussion regarding these past effects.

- **Reasonably Foreseeable Future External Effects.** These include port expansion and the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes (see the discussion for PA.1 in this section). Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.2 would protect more benthic habitat from trawl gear in the future (33 percent) than was protected in 1980 (8.6 percent). Closure areas under this scenario cover a portion of high fishing intensity, thereby providing improvement in the geographic diversity of impacts. However, since TAC is likely to remain high and the locations of the proposed MPAs are not refined, the benefits provided by the closed areas are uncertain. Previously unfished areas would likely be fished and impacts would occur in areas not previously impacted. The additional external effects in combination with the past and predicted internal effects are judged to be conditionally significant adverse. However, as described above for mortality and community diversity, better definition and focus of the closures could lead to a conditionally significant beneficial rating.

Aleutian Islands

Changes to Living Habitat – Direct Mortality of Benthic Organisms

- **Direct/Indirect Effects.** As described above, this effect is judged to be significantly beneficial, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Prevalence of long-lived species of coral makes impacts a particular concern in the Aleutian Islands. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see the PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** As described for PA.1 cumulative effects in the Aleutian Islands, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, and marine pollution all have the potential to cause direct mortality of benthic organisms and changes to living habitat.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of Aleutian Islands benthic organisms. As described above for the Bering Sea, the baseline condition is considered to be already adversely effected. The proposed no-take MPAs will allow some benefits to accrue, but impacts will still occur, especially since TAC remains high. Therefore, the overall effect would be significantly adverse under certain conditions. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

Changes to Benthic Community Structure

- **Direct/Indirect Effects.** As described above, this effect is judged to be significantly beneficial; however the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the Aleutian Islands. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see the Aleutian Islands PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** As described for PA.1, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the Aleutian Islands. As described above for mortality of benthic organisms, the existing impacted baseline, combined with the uncertain benefits of the proposed MPAs, leads to a conclusion of significantly adverse under certain conditions in the cumulative case. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, this effect is judged to be significantly beneficial, but the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 31 percent of the fishable area in the Aleutian Islands was closed to trawling with about 6 percent closed to all fishing. There were no longline-only closures in the Aleutian Islands at that time (see the PA.1 Aleutian Islands cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** These include other fisheries, port expansion, the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution episodes. Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case (see the Aleutian Islands PA.1 cumulative effects discussion in this section).

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.2 would protect more benthic habitat from trawl gear in the future (80 percent) than was protected in 1980 (31 percent). Closures illustrated in PA.2 bookend are well distributed among geographical-habitat types; thus, improvement in geographic diversity of impacts would occur under this FMP scenario. However, since TAC is likely to remain high, and the locations of the proposed MPAs are not refined, the benefits provided by the closed areas are uncertain. Previously unfished areas would likely be fished and impacts would occur in areas not previously impacted. The additional external effects in combination with the past and predicted internal effects are judged to be conditionally significant adverse. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

GOA

<u>Changes to Living Habitat – Direct Mortality of Benthic Organisms</u>

- **Direct/Indirect Effects.** As described above, this effect is judged to be conditionally significant adverse, since there would be much higher effort to catch fish in lower density open areas. It is not clear whether decreased TACs for some species will offset an increase in habitat impacts. Under certain conditions, there could be significantly adverse impacts on mortality of benthic organisms.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Mortality of long-lived species such as tree corals and other sessile epifauna is likely to be persistent in these areas (see the GOA PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** As described for PA.1, dredging, longline fisheries, pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause direct mortality of benthic organisms and changes to living habitat.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for mortality of GOA benthic organisms. The external effects identified above have the potential to provide additional mortality to benthic organisms. Therefore, under certain conditions, the cumulative effects on mortality could be significantly adverse.

<u>Changes to Benthic Community Structure</u>

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant; however, the baseline is considered to be already adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected in heavily fished areas of the GOA. Changes to benthic community structure including a reduction in species diversity have been observed in heavily fished areas of the world (see the GOA PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** As described for PA.1 in the GOA, dredging, longline and pot fisheries, offal discharge, port expansion and use, marine pollution, and natural events all have the potential to cause changes to benthic communities. These changes could have either beneficial or adverse effects on the benthic community.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in benthic community structure of the GOA. As described above for the BSAI, while the FMP provides for additional closure area and no-take MPAs, impacts are not totally eliminated, and the proposed MPAs might not be effective. Therefore, the combination of internal and external impacts on benthic communities is judged to be conditionally significant adverse in the cumulative case. However, as described for the Bering Sea, further definition and refinement of the closure areas may allow for a conditionally significant beneficial cumulative effects rating.

Geographic Diversity of Impacts and Protection

- **Direct/Indirect Effects.** As described above, this effect is judged to be insignificant, but the baseline is considered to be adversely impacted.

- **Persistent Past Effects.** Persistent past effects are expected, since fishing effort and distribution have changed over time as areas have been closed and remain closed. Figures 3.6-6 and 3.6-7 and Table 4.5-51 show that in 1980 about 5 percent of the fishable area in the GOA was closed to trawling, with about seven percent closed to all fishing. The largest closures in the GOA concerned longline fishing where almost 61 percent of the fishable area was closed to longlining. Therefore, in 1980 about 73 percent of the fishable area in the GOA was closed to fishing of one type or another at one time throughout the year (see the GOA PA.1 cumulative effects discussion in this section).

- **Reasonably Foreseeable Future External Effects.** These include other fisheries, port expansion, the potential resultant changes to distribution of fishing effort, offal discharge, and marine pollution events (see the GOA PA.1 cumulative effects discussion in this section). Depending on the distribution of fishing effort, previously un-impacted areas could be impacted by offal discharge and marine pollution. Natural events are not expected to be contributing factors in this case.

- **Cumulative Effects.** Conditionally significant adverse cumulative effects are identified for changes in distribution of fishing effort. The maps and statistics discussed above show that PA.2 would protect much more benthic habitat from trawl gear in the future (72 percent) than was protected in 1980 (16 percent). Closures illustrated by the PA.2 bookend are well distributed among geographical-habitat types. However, slight, if any, improvement in geographic diversity of impact would result. As described above for the BSAI, the proposed MPAs might not be effective. Further refinement of the proposed MPAs may lead to a conditionally significant beneficial rating.

4.9.7 Seabirds Preferred Alternative Analysis

The seabird-specific policy goal of the Preferred Alternative (PA) is the same as all the other Alternatives, to "Avoid Impacts to Seabirds and Marine Mammals". The PA contains one policy objective that is specific to protecting seabirds, "Continue to cooperate with USFWS to protect ESA-listed species and, if appropriate and practicable, other seabird species". The NPFMC could adopt a range of specific management measures in order to implement the policy objectives. The illustrative FMP bookends provide examples of specific management measures the NPFMC would take to implement the Preferred Alternative policy objectives. PA.1 includes the following measures: 1) Take of more than 4 short-tailed albatross within 2 years triggers consultation in groundfish longline fisheries, 2) Maintain current seabird avoidance measures for the longline fleet that were approved at the December 2001 NPFMC meeting, 3) Cooperate with USFWS to develop scientifically-based fishing methods that reduce incidental take of ESA-listed seabird species in the trawl sector. PA.2 retains the first objective for short-tailed albatross take and substitutes the following for the other two objectives: 2) For the longline sector, cooperate with USFWS to develop scientifically-based fishing methods that reduce incidental take for all seabird species, 3) For the trawl sector, cooperate with USFWS to evaluate and implement scientifically-based fishing methods that reduce incidental take of ESA-listed, and if appropriate and practicable, other seabird species. The PA also includes several goals and objectives that would have indirect effects on seabirds, such as the ban on directed forage fish fisheries, modification and potential expansion of the Observer Program based on scientific data needs, the development of ecosystem indicators for use in the TAC-setting process, and the potential establishment of Marine Protected Areas.

Two important agency actions that are pertinent to BSAI/GOA seabirds and the following analysis have occurred since the Draft PSEIS was published in 2003. First, the USFWS issued two Biological Opinions (BiOps) in September 2003 as part of their ESA Section 7 consultations on the federal groundfish fisheries (see NOAA Fisheries website: http://www.fakr.noaa.gov/protectedresources/seabirds.html.). One BiOp takes a programmatic look at the impacts of the BSAI/GOA groundfish FMPs and associated fisheries on the endangered short-tailed albatross and the threatened Steller's eider (USFWS 2003a) while the other BiOp concerns the TAC-setting process for these fisheries (USFWS 2003b). These documents conclude that the fisheries would not likely jeopardize the continued existence or recovery of either the short-tailed albatross or Steller's eider and would not adversely modify Steller's eider critical habitat (no critical habitat has been designated for short-tailed albatross in U.S. waters). The TAC-setting BiOp included updated Incidental Take Statements for these species. For short-tailed albatross, incidental take on longline gear is anticipated to be the same as previous years, with up to 4 birds taken every two years. In addition, for the first time the USFWS included an anticipated take for short-tailed albatross through collisions with trawl gear. Unlike the situation with the longline fleet where there is over ten years of Observer Program data on take of albatross, the USFWS and NOAA Fisheries have only recently begun investigating how frequently albatross may be colliding with trawl gear. Because of this uncertainty, the Incidental Take Statement anticipates up to 2 birds could be taken by the trawl fleet but the time period was left open until the BiOp is superceded by a new one. This open-ended period allows USFWS and NOAA Fisheries to continue gathering data on the potential risk of trawl gear before a new Section 7 consultation is initiated.

The TAC-setting BiOp also included mandatory terms and conditions that NOAA Fisheries must follow in order to be in compliance with the ESA. One is the implementation of seabird deterrent measures for the longline fisheries as proposed by NOAA Fisheries in February 2003 (see below). Other provisions include continued outreach and training of fishing crews as to proper deterrence techniques, continued training of observers in seabird identification, retention of all seabird carcasses until observers can identify and record takes, continued analysis and publication of estimated incidental take in the fisheries, collection of information regarding the efficacy of seabird protection measures, cooperation in reporting sightings of short-tailed albatross, and continued research and reporting on the incidental take of short-tailed albatross in trawl gear.

The second pertinent agency action was the publication of new seabird protection regulations for longline vessels that were based on the joint recommendations of NOAA Fisheries, USFWS, and the Washington Sea Grant Program, approved by the NPFMC in December 2001, proposed by NOAA Fisheries in February 2003 (68 FR 6386), and were enacted in final regulations on January 13, 2004 (69 FR 1930) . These regulations are in effect as of February 2004 and vary by length of vessel, area fished, type of gear, and other factors. They are available at NOAA Fisheries website: http://www.fakr.noaa.gov/protectedresources/seabirds.html.

4.9.7.1 Short-Tailed Albatross

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

Incidental take of the endangered short-tailed albatross in the groundfish fishery is a very rare event, with the last recorded takes occurring in 1998 (see Section 3.7.4 for a history of takes and agency actions taken to protect this species under the ESA). The seabird protection measures that were in effect for the longline fleet prior to the 2004 fishing season had been in place since 1997 and constitute the baseline condition for this analysis. These measures had been strongly influenced by the goal of protecting short-tailed albatross but had not eliminated incidental take, as evidenced by two takes of short-tailed albatross in one month in 1998. A great deal of research and development has been conducted since 1997 to improve the efficacy of seabird protection techniques in the longline fleet. PA.1 would maintain the new seabird protection measures for longline vessels that were enacted in January 2004 (69 FR 1930) . These new regulations are based on the demonstrated effectiveness of using particular deterrent devices to reduce the incidental take of other albatross species (Melvin *et al.* 2001) and are expected to substantially reduce the chances of taking short-tailed albatross on longlines.

Under PA.1, NOAA Fisheries and USFWS would continue current research to develop ways to reduce the risk of short-tailed albatross colliding with trawl gear. Under PA.2, NOAA Fisheries would continue to cooperate with USFWS and other groups to scientifically develop and implement mitigation measures that further reduce the risk of taking short-tailed albatross in both the longline and trawl sectors.

Given the extreme rarity of short-tailed albatross, numbering less than 2,000 birds worldwide, any level of mortality is a conservation concern. For this reason, management actions that substantially reduce the chance of anthropogenic mortality occurring, even if the chance is not totally eliminated, have been pursued under the ESA and are included under the Preferred Alternative. From the perspective of research, management, and fishing industry efforts to reduce the chance of taking short-tailed albatross, the new protection measures have been very substantial. However, the short-tailed albatross population has been increasing at a near-maximum rate under the baseline conditions so a reduced chance of mortality in the fishery, when the measurable frequency of that mortality already approaches zero, may not result in measurable benefits for the population. The risk of incidental take under both PA.1 and PA.2 would be reduced from baseline conditions and would be considered to have insignificant effects on the population of short-tailed albatross.

Availability of Food

Short-tailed albatross forage over vast areas of ocean on species that are taken in minimal amounts by the groundfish fishery and are unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under either PA bookend. Both PA.1 and PA.2 are considered to have insignificant effects on short-tailed albatross through availability of food.

Benthic Habitat

Short-tailed albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under either PA bookend. Both PA.1 and PA.2 are considered to have no effects on short-tailed albatross through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on short-tailed albatross are described in Section 3.7.4 (Table 3.7-11) and the predicted direct and indirect effects of the groundfish fishery under the PA.1 and PA.2 are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for this species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.1 (Table 4.5-52) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under both PA.1 and PA.2, new seabird protection measures on the longline fleet (Section 3.7.1) and possibly the trawl fleet should substantially reduce the chances of taking short-tailed albatross incidentally in the groundfish fishery. Incidental take of short-tailed albatross is predicted to be a very rare event in the groundfish fishery and is considered insignificant at the population level.

- **Persistent Past Effects.** The most important persistent influence on the short-tailed albatross population is their near extinction due to commercial feather hunting. Conservation efforts have allowed the population to recover at or near to its biologically maximum rate. The total fishery-related mortality of short-tailed albatross is unknown, but it does not appear to be having an overriding effect on the population growth rate.

- **Reasonably Foreseeable Future External Effects.** The short-tailed albatross population may be substantially affected by several natural and human-caused mortality factors that may or may not occur in the future. These include volcanic eruptions on their main breeding site, Torishima Island, and increased rates of incidental take in fisheries throughout their range. If the species experiences a substantial increase in mortality that threatens its recovery, such increases may lead to further efforts to protect the species from fishery interactions.

- **Cumulative Effects.** Since the population of short-tailed albatross is susceptible to several natural and human-caused mortality factors that may or may not occur in the future, including incidental take in the groundfish fisheries under the PA, the cumulative effect on short-tailed albatross is considered to be conditionally significant adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects**. The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under both PA.1 and PA.2. This effect is considered insignificant at the population level for short-tailed albatross.

- **Persistent Past Effects.** Short-tailed albatross primarily prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to natural fluctuations in primary productivity and oceanographic factors. Pollution from a variety of land and marine sources has potentially affected short-tailed albatross prey in the past, but specific toxicological effects on forage fish populations are unknown.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on short-tailed albatross prey availability. Pollution is likely to affect short-tailed albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to short-tailed albatross, can not be made at this time.

- **Cumulative Effects**. Since the population decline of short-tailed albatross was caused by hunting rather than changes in habitat, and the habitat once supported millions of these birds, the population recovery of the species is not considered to be limited by food availability. The cumulative effect of all fisheries on the abundance and distribution of short-tailed albatross prey is considered to be insignificant at the population level.

Benthic Habitat

Since short-tailed albatross feed at the surface and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for short-tailed albatross.

4.9.7.2 Laysan Albatross and Black-Footed Albatross

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

The incidental take of Laysan and black-footed albatross are reported in the Observer Program data from 1993-2001 and include the unidentified albatross and an unknown number of the unidentified tubenoses (Tables 3.7-1 through 3.7-5). The number of albatross taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated number of Laysan albatross taken in this period averaged 650 birds per year in the BSAI longline sector (including a share of the unidentified albatross category), 126 birds per year on GOA longlines, and 90 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for a total estimated average take of 866 birds per year in the groundfish fishery. The latest population estimate for the species is 2.4 million birds (Cousins *et al.* 2000). Mortality from the groundfish fishery under the baseline conditions is thus estimated at 0.04 percent of the population and is therefore considered insignificant. For black-footed albatross, estimated mortality in the groundfish fisheries averaged 12 birds per year in the BSAI longline sector (including a share of the unidentified albatross category) and 158 birds per year on GOA longlines (with no observed takes in the BSAI and GOA trawls), for a total estimated average take of 170 birds per year in the groundfish fishery. The latest population estimate for the species is 300,000 birds (Cousins and Cooper 2000). Mortality from the groundfish fishery under the baseline conditions is thus estimated at 0.06 percent of the population and is therefore considered insignificant.

The new seabird protection measures for longline vessels under PA.1 and PA.2 would be expected to result in a substantial reduction of incidental take of Laysan and black-footed albatross relative to the baseline condition (Melvin *et al.* 2001). In addition, as was the case with the longline hazzard research, research on the risk of incidental take of short-tailed albatross in trawl gear would likely be based on measured impacts of the much more common Laysan albatross. PA.1 would incorporate any mitigation measures for the trawl fleet that arise from this research if it appears to reduce the chances of incidentally taking short-tailed albatross. Potential future mitigation of take from trawl third wire collisions would therefore reduce incidental take of Laysan albatross and probably black-footed albatross as well. Under PA.2, scientific research would be used to develop practical and effective measures to further reduce incidental take of ESA-listed and other species on longline and trawl gear. Although reductions in take of Laysan and black-footed albatross would be used to evaluate the most effective techniques to protect short-tailed albatross, research on reducing take of other species could potentially yield additional benefits for the albatross species.

NOAA Fisheries recently finalized the new seabird deterrent regulations for the longline fleet that will be in effect for the 2004 fishing season (69 FR 1930). Most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season. Incidental take data from the 2002 season (NPFMC 2003b) indicates that estimated take of Laysan albatross in the BSAI longline fisheries declined from an average of 643 birds per year (1997-2001) to an estimated 48 birds per year in 2002. In the GOA longline fisheries, Laysan albatross take was reduced from an average of 124 birds per year (1997-2001) to 0 birds in 2002. In this same period, incidental take of black-footed albatross on BSAI longlines declined from an average of 11 birds per year to 0 in 2002. In the GOA, incidental take of black-footed albatross declined from an average of 156 birds per year to 33 birds in 2002. It should be noted that there are a number of factors that influence the number of birds that are caught in any one year besides the type of seabird avoidance measures that are used. These include the spatial and temporal distribution of fishing effort, weather, sea state, and previously observed inter-annual variations in overall food availability that appear to affect the intensity with which seabirds attack baited hooks. It may not be possible to ascertain how much different factors may have contributed to the reduced level of take in 2002 and it remains to be seen whether this reduced level of take will continue in the future. However, it is expected that fleet-wide compliance with the new regulations, which include equipment specifications and deployment standards, should result in a dramatic decline in take of albatross on longline gear.

Since the baseline level of incidental take from all groundfish fisheries is considered insignificant at their respective population levels for both Laysan and black-footed albatross, and incidental take of these species would likely be reduced under both PA.1 and PA.2, the overall effect of the PA.1 and PA.2 on incidental take of both albatross species is considered insignificant.

Availability of Food

Albatross forage over vast areas of ocean on prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections 4.5.4 and 4.5.10). Albatross are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under either PA bookend. Both PA.1 and PA.2 are considered to have insignificant effects on these species through availability of food.

Benthic Habitat

Albatross are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under either PA bookend. Both PA.1 and PA.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on these albatross species are described in Sections 3.7.2 and 3.7.3 (Tables 3.7-6 and 3.7-7) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.5-53) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under PA.1 and PA.2, the new seabird protection measures for the longline fleet are expected to reduce incidental take of both albatross species. Mitigation measures for the trawl fleet may also be developed that would reduce incidental take of these species under both PA.1 and PA.2. Incidental take is considered insignificant at the population level for both species in this group.

- **Persistent Past Effects.** For black-footed and Laysan albatross, past mortality factors include large contributions from foreign longline fisheries and Hawaiian pelagic longline fisheries, smaller contributions from the BSAI/GOA longline and trawl fisheries, and unknown contributions from other longline fisheries (IPHC), other gear-type fisheries, and vessel collisions throughout their range. Both species have been experiencing population declines over the past decade. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment to mortality is unknown for both albatross species in this group.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets that are expected to reduce take of albatross in those fisheries. It is expected that incidental take of black-footed and Laysan albatross in foreign longline fisheries will remain high and will continue to exceed the threshold for population level effects.

- **Cumulative Effects.** Since the populations of black-footed and Laysan albatross are undergoing measurable declines and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries under the PA.1 and PA.2, the cumulative effects on black-footed and Laysan albatross are considered to be significantly adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and forage fish as bycatch under the PA.1 and PA.2. This effect is considered insignificant at the population level for both albatross species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on albatross prey populations can not be assessed at this time.

- **Persistent Past Effects.** Albatross primarily prey on squid species and small schooling fish that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Pollution from a variety of land and marine sources has potentially affected albatross and shearwater prey in the past. However, very little is known about the specific toxicological effects on prey species important to these seabirds or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a minimal effect on albatross prey availability. Pollution is likely to affect albatross prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to albatross, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of albatross prey is considered to be insignificant at the population level for both species.

Benthic Habitat

Since albatross feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect is identified for these species.

4.9.7.3 Shearwaters

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

The incidental take of shearwaters is reported in the Observer Program data from 1993-2001, including an unknown number of the unidentified tubenoses (Tables 3.7-1 through 3.7-5). The number of shearwaters taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated mortality of shearwaters in the groundfish fisheries averaged 578 birds per year in the BSAI longline sector, 18 birds per year on GOA longlines, and 799 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for a total estimated average take of 1395 birds per year in the groundfish fishery. Population estimates of short-tailed and sooty shearwaters are 23 million and 30 million birds, respectively (Everett and Pitman 1993, Springer *et al.* 1999). Incidental take of these species in the groundfish fisheries under the baseline conditions is much less than 0.01 percent of their populations and is thus considered insignificant.

The new seabird protection measures for longline vessels (in effect as of the 2004 fishing season) are not effective for shearwaters because they are able to dive deeper than albatross and fulmars in pursuit of baited hooks (Melvin *et al.* 2001). Expected incidental take of shearwaters on longlines would therefore be similar to the baseline condition under PA.1. Under PA.2, additional research would be conducted to further reduce incidental take of all species on longline gear. This would likely include continued research into integrated weighted groundlines and other techniques which may prove effective for deterring diving birds such as shearwaters.

In the trawl sector, PA.1 would develop methods to reduce the risk of short-tailed albatross colliding with trawl gear. These efforts may also reduce the incidental take of shearwaters if they interact with trawl vessels in a similar manner. Under PA.2, additional research would be conducted to develop practical ways to reduce incidental take of non-ESA species in trawl gear. Since shearwaters are the second most commonly taken species group in trawl gear (after northern fulmars), they would likely receive substantial attention during development of potential mitigation measures under PA.2.

Since the baseline level of incidental take for these species is considered insignificant at their respective population levels and incidental take of these species could be reduced under both PA.1 and PA.2, the overall effect of the PA.1 and PA.2 on incidental take of both shearwater species is considered insignificant.

<u>Availability of Food</u>

Shearwaters forage over vast areas of ocean on planktonic prey that are taken only in negligible amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections 4.5.4 and 4.5.10). Shearwaters are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under either PA bookend. Both PA.1 and PA.2 are considered to have insignificant effects on these species through availability of food.

<u>Benthic Habitat</u>

Shearwaters are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under either PA bookend. Both PA.1 and PA.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on sooty and short-tailed shearwaters are described in Section 3.7.6 (Table 3.7-14) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.2 (Table 4.5-54) and summarized below.

Mortality

- **Direct/Indirect Effects.** Under PA.1, the new seabird protection measures for the longline fleet would be adopted but are not expected to reduce incidental take of shearwaters. Additional research and future mitigation measures could reduce incidental take of these species under PA.2. Mitigation measures for the trawl fleet under PA.1 and PA.2 may also reduce incidental take of shearwaters in the trawl sector. Expected incidental take is considered insignificant at the population level for both shearwater species.

- **Persistent Past Effects.** For sooty and short-tailed shearwaters, mortality factors include large contributions from subsistence and commercial harvest of chicks on the nesting grounds as well as climatic and oceanic fluctuations that cause periodic mass starvation, substantial contributions from foreign, Hawaiian, and BSAI/GOA groundfish longline and trawl fisheries, and a smaller contribution from vessel collisions throughout their range. It is difficult to assess the population trends in these abundant and widespread species, but there is some indications that both species may be declining. The contribution of toxic and plastic pollution on their nesting grounds and in the marine environment to mortality is unknown for both species in this group.

- **Reasonably Foreseeable Future External Effects.** New seabird protection measures have recently been established for the Hawaiian pelagic longline fleets that are similar to those proposed for the Alaskan fisheries. These measures are not expected to reduce incidental take of shearwaters in those fisheries. It is expected that incidental take of shearwaters in foreign fisheries will likely continue as in the past unless longline and trawl deterrence techniques are developed and applied that are effective for diving species.

- **Cumulative Effects.** Since the populations of shearwaters may be undergoing declines and several human-caused mortality factors have been identified and are expected to continue in the future, including contributions from the groundfish fisheries under PA.1 and PA.2, the cumulative effects on sooty and short-tailed shearwaters are considered to be conditionally significant adverse at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a very small amount of squid and plankton as bycatch under PA.1 and PA.2. This effect is considered insignificant at the population level for both shearwater species. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on shearwater prey populations can not be assessed at this time.

- **Persistent Past Effects.** Short-tailed and sooty shearwaters are susceptible to periodic widespread food shortages that have caused massive die-offs in Alaskan waters. Natural fluctuations in primary productivity and oceanographic factors are considered to be the driving forces that determine the abundance of their main prey (euphausiids) rather than competitive interactions with other predators. Since shearwaters can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected shearwater prey in the past. However, very little is known about the specific toxicological effects on species important to these seabirds or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a minimal effect on shearwater prey availability. Pollution is likely to affect shearwater prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to shearwaters, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of shearwater prey is considered to be insignificant at the population level for all species.

Benthic Habitat

Since shearwaters feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for these species.

4.9.7.4 Northern Fulmar

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

Northern fulmars make up a majority of all birds taken in all three gear sectors. The numbers of fulmars taken are reported in the Observer Program data under their own species listing plus an unknown number of the unidentified tubenoses and unidentified seabird groups (Tables 3.7-1 through 3.7-5). The number of fulmars taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001data since these measures were implemented in 1997. The estimated number of fulmars taken in this period averaged 10,689 birds per year in the BSAI longline sector, 406 birds per year on GOA longlines, 3,083 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, and 42 birds per year in BSAI and GOA pots, for an estimated average identified take of 14,220 birds per year in the groundfish fishery. This total does not include any portion of the “unidentified seabird” category in the data set or any estimate of birds killed by vessel strikes. Given the high proportion of fulmars in the identified categories, one could reasonably assume that a large number of the unidentified bird remains were actually fulmars. For this analysis, the portion of unidentified birds in the data that were actually fulmars will be approximated as an additional 1,000 birds per year, mostly from the BSAI longline sector. Vessel strike data have been collected in an *ad hoc* manner but existing records indicate that an average of at least 80 fulmars are killed each year by trawl third wires. Adding these approximations to the identified fulmar takes gives a total estimated average take of about 15,300 birds per year from all fisheries. The latest population estimate for fulmars in the BSAI and GOA is about 2 million birds, with 4 to 5 million in the North Pacific (Hatch and Nettleship 1998). Mortality from the groundfish fishery is thus equal to about 0.76 percent of the BSAI and GOA population.

This baseline level of incidental take is considered to be insignificant at the overall population level. However, because fulmars only breed in a few large colonies in the BSAI/GOA, there is some concern that incidental take from the fisheries could have a colony level effect if a disproportionate amount of the overall take comes from only one colony, particularly the Pribilof Islands since it is the smallest colony. The USFWS has established permanent sample plots on the Pribilof Islands but the usefulness of those census plots to measure potential colony level changes of fulmars is questionable (see Section 3.7.5). The U.S. Geological Survey/Biological Resource Division (USGS/BRD) has recently begun to research the issue using satellite telemetry and genetic analysis to determine the movement patterns of fulmars and the colony of provenance of birds taken in the fishery. Other factors that may cause population levels to fluctuate, including variable environmental conditions, will be investigated as well.

Since northern fulmars constitute the majority of birds taken incidentally in all sectors of the groundfish fisheries, they would likely benefit the most from improved seabird protection measures in both the longline and trawl fleets. Under PA.1, the new seabird protection measures would be expected to substantially reduce incidental take of fulmars from longlines, which accounts for much of the incidental take under baseline conditions. Most of the BSAI freezer longline fleet and many smaller vessels in the GOA began using the new seabird deterrent devices on a voluntary basis during the 2002 fishing season. Incidental take data from the 2002 season (NPFMC 2003b) indicates that estimated take of fulmars in the BSAI longline fisheries declined from an average of 10,689 birds per year (1997-2001) to an estimated 701 birds per year in 2002. In the GOA longline fisheries, fulmar take was reduced from an average of 406 birds per year (1997-2001) to 129 birds in 2002. As described above for albatross, many different factors may have contributed to the reduced level of take in 2002. However, it is expected that fleet-wide compliance with the new regulations, which include equipment and deployment standards, should result in a dramatic decline in take of fulmars on longline gear. Under PA.2, additional research into weighted groundlines and other techniques would likely further reduce incidental take of fulmars.

In the trawl sector, potential new mitigation measures to reduce the risk of collisions with short-tailed albatross would likely be based on measured reductions in take of other albatross and fulmars, as was done for the longline deterrence measures. New seabird protection measures for the trawl fleet under PA.1 would therefore likely reduce incidental take of fulmars. Under PA.2, additional research on reducing take of non-ESA species would also likely benefit fulmars since they are the most frequently taken species in trawl gear.

Incidental take of fulmars in longlines and trawl gear is expected to be greatly reduced from baseline levels under both PA.1 and PA.2. Since the baseline level of incidental take is already considered insignificant at the population level, the substantially reduced levels of take expected under the PA.1 and PA.2 are also considered insignificant at the population level. These reductions in take would greatly reduce concerns about potential colony level effects on the Pribilof Islands although the USGS/BRD would likely continue to investigate the issue.

Availability of Food

Fulmars forage over vast areas of ocean on prey that are taken in very small amounts by the groundfish fisheries and which do not appear to be affected on an ecosystem level by the groundfish harvest (see Forage Fish and Ecosystem Sections, 4.5.4 and 4.5.10). Both PA.1 and PA.2 would continue to ban directed fishing on forage fish species and size classes and would develop ecosystem indicators for use in the TAC-setting process that would be intended to minimize potential adverse effects on non-target species. Fulmars are therefore unlikely to be affected by any potential localized disturbance or depletion of prey from the fishery as managed under either PA bookend. Both PA.1 and PA.2 are considered to have insignificant effects on fulmars through availability of food.

Benthic Habitat

Fulmars are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of fishery management under either PA bookend. Both PA.1 and PA.2 are considered to have no effects on fulmars through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on northern fulmars are described in Section 3.7.5 (Table 3.7-13) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-55 and summarized below.

Mortality

- **Direct/Indirect Effects.** Under the PA.1 and PA.2, the new seabird protection measures for the longline fleet would be adopted and potential mitigation measures for the trawl fleet would be developed. These measures are expected to substantially reduce incidental take of fulmars below the baseline level of incidental take such that mortality from incidental take would be considered insignificant at the population level.

- **Persistent Past Effects.** For northern fulmars, past mortality factors include large contributions from the BSAI/GOA groundfish fisheries and other net and longline fisheries in the North Pacific and Bering Sea. There is no indication of an area-wide population decline, but there is some concern that particular colonies may be experiencing declines. Other potential mortality factors that have been identified include acute and chronic effects of pollution, underestimated mortality in all fisheries, and higher than normal rates of natural mortality (i.e. starvation) due to climatic and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Incidental take of fulmars is expected to continue in all offshore fisheries in the BSAI/GOA. The IPHC fisheries will be subject to new seabird avoidance measures, so incidental take from the halibut and sablefish fleet is expected to decline substantially. Future oil spills and other incidents of pollution are likely, but their effects on fulmars will depend on many factors that can not be predicted.

- **Cumulative Effects.** Since the regional population of northern fulmars appears to be stable and the primary human-caused mortality factors, including contributions from the groundfish fisheries under PA.1 and PA.2, are expected to decline in the future, the cumulative effects on fulmars are considered to be insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch under both PA.1 and PA.2. This effect is considered insignificant at the population level for northern fulmars. While groundfish vessels contribute to overall marine pollution through accidental spills and vessel accidents, the effects of this pollution on fulmar prey populations can not be assessed at this time.

- **Persistent Past Effects.** Fulmars prey on squid and small schooling fishes that have been targeted by fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be minimal compared to climate and oceanographic factors. Since fulmars can forage over huge areas, they are unlikely to have been affected by localized disturbance or depletion of their prey fields caused by fisheries. Pollution from a variety of land and marine sources has potentially affected fulmar prey in the past. However, very little is known about the specific toxicological effects on species important to fulmars or what sources of pollution may be the most important.

- **Reasonably Foreseeable Future External Effects.** There are no foreseeable fisheries that will likely have more than a negligible effect on fulmar prey availability. Pollution is likely to affect fulmar prey in the future, but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey to fulmars, cannot be made at this time.

- **Cumulative Effects.** The cumulative effect of all fisheries on the abundance and distribution of fulmar prey is considered to be insignificant at the population level.

Benthic Habitat

Since fulmars feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernible effect on their prey. Therefore, no cumulative effect is identified for this species.

4.9.7.5 Species of Management Concern (Red-Legged Kittiwakes, Marbled and Kittlitz's Murrelets)

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

The population of red-legged kittiwakes is estimated at around 150,000 birds, almost 80 percent of which nest on St. George Island in the Pribilofs. The combination of their restricted breeding area and substantial declines on permanent census plots led to their classification as a USFWS species of management concern. Red-legged kittiwakes have a separate species code in the Observer Program data on incidental take and may also be reported under the "gull" category and potentially under "unidentified seabirds" (Tables 3.7-1 through 3.7-5). Between 1993 and 2000, no specified red-legged kittiwakes were recorded as taken in any of the BSAI and GOA groundfish fisheries. One red-legged kittiwake was observed to be taken in a BSAI longline fishery in 2002, yielding an estimated 1-14 birds taken by the fleet. One red-legged kittiwake was found in an observer sample in a Bering Sea trawl in 2001 and one in 2002 (NPFMC 2003b). Because of different numbers and proportions of sampled hauls, these observed takes yielded estimated takes for the trawl fleet of 1- 37 birds in 2001 and 9-124 birds in 2002.

The new seabird avoidance measures for the longline fleet are expected to substantially reduce the incidental take of surface-feeding seabirds under PA.1. Since the incidental take of red-legged kittiwakes on longlines is apparently already very rare, a reduced level of take would be considered insignificant at the population level. Incidental take in trawl gear is also apparently rare and may or may not be reduced by potential mitigation measures that would be developed for the trawl fleet under PA.1 and PA.2. Since very few red-legged kittiwakes are likely to be taken in the groundfish fisheries under PA.1 and PA.2, the effect of this mortality is considered insignificant on the population-level.

Marbled and Kittlitz's murrelets are species of management concern in Alaska due to recent dramatic declines in their numbers in core habitats in southeast Alaska. Both of these species have separate species codes in the Observer Program data and may also be reported under the "alcids" and perhaps the "unidentified seabird" groups. No marbled or Kittlitz's murrelets have been specifically reported taken in the observed groundfish fisheries between 1993 and 2001 (Tables 3.7-1 through 3.7-5). Given their nearshore preferences and non-gregarious behavior, it is unlikely that murrelets are taken regularly in any of the BSAI/GOA groundfish fisheries. Since alcids are taken so infrequently on longlines, seabird avoidance measures for longlines would likely not affect the incidental take of murrelets. Incidental take in trawl gear, if it occurs at all, may or may not be reduced by potential mitigation measures that would be developed for the trawl fleet under PA.1 and PA.2. Since the expected incidental take of marbled and Kittlitz's murrelets approaches zero under the PA, this source of mortality is considered insignificant at the population level for both species.

Availability of Food

Red-legged kittiwakes consume several species of small schooling fish as well as zooplankton. Given the wide variety of foods used by red-legged kittiwakes and the extensive areas over which they forage, it seems unlikely that they would be susceptible to localized depletion of prey during the non-breeding season. During the breeding season, kittiwakes are more limited in their options and are more susceptible to localized depletions of prey around their colonies. They would be especially susceptible to prey depletions around the Pribilof Islands, where 80 percent of the population breeds. However, the species and size classes of forage fish and zooplankton that red-legged kittiwakes consume are taken only in negligible amounts as bycatch in the groundfish fisheries and the ban on directed fisheries on forage fish would remain in place under both PA.1 and PA.2. The abundance and distribution of kittiwake prey are not expected to be affected on an ecosystem level by the groundfish harvest under either PA.1 or PA.2 (see Forage Fish and Ecosystem Sections 4.9.4 and 4.9.10). PA.1 and PA.2 are therefore considered to have insignificant effects on the availability of food for red-legged kittiwakes.

Marbled and Kittlitz's murrelets forage in shallow waters within 5 kilometers (km) of shore and feed on small fish such as capelin and Pacific sandlance as well as zooplankton and other invertebrates. The groundfish fisheries have very little spatial overlap with murrelet foraging areas and, as described above for kittiwakes, are expected to have insignificant effects on the abundance and distribution of their prey species. The overall effect of PA.1 and PA.2 on the availability of food for these species is considered insignificant at the population level.

Benthic Habitat

Red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of groundfish fishery management. Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles. However, benthic habitats in their nearshore foraging areas would not be affected directly by groundfish trawls under PA.1 and PA.2 as these would take place further offshore. Both PA.1 and PA.2 are considered to have insignificant effects on marbled and Kittlitz's murrelets and no effects on red-legged kittiwakes through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on red-legged kittiwakes, marbled murrelets, and Kittlitz's murrelets are described in Sections 3.7.13 and 3.7.17 (Tables 3.7-22 and 3.7-26), and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The cumulative effects for these species would be dominated by factors external to the groundfish fisheries and would be the same as those described in Section 4.5.7.5 (Table 4.5-56) and summarized below.

<u>Mortality</u>

- **Direct/Indirect Effects.** Under both PA.1 and PA.2, the incidental take of red-legged kittiwakes and both murrelets is expected to be rare and insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging (red-legged kittiwakes), incidental take in coastal salmon gillnet and other net fisheries (murrelets), oil spills (murrelets), logging of nest trees (marbled murrelets), and climatic warming that reduces glacial habitat (Kittlitz's murrelet). Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed very little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. For red-legged kittiwakes, the introduction of nest predators or a large oil spill around the Pribilof Islands in nesting season could have significant effects on mortality. For the murrelet species, oil spills in nearshore habitats and incidental take in salmon and other coastal net fisheries are likely to remain the largest factors in the future. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality. If the Kittlitz's murrelet population continues to decline and the species is listed under the ESA, new regulations may be placed on the various nearshore net fisheries to monitor and reduce incidental take of the species. These measures would also benefit marbled murrelets.

- **Cumulative Effects.** The three species in this group have all experienced substantial population declines in the recent past and are all susceptible to future human-caused mortality factors including potentially small contributions from the groundfish fishery. The decline of red-legged kittiwakes on the Pribilofs may have been reversed recently but it is not clear if their recovery will continue in the future. The cumulative effect for red-legged kittiwake is considered conditionally significant adverse at the population level through mortality. Both murrelet species continue to decline in their core areas and are thus considered to have significantly adverse cumulative effects at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and pelagic invertebrates as bycatch. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all three species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All three species prey on small schooling fishes, and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources, including the EVOS, has likely affected the prey of these species in the past. Since murrelets are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded murrelets from certain important foraging areas and contributed to their population declines.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** While the groundfish fisheries are considered to have an insignificant effect on prey availability on their own, the dynamic interaction of natural and human-caused events, including fisheries and pollution, on the availability of forage fish and invertebrate prey to seabirds is only beginning to be explored with directed research. The potential roles of changes in food availability to the observed population declines in these species are still under investigation. Since this dynamic could conceivably be adverse or beneficial depending on different circumstances, the cumulative effect on prey availability is considered to be unknown for these three species.

Benthic Habitat

Since red-legged kittiwakes are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of the groundfish fishery, no cumulative effect is identified for this species through benthic habitat.

Marbled and Kittlitz's murrelets feed on species that depend on benthic habitats for at least part of their life cycles, but they forage in shallow waters that are inshore of the groundfish fishery. Although a number of natural and anthropogenic factors may impact benthic habitat important to murrelet prey, fluctuations in prey abundance have not been implicated in the population declines of either species. The cumulative effects on both murrelet species through changes in benthic habitat, including a minimal contribution from the groundfish fisheries, are therefore considered insignificant.

4.9.7.6 Other Piscivorous Species (Most Alcids, Gulls, and Cormorants)

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

The incidental take of species considered in this piscivorous group is reported in the Observer Program data under the gull, alcid, and "other" categories, as well as an unknown number of the "unidentified seabird" category (Tables 3.7-1 through 3.7-5). The number of piscivores taken under the baseline condition of seabird protection measures can be estimated from the 1997-2001 data since these measures were implemented in 1997. The estimated number of gulls taken in this period averaged 3,268 birds per year in the BSAI longline sector, 147 birds per year on GOA longlines, and 274 birds per year (mean of low and high estimates) in the BSAI and GOA trawls, for an estimated average take of 3,689 birds per year in the groundfish fishery. Even if a large proportion of the unidentified seabirds are gulls, this level of mortality is considered insignificant at the population level given the combined estimated abundance (2.5 million birds) of the different gull species in the BSAI and GOA (Table 3.7-21).

For the alcids, mortality from the groundfish fishery comes almost entirely from the trawl sector and averaged 259 birds per year (mean of low and high estimates) in the BSAI/GOA trawls. Given the estimated abundance of large alcids in these waters (approaching 20 million, Table 3.7-21), this level of mortality is considered insignificant at the population level. The 3 cormorant species all live and feed in nearshore waters and would thus be unlikely to be taken in the groundfish fisheries. Incidental take of cormorants would be included in the "other" category, which approaches zero and is therefore considered an insignificant source of mortality at the population level.

Under PA.1, the new seabird protection measures for the longline fleet would be expected to result in a substantial overall reduction in take of surface-feeding species such as gulls. Under PA.2, additional research into weighted groundlines and other techniques would also likely reduce take of gulls. These species may also benefit from reduced take in the trawl sector due to potential mitigation measures for the trawl fleet under both PA.1 and PA.2. Trawl gear protection measures would have more potential to reduce incidental take of alcids than any modifications to longline techniques because alcids are taken mostly in trawl gear. Since the baseline level of incidental take from all gear types is already considered insignificant at the population level for gulls and alcids, reduced levels of take under PA.1 and PA.2 are expected to have insignificant effects on piscivorous species through incidental take.

Availability of Food

Foraging success by piscivorous seabirds depends not only on the biomass of forage stocks in their feeding areas, but also on the availability of these stocks to the birds. The availability of prey is affected by a number of oceanographic and biological factors (see Section 3.7.1) that may vary substantially over short time periods and distances. The question of whether the intensity and structure of the groundfish fishery under the baseline condition has adverse or beneficial effects on the availability of forage fish for seabirds has not been addressed through directed research. Many of the data gaps identified in Section 5.1.2.8 address this issue. Although there are very little empirical data on how a fishery might affect the availability of forage fish to seabirds, it is assumed that fishing (with trawl gear at least) could disrupt the movements and structure of forage fish schools such that they would be less available to seabirds, at least for a short period of time. Localized depletion or disruption of prey species around seabird colonies could be particularly detrimental during the chick-rearing period for breeding seabirds. However, most of the groundfish fisheries are conducted during the non-summer months, with minor overlap in the late spring and early fall months. In addition, many species can forage up to 40 km from their colonies during chick-rearing with a few species ranging to 100 km so any localized and short term disruptions of forage fish would have minimal effects at the population level. The species and size classes of forage fish (and zooplankton) that piscivorous seabirds feed on are taken only in negligible amounts as bycatch and incidental take by the groundfish fisheries. The groundfish harvest does not appear to be "fishing down the food web" or otherwise affecting seabird prey on an ecosystem level (see Ecosystem, Section 4.5.10). The existing ban on the development of a commercial forage fish fishery (BSAI/GOA FMP Amendments 36/39) is considered to be beneficial to seabirds by preventing a potentially adverse fishery from developing. This ban would be maintained under both PA.1 and PA.2.

The fisheries provide an artificial yet nutritious supplement to seabird diets in the form of processing waste and offal. No studies have been conducted in Alaska on whether this food source provides a significant benefit to the survival rate or reproductive success of any species on the population or colony level. It is likely that the value of this supplemental food varies over time and space, fluctuating with the availability of natural food supplies and seasonal nutritional needs. Whereas some birds may benefit from the food supply provided by offal and processing waste, such waste also acts as an attractant that may lead to increased incidental take in fishing gear. In addition, some species, such as the large gulls, tend to be more successful at competing for fish scraps at vessels and processors and may thus receive a greater nutritional boost than the smaller species. Since the large gulls are also nest predators of other species, especially kittiwakes and murres, the supplemental food from fishery wastes may be beneficial to some species and detrimental to others within this species group. Thus, this indirect effect of the fishery potentially has both beneficial and adverse effects on seabirds and the net benefit or liability is unknown. Under PA.1 and PA.2, the contribution of the fishery to the food supply of gulls in the form of fishery discards would be about the same as the baseline or reduced as a result of bycatch reduction and IR/IU measures.

Population trends and reproductive success rates of most piscivorous species in the BSAI/GOA are mixed, with some species and colonies doing well in some areas and years while the same species show declines and breeding failures in other locations and years (Dragoo *et al.* 2001). Although some species are susceptible to periodic die-offs due to starvation, natural fluctuations in ocean currents and climatic variables could account for many of these episodes. There is no evidence that populations of the piscivorous seabirds considered in this group have been experiencing consistent or area-wide declines in productivity. Since the structure and intensity of the fisheries under PA.1 and PA.2 would be similar or reduced in scope from existing conditions, the potential impact of the fisheries on piscivorous seabirds through prey availability would be similar to the baseline condition and would be considered to be insignificant at the population level for all piscivorous seabirds.

<u>Benthic Habitat</u>

Cormorants and alcids have diverse diets that include both small schooling fishes (capelin and sand lance) as well as demersal fish species and crustaceans. These birds are capable of diving from 40 m to over 100 m deep and are thus able to reach the ocean floor in many areas. Some species, such as cormorants and guillemots, usually forage in coastal waters during the breeding season, but other species forage well away from land. Bottom trawl gear has the greatest potential to indirectly affect these diving seabirds via physical changes to benthic habitat but pelagic trawls (to various extents), pot gear, and longline gear also contact the ocean floor. Trawling (and to a lesser extent other fishing gear disturbance) can reduce habitat complexity and productivity (NRC 2002). Specific effects of trawling on seabird prey species in the BSAI/GOA (through habitat change rather than by direct take) are poorly known (see Sections 3.6 and 5.1.2.7 on EFH for a discussion of research needed to address data gaps in benthic habitat changes due to trawling). However, none of the species in this group appear to have experienced consistent or widespread population declines so there is no indication that the carrying capacity of the environment has been decreased through changes to benthic habitat (or any other mechanism). Overall trawl effort in the BSAI/GOA relative to the baseline conditions is predicted to be similar under PA.1 and reduced under PA.2. The effects on piscivorous seabirds through potential changes in benthic habitat are therefore considered insignificant at the population level.

Cumulative Effects of PA.1 and PA.2

The past/present effects on the species in this group, including most alcids, gulls, and cormorants, are described in their species accounts in Section 3.7 (Tables 3.7-16 and 3.7-20) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-57 and summarized below.

<u>Mortality</u>

- **Direct/Indirect Effects.** Incidental take of surface-feeding piscivores is expected to decrease due to new seabird protection measures for the longline fleet. Incidental take of diving species may also be reduced if new mitigation measures are developed and implemented for the longline and trawl fleets under PA.2. The incidental take for all species in this group is expected to be insignificant at the population level under both PA.1 and PA.2.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence hunting and egging, incidental take in a variety of foreign and U.S. coastal and pelagic fisheries, oil spills and other pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e., rats) to seabird colonies. Conservation concerns focus on preventing potential impacts around breeding colonies during the nesting season since populations are concentrated in time and space. For some species, human impacts in nearshore habitats will likely have a much greater effect on their populations than offshore fisheries. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may also contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including potentially small contributions from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are considered insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch and incidental take. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** All species in this group prey on small schooling fishes and an assortment of invertebrates that have been targeted or taken as bycatch by external fisheries in various parts of their range. While these fisheries may have caused some localized depletions of prey, their effect on overall prey abundance is considered to be small compared to climate and oceanographic factors. Pollution from a variety of land and marine sources has likely affected the prey of these species in the past. Since some of the alcids are easily disturbed by marine vessels of all kinds, high concentrations of vessel traffic in some areas may have effectively excluded them from certain important foraging areas.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have an effect on prey availability for these species. Pollution is likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute to the dynamic interaction of natural and human-caused events that affect the availability of forage fish and invertebrate prey to seabirds. While this dynamic is only beginning to be explored with directed research, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new major contributing factors are expected in the future under PA.1 and PA.2, the cumulative effect on prey availability is considered insignificant at the population level for these species.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, have the potential to modify benthic habitats and have indirect effects on the food web of diving piscivorous species. The overall effects on piscivorous seabirds through potential changes in benthic habitat are considered insignificant.

- **Persistent Past Effects.** Benthic habitats important to the diving species in this group have been affected by various foreign and U.S. fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated, so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to seabirds. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may have persistent effects in certain areas.

- **Reasonably Foreseeable Future External Effects.** All future fisheries in the BSAI/GOA that use bottom contact fishing gear are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will continue.

- **Cumulative Effects.** The groundfish fisheries contribute to the many human-caused and natural factors that alter benthic habitats important to the food web of piscivorous seabirds. While there has been limited research on specific effects of benthic habitat disturbance on seabirds, the lack of substantial, consistent, or area-wide population declines in these species indicates that the baseline conditions do not have an overriding adverse effect on the natural fluctuations of these seabird populations. Since no new external contributing factors are expected in the future and the intensity of trawling is expected to remain the same under PA.1 and be reduced under PA.2, the cumulative effect on benthic habitat is considered insignificant at the population level for these species.

4.9.7.7 Other Planktivorous Species (Storm-Petrels and Most Auklets)

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

Leach's and fork-tailed storm-petrels are not identified to species in the Observer Program data but they do have an"unidentified storm-petrel" code and may be reported in the "unidentified tubenoses," "other," and "unidentified seabird" categories (Tables 3.7-1 through 3.7-5). The numbers of storm-petrels in these categories are unknown but likely to be small given their feeding behavior. Given the abundance of these species in the BSAI/GOA area, with a combined population estimate of over 10 million birds (Table 3.7-21), incidental take of storm-petrels under the baseline conditions is considered to be insignificant at the population level. Although some of the planktivorous auklets have individual species codes in the Observer Program data, they are reported in the "alcid" and "unidentified seabird" categories. It is unlikely that they are taken on longlines at all and probably constitute only a small fraction of the trawl take. Given their abundance in the BSAI/GOA, with a combined population of over 10 million birds (Table 3.7-21), incidental take of auklets under the baseline conditions is considered to be insignificant at the population level.

Under the PA.1 and PA.2, new seabird avoidance measures would be expected to reduce incidental take of surface-feeding and diving seabird species from both longlines and trawls. Since the incidental take of these species is considered to be insignificant under the baseline conditions, reduced levels of take would also be considered insignificant. The effects of both PA.1 and PA.2 on incidental take of planktivorous species are therefore considered to be insignificant at the population level.

Another means of incidental take in the fishery is by birds striking the vessel or rigging. The Observer Program does not record vessel strikes on a systematic basis so data on the frequency or extent of such strikes are very limited (NPFMC 2003b). Crested auklets do not seem to strike fishing vessels very frequently but when they do, the incidents often involve large numbers of birds. According to preliminary analysis of the observer records of bird-strikes from 1993-2000, 1,305 crested auklets were involved in 7 recorded collisions. In one historical account, approximately 6,000 crested auklets were attracted to lights and collided with a fishing vessel near Kodiak Island during the winter of 1977 (Dick and Donaldson 1978). Storm-petrels are also prone to periodic collisions involving many birds (631 birds in 19 recorded incidents). Bird strikes are probably most numerous during the night and during storms or foggy conditions when bright deck lights are on, which can cause the birds to be disoriented. Given the sporadic nature of these collisions and the small numbers of birds involved relative to their overall populations, the effect of the fisheries on these species through vessel collisions is considered insignificant at the population level under the baseline conditions. Since fishing effort under PA.1 and PA.2 would be similar to the baseline or reduced, the effect of PA.1 and PA.2 on incidental take from vessel collisions is considered insignificant.

Availability of Food

Storm-petrels are relatively small surface feeding seabirds that primarily target zooplankton and juvenile fish. The auklets feed on zooplankton (euphausiids), juvenile fish, and squid. The abundance and distribution of these prey species are affected by a number of oceanographic and biological factors (see Section 3.7.1) that may vary substantially over short time periods and distances. The groundfish fisheries could indirectly affect the availability of zooplankton and small schooling fish to seabirds through changes in the abundance and distribution of target fish species that also prey on small fish and zooplankton. For example, since young pollock are planktivores, large changes to pollock populations as a result of fishing could theoretically affect the carrying capacity for storm-petrels and auklets. However, zooplankton and juvenile fish abundance and distribution are thought to be influenced much more by primary productivity and oceanographic fluctuations (bottom-up factors) than predator/prey relationships (top-down factors) (see Section 4.5.10). Since the structure and intensity of the fisheries managed under PA.1 and PA.2 would be similar or reduced relative to the baseline, the effect of PA.1 and PA.2 on prey availability for planktivores is considered insignificant at the population level.

Benthic Habitat

Storm-petrels and auklets are not benthic feeders and are not expected to be affected by any changes in benthic habitat that might occur as a result of groundfish management. The PA.1 and PA.2 are considered to have no effects on these species through benthic habitat.

Cumulative Effects of PA.1 and PA.2

The past/present effects on the species in this group, including storm-petrels and most auklets, are described in Sections 3.7.7 and 3.7.18 (Tables 3.7-15 and 3.7-27) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-58 and summarized below.

Mortality

- **Direct/Indirect Effects.** Incidental take of the species in this group is expected to remain sporadic in occurrence and affect relatively few individuals and is considered to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include subsistence harvest, incidental take in foreign and U.S. coastal and pelagic fisheries, oil spills and other marine pollution, fox farming, and regime shifts that have caused episodes of mass starvation. Incidental take in the BSAI/GOA groundfish fisheries appears to have contributed relatively little to the mortality of these species.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future except for fox farming. A similar, though unintentional, effect is the possible introduction of nest predators (i.e., rats) to seabird colonies. The contribution from chronic sources of pollution, both from terrestrial and marine sources, may contribute to future mortality.

- **Cumulative Effects.** Although a number of past and future human-caused mortality factors, including small contributions of incidental take from the groundfish fishery, have been identified for the species in this group, none of them have experienced substantial, consistent, or area-wide population declines in the recent past. The cumulative effects for these species are considered insignificant at the population level through mortality.

Changes in Food Availability

- **Direct/Indirect Effects.** The groundfish fisheries would continue to take a small amount of forage fish and invertebrate prey as bycatch. Indirect effects on zooplankton and juvenile fish abundance through changes in the abundance of target fish predators is considered minor compared to seasonal changes in primary productivity and oceanographic factors. The effect of the fishery on the abundance and distribution of seabird prey species is considered insignificant at the population level for all species in this group. While groundfish vessels contribute to overall marine pollution and disturbance, the effects of vessel hazards on seabird prey populations can not be assessed at this time.

- **Persistent Past Effects.** Factors that have affected the abundance and distribution of zooplankton and juvenile fish include bycatch in squid and forage fish fisheries, marine pollution, and the decimation of planktivorous whales by commercial whaling. These effects are considered minor compared to seasonal and oceanographic fluctuations.

- **Reasonably Foreseeable Future External Effects.** Future squid and herring fisheries as well as other net fisheries that take forage fish as bycatch may have minimal effects on prey availability for these species. Pollution is likely to affect prey in the future but specific predictions on the nature and scope of the effects, especially as they relate to the availability of prey on a scale important to the birds, can not be made at this time.

- **Cumulative Effects.** The groundfish fisheries contribute in an indirect way to human influences on planktonic prey availability, and are considered minimal compared to natural fluctuations. These cumulative effects are considered insignificant on the population level for all species in this group.

Benthic Habitat

Since these planktivorous seabirds feed at the surface or with shallow dives and their prey live in the upper and middle levels of the water column, potential changes in benthic habitat from groundfish trawls or any other fishing gear would have no discernable effect on their prey. Therefore, no cumulative effect on benthic habitat is identified for these species.

4.9.7.8 Spectacled Eiders and Steller's Eiders

Direct/Indirect Effects of PA.1 and PA.2

Incidental Take

Spectacled eiders interact very little, if at all, with the groundfish fisheries because most of the habitat for this species is located in the northern Bering Sea or in inshore areas of northwest Alaska. There is therefore very little opportunity for the groundfish fisheries to affect spectacled eiders through mortality. Although spectacled eiders have an individual species code in the Observer Program manual, no spectacled eiders have been observed to be taken in any of the fisheries since data collection began in 1993. In the most recent ESA Section 7 consultation (USFWS 2003a, USFWS 2003b), the USFWS concluded that the groundfish fisheries had negligible impacts on the population recovery or critical habitat of spectacled eiders.

The winter distribution of Steller's eiders does include areas where groundfish fisheries occur although these birds prefer shallow, nearshore waters. There is some overlap between the fisheries and Steller's eider critical habitat in the northwestern portion of Kuskokwim Bay (Kuskokwim Shoals). Only two vessels fished this area in 2001, both over 200 ft LOA so there was 100 percent observer coverage. Steller's eiders have an individual species code in the Observer Program manual but no incidental takes have been documented since 1995 (Tables 3.7-1 through 3.7-5).

Under the PA.1 and PA.2, NOAA Fisheries would continue to consult with USFWS to protect all threatened or endangered species from potential adverse effects of the groundfish fishery. PA.1 and PA.2 are not expected to change the distribution of the groundfish fisheries to the point that they overlap with the distribution of spectacled eider habitat and are therefore considered to have no effects on spectacled eiders through incidental take. Incidental take of Steller's eiders in fishing gear already approaches zero under the baseline conditions so it is unlikely that new longline or trawl mitigation methods would yield substantial benefits for the species or be implemented on their behalf. The primary danger would appear to be the risk of collisions with all vessels, especially as birds are attracted to deck lights under poor visibility conditions. Minimizing the amount of light directed out to sea may help mitigate this risk. Based on the very minimal overlap between the predicted fisheries and Steller's eider, including only the Kuskokwim Shoals area, incidental take under the PA.1 and PA.2 will likely remain at levels approaching zero and is considered to have insignificant effects on the populations of this species through incidental take.

Availability of Food

The abundance of marine invertebrate species important to the spectacled and Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. The groundfish fisheries catch only negligible amounts of these species and are unlikely to affect their abundance or distribution through ecosystem level effects under the baseline conditions (see Section, 4.5.10). As discussed above, there is essentially no overlap between the groundfish trawl fisheries and spectacled eider habitat under the baseline conditions. PA.1 and PA.2 are not expected to change this situation and are considered to have no effects on spectacled eiders through prey availability. Under both PA.1 and PA.2, there would be very little overlap between the groundfish fisheries and foraging areas for Steller's eiders, so the direct take of eider prey through bycatch would be negligible. The effects of the groundfish fisheries on prey abundance and availability (through direct take rather than habitat disruption) are considered insignificant at the population level for this species.

Benthic Habitat

Gear impacts on benthic habitat used by spectacled and Steller's eiders would primarily be from bottom trawl gear although pelagic trawls and pot gear also make contact with the bottom and contribute to benthic disturbance. Trawling (and to a lesser extent other fishing gear disturbance) can reduce habitat complexity and productivity (NRC 2002). The effects of trawl gear on benthic habitat are discussed in the habitat sections of this document (Sections 3.6.4 and 4.5.6).

Based on an analysis of the Observer Program data, no overlap occurred between spectacled eider critical habitat and the groundfish fishery under the baseline conditions. As discussed above, there is essentially no overlap between the groundfish trawl fisheries and spectacled eider habitat under the baseline conditions. The PA.1 and PA.2 are not expected to change this situation and are considered to have no effects on spectacled eiders through benthic habitat changes.

Since Steller's eiders forage almost exclusively in shallow waters inshore of the groundfish fisheries, their preferred winter habitats are not subject to groundfish fishing effort. During the breeding season, the overlap of bottom trawl fisheries and Steller's eider critical habitat is also very limited, involving only a few vessels in a limited area of Kuskokwim Bay (NPFMC 2003b). The effects of this small bottom trawl fishery on Steller's eider critical habitat have not been investigated but considering the limited fishing effort and large area of critical habitat that is not fished, it is unlikely that the changes in benthic habitat resulting from this fishery would affect Steller's eiders on a population level. During Section 7 consultations with NOAA Fisheries, USFWS also concluded that the fisheries were not likely to adversely affect Steller's eider critical habitat or their food supply through bottom-contact fishing gear (USFWS 2003a). For Steller's eiders, trawl effort in their critical habitat is limited to Kuskokwim Shoals under the baseline conditions. The small amount of fishing in this area is limited by logistical considerations and lack of interest by the fleet. No changes in management under the PA.1 and PA.2 would lead to an increase use of this area or any other foraging area. Potential effects are likely to remain similar to the baseline condition, which are considered insignificant. The overall effect of the PA.1 and PA.2 on the benthic habitat of Steller's eider is considered to be insignificant at the population level.

Cumulative Effects of PA.1 and PA.2

The past/present effects on spectacled and Steller's eiders are described in Sections 3.7.9 and 3.7.10 (Tables 3.7-17 and 3.7-18) and the predicted direct and indirect effects of the groundfish fishery are described above (Table 4.9-4). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in a cumulative way. The effects considered in this analysis are listed in Table 4.5-59 and summarized below.

Mortality

- **Direct/Indirect Effects.** Incidental take of spectacled and Steller's eiders is expected to be similar to the baseline condition and is considered to be insignificant at the population level.

- **Persistent Past Effects.** Past sources of mortality that may continue to have an effect on these species include sport hunting and subsistence harvest in Russia and Alaska, incidental take in Russian and Alaskan coastal fisheries, oil spills and other marine pollution that causes physiological stress and reduces survival rates, lead shot poisoning on the nesting grounds, and collisions with vessels and other structures. Incidental take in the BSAI/GOA groundfish fisheries appears to have been very rare for Steller's eider. Both species have been afforded protection through the ESA.

- **Reasonably Foreseeable Future External Effects.** All of the mortality factors listed above in persistent past effects are likely to continue in the future. Conservation concerns focus on preventing potential impacts in critical habitat areas.

- **Cumulative Effects.** The groundfish fisheries do not contribute to direct mortality of spectacled eiders, so no cumulative effect is identified for that species. Decreased adult survival rates appear to have driven the past population decline of Steller's eiders. Known sources of direct human-caused mortality of Steller's eider, including very rare incidental take in the groundfish fisheries, do not appear to account for the past population decline in Alaska. However, several indirect factors may be contributing to decreased adult survival rates, including climate-induced changes in habitat, concentration of predators around nesting areas due to nearby human habitation, and pollution of nearshore waters from chronic and periodic sources of petroleum products (USFWS 2003a). Since the Alaska breeding population of Steller's eiders has declined dramatically in the past and has not recovered, and because several human-induced sources of mortality have been identified as potential contributing factors to this decline, including the potential for contributions to pollution and vessel collisions from the groundfish fisheries as managed under PA.1 or PA.2, the cumulative effects of mortality on Steller's eiders are considered significant adverse at the population level.

Changes in Food Availability

There is no overlap predicted between spectacled eider critical habitat and the groundfish fisheries; therefore, no cumulative effects have been identified under PA.1 or PA.2. The abundance of marine invertebrate species important to Steller's eiders, including bivalves, snails, crustaceans, and polychaete worms, could potentially be affected by disturbance to their benthic habitat. These effects will be discussed below. Although anthropogenic factors may affect eider prey in limited locations, including chronic sources of pollution near harbors, natural factors such as seasonal, tidal, and oceanographic fluctuations are considered to play a dominant role in determining the abundance and distribution of eider prey. The cumulative effects associated with the groundfish fisheries and other human activities are therefore considered to have insignificant effects on prey availability for Steller's eiders.

Benthic Habitat

- **Direct/Indirect Effects.** Bottom trawls, and to a lesser extent pelagic trawls and pot gear, disrupt benthic habitats that support the prey of eiders. Under PA.1 and PA.2, the groundfish fishery is not expected to occur in spectacled eider critical habitat or any other area that they typically use; therefore, no effects have been identified. A limited amount of bottom trawling is expected to overlap with Steller's eider critical habitat. The overall effects of PA.1 and PA.2 on Steller's eiders through potential changes in benthic habitat are considered insignificant at the population level.

- **Persistent Past Effects.** Benthic habitats important to spectacled and Steller's eiders have been affected by various trawl and pot fisheries for many years and include nearshore as well as offshore fisheries. The magnitude and longevity of the effects of these different types of fisheries have only begun to be investigated, so it is unclear what or where habitat effects are persistent, especially in regard to the indirect effects on prey species important to eiders. Natural sources of benthic habitat disruption, such as strong ocean currents, ice scouring, and foraging by gray whales and walrus, may have persistent effects in certain areas. Climate change and ocean temperature fluctuations may also play a role in altering the benthic environment.

- **Reasonably Foreseeable Future External Effects.** All future fisheries that use bottom contact fishing gear in areas used by eiders are likely to affect benthic habitat to some extent. Natural sources of benthic habitat disruption will also continue.

- **Cumulative Effects.** There is no overlap predicted between spectacled eider critical habitat and the groundfish fisheries; therefore, no cumulative effects on benthic habitat have been identified for this species. While the groundfish fisheries are predicted to have little spatial overlap with Steller's eider habitat under PA.1 or PA.2, the interaction of all human-caused and natural disturbances on benthic habitat important to Steller's eiders has not been examined with respect to their population declines in the past. The cumulative effects of benthic habitat disruptions and changes over the years as they relate to the food web important to Steller's eiders are considered to be unknown.

4.9.8 Marine Mammals Preferred Alternative Analysis

4.9.8.1 Western Distinct Population Segment of Steller Sea Lions

Direct/Indirect Effects PA.1 – Western Distinct Population Segment of Steller Sea Lions

<u>Incidental Take/Entanglement in Marine Debris</u>

The analysis used to determine changes in the level of incidental takes described in Section 4.5.8 was applied to establish the significance of incidental take and entanglement of marine mammals expected to occur under each FMP. Regarding incidental take, PA.1 is not likely to result in significant changes to the population trajectory of the western distinct population segment (western population) of Steller sea lions. An average of 8.4 Steller sea lions from the western population was estimated to have been taken incidental to groundfish fisheries from 1995-1999 (Angliss *et al.* 2001) (Table 4.5-60). The ratio of observed takes of Steller sea lions to observed groundfish catch (from 1995 to 1999) was multiplied by the new projected groundfish catch (all fisheries combined) to estimate incidental takes expected to occur over the next six years under this alternative management regime. The estimated annual incidental take level of Steller sea lions under PA.1 in all areas combined is expected to be less than ten based on expected catch in this FMP, or about one sea lion per 220,000 mt of groundfish harvested.

Incidental bycatch frequencies in the BSAI, which are typically low, reflect locations where fishing effort was highest. In the Aleutian Islands and GOA, incidental takes are often within critical habitat, though in the Bering Sea such bycatch is farther offshore and along the continental shelf. Otherwise there seems to be no apparent "hot spot" of incidental catch disproportionate with fishing effort. Therefore, it is appropriate to estimate the take ratios based on estimated catch. However, if these take rates differ between observed and unobserved vessels then these take estimates would be biased accordingly. These rates also reflect a prohibition of trawling within 10 or 20 nm of 37 rookeries which likely reduces the potential for incidental take, particularly during the breeding season when females are on feeding trips within the critical habitat area.

Entanglement of sea lions in derelict fishing gear or other marine debris does not appear to represent a significant threat to the population. From a sample of rookeries and haul-out sites in the Aleutian Islands in which 15,957 adults were observed, Loughlin *et al.* (1986) found only 11 (0.07percent) entangled in marine debris, sone of which was derelict fishing gear. Observations of sea lions at Marmot Island for several months during the same year observed two out of 2,200 adults (0.09 percent) entangled in marine debris. Between 1993 and 1997, only one fishery-related stranding was reported from the range of the western populations: a sea lion observed in August 1997 with troll gear in its mouth and down its throat (Angliss *et al.*2001). Entanglement of sea lions in derelict fishing gear or other marine debris does not appear to present a significant threat to the populations. In conclusion, incidental take and entanglement in marine debris under PA.1 is insignificant according to the criteria set for significance (Table 4.1-6).

The Marine Mammals Protection Act (MMPA) requires NOAA Fisheries (NMFS Office of Protected Resources) to assess whether human-caused mortality threatens the stability or recovery on any species of marine mammal. The MMPA defines a measurement tool fo this purpose, the potential biological removal (PBR), that is a calculated value of the maximum number of animals, not including natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population. This calculation takes into consideration the most recent population estimates, historic population trends, status of the stock in relation to historic levels (i.e., whether it is depressed or not), and potential rates of recovery. According to the most recent stock assessment, PBR for the western population of Steller sea lions is 208 animals per year (Angliss and Lodge 2002). Mortality from incidental take an entanglement in marine debris is likely to continue under PA.1 at levels that are small (less than 10 percent) relative to PBR and is therefore considered insignificant according to the criteria set for significance (Table 4.1-6).

Fisheries Harvest of Prey Species

Changes in the fishing mortality rate for Steller sea lion prey species were calculated using output from the Multi-species Management Model which projected catch rates for the various FMPs. The estimated fishing mortality rates expected to occur under each FMP management regime were compared to the baseline fishing mortality rate in order to apply the significance criteria established in Table 4.1-6 for determining the effects on marine mammal populations. The baseline fishing mortality rates for the individual BSAI and GOA groundfish fisheries, the fishing mortality rates projected to occur under each alternative FMP, and the relative difference between the baseline and alternative fishing mortality rates are shown in Table 4.5-61.

Under PA.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 23 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals, the change in harvest of this key Steller sea lion prey species is considered significantly adverse. It is worth noting that the harvest rate of pollock in the EBS was abnormally low in 2002. This low harvest rate was due to the high abundance or commercially sized pollock in the EBS which resulted in a large recommended ABC for this population, By definition ABC is set annually at a level deemed to be biologically acceptable based on the status and dynamics of the population, environmental conditions, and other ecological factors (e.g., natural mortality). The baseline groundfish FMPs contain catch provisions referred to as OYs that limit the total amount of BSAI and GOA groundfish harvest. Unlike the ABC, which is applied to individual species or species groups, the OY limit applies to the entire complex of commercially important species as well as other species with lesser or no commercial importance in each management region, In 1981, the OY for total BSAI groundfish catch was set as a range from 1.4 to 2.0 million mt. In 2002, the recommended ABC for pollock in the EBS was greater than the OY ceiling and was therefore capped to stay within the OY range. Because the 2002 EBS pollock TAC was capped by the OY ceiling, F was lower than that deemed to be biologically acceptable. Therefore, in relative terms, subsequent increases in F expected to occur under PA.1 for EBS pollock may not result in significantly adverse effects to predators in terms of the biomass of prey available, despite being categorized as such under the established significance criteria. The harvest of EBS pollock under the PA.1 management regime meets the criteria of a significantly adverse impact to Steller sea lions, although the actual effects are likely insignificant due to the low fishing mortality under the baseline.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 23 percent relative to the comparative baseline over the next five years under PA.1. This change in the fishing mortality rate is significantly beneficial for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline conditions. There is no change in the projected catch of Aleutian Islands pollock between the baseline and PA.1 and therefore effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level.

Under PA.1, the BSAI Pacific cod fishing mortality rate is expected to decrease by 19 percent. This change is determined to be insignificant to Steller sea lions according to the criteria established in Table 4.5-61. Under PA.1, the GOA Pacific cod fishing mortality rate is expected to increase by 19 percent which was determined to be insignificant to Steller sea lions. Changes in Aleutian Islands Atka mackerel harvest are expected to be significantly adverse to Steller sea lions with an expected increase in the fishing mortality rate of 60 percent relative to the baseline under PA.1.

Little difference is expected relative to the baseline and among the alternatives for the harvest of other and non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions.

The comparative baseline conditions include all Steller sea lion protection measures that were adopted in 2001 (NMFS 2001a). These measures would be retained under PA.1 and include provisions to protect prey resources such as area closures, critical habitat harvest limits on prey species, gear and TAC restrictions, and a modified global harvest control rule to prohibit fishing when spawning biomass per recruit is reduced to 20% of the unfished level. With these controls, the combined harvest of prey was found to not jeopardize the continued existence of the western populations of Steller sea lions (NMFS 2001a). While ratings for harvest of individual prey species range from significantly beneficial to significantly adverse, overall harvest levels under PA.1 would be similar to the 2002 baseline conditions and are thus considered insignificant to the western population of Steller sea lions.

Spatial and Temporal Concentration of the Fishery

The criterion used to evaluate the spatial and temporal effects of the groundfish fisheries on marine mammal populations is that the FMP would be expected to result in either increased or decreased spatial and temporal concentrations in key marine mammal foraging areas and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. The spatial/temporal measures under the baseline conditions were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions in their key foraging areas during periods that are believed to be critical to Steller sea lions. Opportunistic sightings of Steller sea lions (sightings reported ancillary to other activities; e.g., surveys for other species, fishing, or shipping) indicate that Steller sea lions occur in offshore areas where protective measures designed to reduce fishing and sea lion interactions have not been instituted (POP 1997). The potential for competitive interactions between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures, yet where sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as global controls. Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the western population of Steller sea lions in the wild. Spatial and temporal fishing measures in PA.1 do not deviate from the baseline; thus, the effects of the spatial/temporal concentration of the fisheries under PA.1 are determined to be insignificant to Steller sea lions according to the criteria established in Table 4.1-6.

Disturbance

With regard to disturbance, existing management measures are designed to reduce nearshore disturbance of Steller sea lions. In particular, the prohibition of vessel entry within 3 nm of major rookeries avoids intentional and unintentional hazing of hauled out sea lions or those aggregated near shore. A total of 3,250 square kilometer (km^2) around 36 sites is offered this protection.

It is not clear what might constitute adverse disturbance elsewhere, such as in pelagic foraging areas. Vessel traffic, nets moving through the water column, or underwater sound production may all represent perturbations, which could affect foraging behavior, but few data exist to determine their relevance to Steller sea lions. The influence of trawl activities on Steller sea lion foraging success can not be addressed directly with existing data. Foraging could potentially be affected not only by interactions between vessels and sea lions, but also as a function of changes in fish schooling behavior, distributions or densities in response to harvesting activities. In other words, disturbance to the prey base may be as relevant a consideration as disturbance to the predator itself.

For the purposes of this analysis, it is recognized that some level of prey disturbance may occur as a fisheries effect. The impact on marine mammals who prey on fish schools is a function of both the amount of fishing activity and its concentration in space and time, neither of which may be extreme enough under the status quo to represent population level concerns. To the extent that the baseline condition imposes limits on fishing activities inside critical habitat, it is assumed some protection from these disturbance effects is currently provided. These protections occur as byproducts of other actions that either reduce fishing effort or create buffer zones to limit impacts on foraging. With these measures in place, the baseline is consistent with the underlying goal of reducing disturbance effects.

Anecdotal evidence suggests that fisheries/disturbance related events are unlikely to be of consequence to the Steller's population as a whole. For instance, vessel traffic and underwater sound production have long been features of the Bering Sea and GOA, at least over much of the twentieth century. Such circumstances have prevailed before, as well as after the decline of Steller sea lions, suggesting no obvious causal link. Steller sea lions also appear to be tolerant of at least some anthropogenic effects, recognizing their attraction to fish processing facilities and gillnets as well as their distributions in proximity to ports. Further, the eastern population of Steller sea lions is increasing, despite anthropogenic activities throughout their range on the west coast of North America and particularly in southeast Alaska. The management regime under PA.1 is not expected to result in increased disturbance to Steller sea lions relative to the baseline and are therefore rated insignificant.

Cumulative Effects PA.1 – Western Distinct Population Segment of Steller Sea Lions

The past/present effects on the western population of the Steller sea lions are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects bring change in prey availability and change in the spatial and temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** The level of mortality resulting from incidental take and entanglement in marine debris under PA.1 occurs at frequencies that do not have population level effects on the western population of Steller sea lions and is therefore considered insignificant.

- **Persistent Past Effects**. Substantial mortality of Steller sea lions did not occur in the fisheries until after the 1950s. The take of Steller sea lions was substantial after this time with over 20,000 animals believed to have been incidentally killed in the foreign and JV groundfish fisheries from 1966 to 1988, although data from this period is not complete (Perez and Loughlin 1991). In the BSAI groundfish trawl fisheries, incidental take has declined from about 20 per year in the early 1990s to an average of 7.8 sea lions per year from 1996-2000. The number of Steller sea lions incidentally taken by state-managed nearshore salmon gillnet fisheries and halibut longline fisheries estimated 14.5 sea lions per year in the PWS drift gillnet fisheries (Wynne et al. 1992). It is thought that shooting used to be a significant source of mortality prior listing the Steller sea lion as endangered under the ESA. Two cases of illegal shooting were prosecuted in the Kodiak area in 1998 involving two Steller sea lions from the western population (Angliss et al. 2001). The subsistence harvest in western stock has decreased from over the last ten years from 547 to 171 animals per year (1992-1998) (Angliss and Lodge 2002). Commercial harvest of sea lions for hides and meat occurred prior to 1900 and likely depleted some local populations. Over a nine year period, 1963 to 1972, more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick et al. 1987). Predation by transient killer whales and sharks has always contributed to the natural mortality of Steller sea lions, but the numbers of sea lions taken and the relative contribution of this factor to the recent population decline and lack of recovery is currently under investigation (Matkin *et al.* 2001, Matkin *et al.* 2003, Springer *et al.* 2003).

- **Reasonably Foreseeable Future External Effects**. Incidental take in the state-managed fisheries such as salmon gillnet fisheries will continue in the foreseeable future, but the numbers of Steller sea lions will likely be relatively low (less than ten per year). Entanglement and intentional shootings would be expected to continue at a similar level to the baseline condition. Pollution is unlikely to be a significant contributor to western Steller sea lion mortality due to its isolation from population centers. Predation will continue to contribute to natural mortality, but climate change and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effects**. The cumulative effect of mortality based on the contribution of internal effects of the groundfish fishery under PA.1 and external mortality factors is considered significantly adverse for the western population of Steller sea lions. The western population of Steller sea lions has declined approximately 80 percent since the 1970s and was listed as endangered under the ESA in 1997. A number of human-caused mortality factors have been identified as potentially contributing to this decline and lack of recovery. According to current estimates, incidental take from the BSAI and GOA groundfish fisheries and other fisheries (29 individuals) and subsistence harvest (198 individuals), exceeds the PBR (208 individuals) for the western population of Steller sea lions (Angliss and Lodge 2002). In addition, natural mortality factors such as predation by transient killer whales and sharks, may be relatively more important for a depressed population and may be inhibiting the recovery of the Steller sea lion population. Since the population is still depressed from historic levels and has not recovered to the point that a recovery rate can be reliably calculate, and because overall human-caused mortality exceeds the PBR for this population, the cumulative effect of all mortality factors is considered significantly adverse for the western population of Steller sea lions. The contribution of the groundfish fisheries under PA.1 is expected to be small compared to total human-caused mortality and to be similar to the baseline level, which has been determined not to jeopardize the continued existence or recovery of the western population under the ESA (NMFS 2001a).

Prey Availability

- **Direct/Indirect Effects.** The harvest of Steller sea lion prey species by the groundfish fisheries under PA.1 is similar to the baseline condition and is expected to result in insignificant population-level effects to Steller sea lions.

- **Persistent Past Effects**. Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in State of Alaska waters, and partial overlap with other state-managed fisheries. These species were targeted in the past foreign and JV groundfish fisheries. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s and one hypothesis is that the combined fisheries, perhaps in conjunction with climate and oceanographic fluctuations, greatly reduced the availability of forage fish to Steller sea lions. NMFS has issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat, with most of the focus on the western population. The most recent Steller sea lion BiOp and EIS (NMFS 2001b and 2001c) explores this subject in great depth.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries such as salmon and herring are expected to continue in future years in a generally similar manner to the baseline conditions. New fisheries in State of Alaska or federal waters are not anticipated. Climate changes and regime shifts were identified as potential effects on the availability of prey, but the direction or magnitude of these changes are difficult to predict. Climate induced changes have been suspected in the decline of the western Steller sea lion population.

- **Cumulative Effects**. The cumulative effect on prey availability for Steller sea lions is based on direct, indirect, and external effects on prey and is considered conditionally significant adverse. This rating is based on the adverse effects on prey availability in the past from foreign, JV, and domestic groundfish fisheries, the state-managed salmon and herring fisheries, and indications that prey availability has been a key factor in the decline of the western population over the last several decades. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine with natural fluctuations to affect prey availability such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Spatial and Temporal Concentration of Fisheries

- **Direct/Indirect Effects.** The spatial and temporal concentration of the fisheries under PA.1 does not substantially deviate from the baseline condition. Thus, the effects of the spatial/temporal concentration of the fisheries under PA.1 are determined to be insignificant to Steller sea lions.

- **Persistent Past Effects**. Past foreign, JV, and domestic groundfish fisheries, as well as state-managed fisheries for salmon and herring have all attempted to maximize their catch per unit effort by concentrating their fishing at times and places where fish are most concentrated. There is substantial evidence that nutritional stress played an important role in the rapid decline of the western population of Steller sea lions during the late 1970s and 1980s and one hypothesis is that the combined fisheries caused localized depletion of forage fish. Past changes in the domestic groundfish harvest regulations have dispersed the fishing effort in time and space in order to minimize the potential for localized depletion of Steller sea lion prey. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of sea lion protective measures, which constitute the baseline condition.

- **Reasonably Foreseeable Future External Effects**. The only reasonably foreseeable future factors external to the groundfish fisheries that may affect the survivability and/or reproductive success of the western Steller sea lion population include the state-managed salmon and herring fisheries, which remove Steller sea lion prey during the spring and summer months. These fisheries are expected to continue to be managed in a manner similar to recent years. No new State of Alaska or federal fisheries are anticipated at this time.

- **Cumulative Effect**. The cumulative effect of the spatial/temporal harvest of prey is based on past and future effects of the groundfish fisheries and state-managed fisheries and is considered conditionally significant adverse. Although there are several hypotheses regarding the decline and lack of recovery of Steller sea lions, localized depletion of prey due to commercial fishing is a plausible mechanism for population level effects. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine to cause localized depletion of prey in key areas such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Disturbance

- **Direct/Indirect Effects**. Current federal groundfish fisheries disturbance to the western population of Steller sea lions is considered insignificant under the baseline condition. Since PA.1 retains the area closures contained under the baseline, disturbance levels under this PA.1 would also be considered insignificant at the population-level.

- **Persistent Past Effects**. Past sources of disturbance on the western population of Steller sea lions include foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Commercial harvests, intentional shootings, and subsistence harvests of Steller sea lions have also been identified as disturbance sources. General vessel traffic and disturbances to the prey field from gear have regularly occurred in the past.

- **Reasonably Foreseeable Future External Effects**. Future disturbance is expected at some level from state-managed salmon and herring fisheries, as well as general fishing and non-fishing vessel traffic in Steller Sea lion foraging areas. Subsistence harvest is identified as a continuing source of disturbance to Steller sea lions. The level of disturbance is expected to be similar to the baseline conditions.

- **Cumulative Effects**. The level of disturbance to Steller sea lions resulting from internal and external effects is expected to be similar to baseline conditions, and is rated as insignificant under PA.1.

Direct/Indirect Effects PA.2 – Western Distinct Population Segment of Steller Sea Lions

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under PA.1 for the western population of Steller sea lions and are considered insignificant.

Fisheries Harvest of Prey Species

Under PA.2, the fishing mortality rate of EBS pollock is expected to increase by an average of 28 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest of this key Steller sea lion prey species is considered to be significantly adverse (see the discussion under PA.1 regarding the aberrant fishing mortality rate in 2002, which served as the comparative baseline.) The harvest of EBS pollock under the PA.2 management regime meets the criteria of a significantly adverse impact to Steller sea lions, although the actual effect on Steller sea lions is likely not as significant in terms of the biomass of prey available, as discussed under PA.1.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 23 percent relative to the comparative baseline over the next five years under PA.2. This change in F is rated as significantly beneficial under the PA.2 scenario for Steller sea lions. Fishing mortality rates are not calculated for Aleutian Islands pollock as there was no directed Aleutian Islands pollock fishery under the baseline conditions. There is no change in the projected catch of Aleutian Islands pollock between the baseline and PA.2; therefore, the effects of Aleutian Islands pollock harvests are deemed to be insignificant to Steller sea lions at the population level for this FMP.

Under PA.2, the BSAI and GOA Pacific cod fishing mortality rates are expected to decrease by 11 percent and increase six percent, respectively, over the next five years. These respective changes are determined to be insignificant to Steller sea lions. Changes in Aleutian Islands Atka mackerel harvest are expected to be insignificant to Steller sea lions under the PA.2, with a projected increase in F of 15 percent relative to the baseline. Harvest of Aleutian Islands Atka mackerel under PA.2 would be insignificant to the western population of Steller sea lions.

Little difference is expected relative to the baseline and among the alternatives for harvest of other and non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions.

Under the comparative baseline conditions, the combined harvest of prey was found to not jeopardize the continued existence of the western populations of Steller sea lions (NMFS 2001a).While ratings for harvest of individual prey species range from significantly beneficial to significantly adverse, overall harvest levels under PA.2 would be somewhat reduced from the 2002 baseline conditions and are thus considered insignificant to the western population of Steller sea lions.

Spatial and Temporal Concentration of the Fishery

The criterion used to evaluate the spatial and temporal effects of the groundfish fisheries on marine mammal populations is that the FMP would be expected to result in either increased or decreased spatial and temporal concentrations in key marine mammal foraging areas, and periods such that prey resources are altered to the extent that population-level effects would be expected to occur. The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures, yet where Steller sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as global controls. Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the western population of Steller sea lions in the wild. The PA.2 alternative bookend offers opportunities for additional temporal and spatial protection by adjusting current protection measures as appropriate scientific information becomes available to avoid jeopardy to ESA-listed Steller sea lions. Future protective measures would be in addition to those that exist for Steller sea lion protection under the baseline conditions and have the potential to provide beneficial effects to Steller sea lions. However, because additional spatial and temporal measures may or not be adopted and would depend on future research, no specific measures have been added or repealed under PA.2 so the spatial and temporal concentration of the fishery is not expected to significantly change relative to the baseline. PA.2 is therefore rated as insignificant for this effect.

Disturbance

Effects do not deviate from those described under PA.1 and are considered insignificant.

Cumulative Effects PA.2 – Western Distinct Population Segment of Steller Sea Lions

The past/present effects on the western population of Steller sea lions are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under PA.2 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects being change in prey availability and change in the spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects.** With regard to incidental take and entanglement, PA.2 is likely to have insignificant effects on the population trajectory of the western population of Steller sea lions.

- **Persistent Past Effects**. Past sources of mortality are the same as discussed under PA.1.

- **Reasonably Foreseeable Future External Effects**. Reasonably foreseeable future sources of mortality are the same as discussed under PA.1.

- **Cumulative Effects**. The level of mortality resulting from the internal groundfish fisheries and external sources is expected to exceed the PBR for this population. Thus, the cumulative effects under PA.2 are rated as significantly adverse. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and is not considered to cause jeopardy under the ESA (NMFS 2001a).

Prey Availability

- **Direct/Indirect Effects.** Under PA.2, the federal groundfish harvest of Steller sea lion prey species is expected to be similar to the baseline condition and is rated as insignificant.

- **Persistent Past Effects**. Past effects are the same as discussed under PA.1.

- **Reasonably Foreseeable Future External Effects**. The reasonably foreseeable future effects are the same as discussed under PA.1.

- **Cumulative Effects**. Cumulative effects on the fishing mortality rate of prey species resulting from internal and external removals is considered conditionally significant adverse. This rating is conditional on whether future combined harvests of Steller sea lion prey are a key factor in the continued decline or lack of recovery of the western population of Steller sea lions.

Spatial and Temporal Effects of Harvest

- **Direct/Indirect Effects.** Under PA.2, the effects of the spatial/temporal concentration of the groundfish fisheries are determined to be similar to those under baseline conditions and are thus rated as insignificant.

- **Persistent Past Effects**. Persistent past effects are the same as those described under PA.1.

- **Reasonably Foreseeable Future External Effects**. Reasonably foreseeable future external effects are the same as described under PA.1.

- **Cumulative Effect**. The cumulative effect of the spatial/temporal harvest of prey is based on past and future effects of the groundfish fisheries and state-managed fisheries and is considered conditionally significant adverse. Although there are several hypotheses regarding the decline and lack of recovery of Steller sea lions, localized depletion of prey due to commercial fishing is a plausible mechanism for population level effects. This rating is conditional based on the uncertainty of whether future harvests from all fisheries will combine to cause localized depletion of prey in key areas such that the western population of the Steller sea lion continues to decline or is delayed in its recovery.

Disturbance

- **Direct/Indirect Effects**. The level of disturbance under PA.2 is expected to be similar to the baseline condition and is therefore considered insignificant.

- **Persistent Past Effects**. Past disturbance sources are the same as discussed under PA.1.

- **Reasonably Foreseeable Future External Effects**. The reasonably foreseeable future sources of disturbance are the same as discussed under PA.1.

- **Cumulative Effects**. The level of disturbance resulting from internal and external sources is expected to be similar to the baseline condition and is therefore considered insignificant.

4.9.8.2 Eastern Distinct Population Segment of Steller Sea Lions

Direct/Indirect Effects PA.1 – Eastern Distinct Population Segment of Steller Sea Lions

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, PA.1 is not likely to result in significant changes to the population trajectory of the eastern distinct population segment (eastern population) of Steller sea lions. No Steller sea lions from the eastern population were taken incidentally by groundfish fisheries from 1995-1999 (Angliss *et al.* 2001) (Table 4.5-60). In this context, incidental take refers to animals which are deceased or have injuries that are expected to result in death. Because no animals from the eastern population have been taken incidentally by groundfish fisheries, changes in catch resulting from PA.1 are not expected to result in an increase in the level of incidental takes.

Entanglement of Steller sea lions from the eastern population in derelict fishing gear or other materials seems to occur at frequencies that do not have significant effects on the population. Thus, incidental take and entanglement in marine debris under PA.1 is insignificant according to the significance criteria (Table 4.1-6).

Fisheries Harvest of Prey Species

BSAI groundfish fisheries are not likely to have large impacts on the prey availability of the eastern population of Steller sea lions, as there is little overlap with this population and fisheries which harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to affect the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock and Pacific cod under PA.1 are expected to decrease by 23 percent and increase by 19 percent, respectively, relative to the comparative baseline over the next five years. Changes in the fishing mortality rates expected to occur under PA.1 are significantly beneficial for GOA pollock and insignificant for Pacific cod harvests.

Little difference is expected relative to the baseline and among the alternatives for harvest of other, non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to Steller sea lions.

The combined harvest of prey species for the eastern population of Steller sea lion under PA.1 is expected to be similar or less than the baseline conditions and have insignificant population-level effects on the eastern population of Steller sea lions.

Spatial and Temporal Concentration of the Fishery

The groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the eastern population of Steller sea lions. The spatial and temporal concentration of the fishery under PA.1 is not expected to change significantly relative to the baseline and is therefore rated as having insignificant effects on Steller sea lions.

Disturbance

PA.1 retains the area closures contained under the baseline. The management regime under PA.1 is not expected to result in increased disturbance to Steller sea lions relative to the baseline. The effects of disturbance are rated insignificant under the PA.1 management scenario.

Cumulative Effects PA.1 – Eastern Distinct Population Segment of Steller Sea Lions

The past/present effects on the eastern population of the Steller sea lion are described in Section 3.8.1 (Table 3.8-1) and the predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects being change in prey availability and change in spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. With regard to incidental take and entanglement, PA.1 is not likely to result in significant changes to the population trajectory of the eastern population of Steller sea lions.

- **Persistent Past Effects.** It is thought that shooting used to be a significant source of mortality prior to listing the Steller sea lion as threatened on the ESA. NOAA Fisheries, Alaska Enforcement Division has successfully prosecuted two cases of illegal shooting involving four Steller sea lions from the eastern population (Angliss *et al.* 2001). It is not known to what extent illegal shooting continues in the eastern population, but stranding of Steller sea lions with bullet holes still occurs. Predator control programs associated with mariculture facilities in British Columbia accounts for a mean of 44 animals killed per year from the eastern population (Angliss *et al.* 2001). The subsistence harvest in the eastern population of the Steller sea lion is very small and consists of an average of two Steller sea lions taken per year from southeast Alaska (1992-1997) (Angliss and Lodge 2002). Commercial harvest of Steller sea lions for hides and meat occurred prior to 1900 and likely depleted local populations. Over a nine year period (1963 to 1972) more than 45,000 Steller sea lion pups were taken for commercial purposes (Merrick *et al.* 1987). The proportion of these from the eastern population are unknown. Steller sea lions are incidentally taken in low numbers by commercial fisheries other than groundfish fisheries, including some state-managed salmon drift and set gillnet fisheries and the salmon troll fishery in southeast Alaska (mean of 1.25 and 0.2, respectively) (Angliss *et al.* 2001). Small numbers of Steller sea lions from the eastern population are taken outside of southeast Alaska in groundfish fisheries (0.45 per year in Washington, Oregon, and California) and set gillnet fisheries in northern Washington State (0.2 per year) (Angliss *et al.* 2001). The PBR for this population is 1,396 and current human caused mortality is 45.5, substantially less than ten percent of the PBR.

- **Reasonably Foreseeable Future External Effects.** Incidental take in the state-managed fisheries such as salmon gillnet and troll fisheries will continue in the foreseeable future but the numbers of Steller sea lions will likely be relatively low (less than ten per year). Groundfish fisheries in Washington, Oregon and California and salmon set gillnets fisheries will continue to take small numbers from this population. Entanglement and intentional shootings would be expected to continue. Pollution is likely more of a factor for this population due to its closer association with population centers. Climate changes and regime shifts would not be expected to have direct effects on mortality of Steller sea lions.

- **Cumulative Effect.** The level of take resulting from internal effects of the groundfish fisheries and external mortality effects are expected to have a negligible impact on the eastern population of Steller sea lions. These combined effects are considered insignificant since the overall human-caused mortality does not approach the PBR for this population. Although this population is listed as threatened under the ESA, the population has been increasing over the last 20 years. The contribution of the groundfish fisheries is very small in comparison to the total human-caused mortality and is not determined to cause jeopardy under the ESA (NMFS 2001a).

<u>Effects of Prey Availability</u>

- **Direct/Indirect Effects.** The fishing mortality rate of Steller sea lion prey species under PA.1 is similar to baseline conditions and is not expected to result in population-level effects.

- **Persistent Past Effects**. Past effects on key prey species of Steller sea lions include harvest of species that are targeted or taken as bycatch by the GOA groundfish fisheries and parallel fisheries in State of Alaska waters, and partial overlap with other state-managed fisheries. These species were also targeted in the past foreign and JV groundfish fisheries. NOAA Fisheries issued a number of BiOps since 1991 that analyzed the key issue of whether the groundfish fisheries were contributing to the decline of sea lion populations or causing adverse impacts to their critical habitat, although most of the focus was on the western population. The most recent Steller sea lion BiOp and EIS (NMFS 2001b and 2001c) explores this subject in great depth.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries such as salmon and herring are expected to continue in future years in a generally similar manner to the baseline conditions. New fisheries in State of Alaska or federal waters are not anticipated. Climate changes or regime shifts were identified as potentially having adverse effects of availability of prey, but the direction or magnitude of these changes are difficult to predict. Climate induced change has been suspected in the decline of the western population Steller sea lion, but effects of climate change or regime shifts on the eastern population of the Steller sea lion are largely unknown.

- **Cumulative Effects**. The cumulative effects of prey availability on the eastern population of the Steller sea lion are considered to be insignificant at the population level. The eastern population of Steller sea lions has been increasing steadily over the last 20 years so prey availability is not considered to be limiting the recovery of the population.

<u>Spatial and Temporal Concentration of the Fishery</u>

- **Direct/Indirect Effects.** The spatial and temporal concentration of the fisheries under PA.1 is not expected to deviate from the baseline and is therefore determined to be insignificant to the eastern population of Steller sea lions.

- **Persistent Past Effects.** Past effects of spatial and temporal harvest of prey were identified for foreign, JV, federal and domestic groundfish fisheries and state-managed fisheries for salmon and herring. Past changes in the groundfish harvest have dispersed the fishing effort in time and space in order to minimize effects on Steller sea lions. Minimizing the competitive overlap between the fisheries and Steller sea lions is the primary focus of sea lion protective measures, which remain in effect under PA.1.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries such as salmon set and drift gillnet fisheries, salmon troll fisheries and herring fisheries are expected to continue in future years in a manner similar to the baseline conditions.

- **Cumulative Effects**. The cumulative effect of the spatial and temporal harvest of prey based on both internal effects of the groundfish fishery and external effects, such as the state-managed fisheries, is likely to remain similar to the baseline condition, which has occurred while the population has increased steadily, and is therefore considered insignificant for the eastern population of Steller sea lions.

<u>Disturbance</u>

- **Direct/Indirect Effects**. The disturbance levels on Steller sea lions under the PA.1 are expected to be similar to the baseline condition and are not expected to have a population-level effect. Therefore, PA.1 is considered insignificant. Protection measure around rookeries and haul-outs will continue under PA.1.

- **Persistent Past Effects.** Past disturbance was identified from foreign, JV, and federal domestic groundfish fisheries, and state-managed salmon and herring fisheries. General vessel traffic has also contributed to the disturbance level on this population. Intentional shooting has likely been a disturbance factor in past years.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries and vessel traffic will likely continue in the future at a level similar to the baseline conditions. Disturbance from subsistence harvest is not a issue for this population.

- **Cumulative Effects**. The cumulative effects on disturbance levels resulting from internal and external sources are expected to be similar to baseline conditions and are not likely to have a population-level effect. Therefore, disturbance under PA.1 is considered insignificant.

Direct/Indirect Effects PA.2 – Eastern Distinct Population Segment of Steller Sea Lions

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Fisheries Harvest of Prey Species

BSAI groundfish fisheries are not likely to have large impacts on the prey availability of the eastern population of Steller sea lions, as there is little overlap with this population and fisheries which harvest Steller sea lion prey species. Only fisheries in the GOA would be expected to affect the eastern population of Steller sea lions. Average fishing mortality rates of GOA pollock under PA.2 are expected to decrease 29 percent relative to the comparative baseline over the next five years. Average fishing mortality rates of GOA Pacific cod are expected to increase by six percent relative to the comparative baseline over the next five years. The changes in the fishing mortality rate expected to occur under PA.2 are significantly beneficial for GOA pollock and insignificant for Pacific cod harvests.

Little difference is expected relative to the baseline and among the alternatives for harvest of other and non-target species that are prey for Steller sea lions (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the FMP alternatives were determined to be insignificant to Steller sea lions. The combined harvest of Steller sea lion prey species under PA.2 is expected to result in insignificant population-level effects on the eastern population of the Steller sea lions.

Spatial and Temporal Concentration of the Fishery

The spatial and temporal measures in PA.2 were designed with the objective of reducing competitive interactions between groundfish fisheries and Steller sea lions. The potential for competitive interaction between groundfish fisheries and Steller sea lions exists in areas that are not managed with seasonal or spatial fishery closures, yet where sea lions are known to occur. Under the baseline conditions, such potential interactions are thought to be reduced by overall groundfish harvest limits, also referred to as global controls. Additionally, groundfish fisheries have been dispersed in time and space under the baseline conditions, such that the competitive interactions with Steller sea lions are thought to be mitigated to a level that is not expected to appreciably reduce the likelihood of survival and recovery of the eastern population of Steller sea lions in the wild. PA.2 offers opportunities for additional temporal and spatial protections which would offer increased protection in areas determined to be important for Steller sea lions. These protective measures would be in addition to those that exist for Steller sea lion protection under the baseline conditions and have the potential to provide beneficial effects to Steller sea lions. However, because additional spatial and temporal measures may or not be adopted and would depend on future research, no specific measures have been added or repealed under PA.2 so the spatial and temporal concentration of the fishery is not expected to significantly change relative to the baseline. PA.2 is therefore rated as insignificant for this effect.

Disturbance

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Cumulative Effects PA.2 – Eastern Distinct Population Segment of Steller Sea Lions

For the eastern population of the Steller sea lions, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

4.9.8.3 Northern Fur Seals

Direct/Indirect Effects PA.1 – Northern Fur Seals

Incidental Take/Entanglement in Marine Debris

The incidental take of northern fur seals is uncommon in the groundfish fisheries. The last recorded mortality in any Alaskan groundfish fishery occurred in 1996, when the take rate was one animal per 1,862,573 mt of groundfish harvested. Observer records from 1990 to 1999 indicate that direct interactions with groundfish vessels occurred only in the BSAI trawl fishery, despite observer placement in pot, longline and trawl fisheries in both the BSAI and GOA. In the BSAI trawl fishery, the average annual take rate (1995 to 1999) was 0.6. This level of take is inconsequential to population trends.

Northern fur seal entanglement in marine debris is more common than any other species of marine mammal in Alaskan waters (Laist 1987, 1997, Fowler 1987). Fowler (1987) concluded that mortality of northern fur seals from entanglement in marine debris contributed significantly to declining trends in the Pribilof Islands during mid to late 1970s and early 1980s. The contribution of intentional discard of net debris from Alaskan groundfish fisheries vessels is thought to have declined over the past decade. However, consistent numbers of seals entangled in packing bands on St. Paul Island may reflect disposal of these materials in proximity to the islands. Recent data from satellite-tracked drifters deployed in the Bering Sea suggests a "trapped" circulation pattern around the Pribilof Islands (Stabeno *et al.* 1999) which may retain marine debris in the nearshore environment. An increase in the number of Antarctic fur seals (*Arctocephalus gazella*) entangled in polypropylene packing bands was observed at Bird Island, South Georgia, in the late 1980s as these materials came into common usage by at-sea processing vessels (Croxall *et al.* 1990). Involuntary sources of marine debris, as in loss of gear, are diminishing as fishery cooperative systems develop (such as in the BSAI offshore pollock allocation). That is, as the pace of fisheries is slowed, there is less incentive to risk capital equipment. Data do not yet exist to assess the rates at which various gear types are lost or discarded to result in risk to fur seals, especially in regard to fishery or nation of origin. In consideration of progress in stemming the loss and discard of net fragments and other plastic debris by domestic commercial fisheries, the extent to which the current FMP could change the rate of fur seal entanglement in marine debris is considered to be low. There seem to be few options, given the likelihood that sources beyond the control of fisheries managers (i.e., foreign fisheries, international shipping, and shoreside refuse) constitute significant sources of discard. According to these factors and projected catch levels under PA.1, incidental takes and entanglements of northern fur seals are expected to occur incidental to groundfish fisheries at levels that are not expected to result in population-level effects. Increased harvest rates under this management alternative are not large enough for expected take levels to increase relative to the baseline. Therefore, this effect is rated insignificant under PA.1 as it is under baseline conditions.

Fisheries Harvest of Prey Species

The diet of northen fur seals includes a wide range of fish species, with less apparent dependence on Pacific cod and Atka mackerel compared to Steller sea lions. However, both adult and juvenile pollock occur in the diet of northern fur seals and consumption rates vary according to the abundance of different age classes of pollock in the foraging environment (Swartzman and Haar 1983, Sinclair *et al*. 1996). Because fur seals are opportunistic foragers, the presence of strong year-classes results in a disproportionately high percentage of that age class of pollock in the fur seal diet. Evaluation of the effects of harvest of prey species on northen fur seals, focuses less on removals of Pacific cod and Atka mackerel and more broadly on removals of pollock and small schooling fishes. Northen fur seals forage at shallow to mid-water depths of 0 to 820 ft (0-250 m), both near shore and in pelagic regions of their migratory range. Female and young male fur seals generally consume both juvenile and adult small-sized (2 to 8 inches) schooling fishes and squids although diet varies across oceanographic subregions along heir migration routes and around breeding location in the Pribilof Islands. In the eastern Bering Sea, primary prey species include pollock and pacific cod, but deep sea smelts, lanternfish, and squids are also major components. Studies based on scat analyses have indicated that the pollock and Pacific cod consumed by fur seals tend to be smaller than those selected by the target fisheries; however, data from stomach collections from the 1960s through the 1980s indicate that fur seals often consume adult pollock. Recent studies using bio-chemical methods to study the diet of northen fur seals suggest that the diet of deep diving fur seals in water over the continental shelf includes adult pollock (Kurle and Worthy 2000, Goebel 2002).

Under PA.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 23 percent relative to the comparative baseline. Assuming that adult pollock are a key prey species of the northern fur seal, this change in the harvest is rated significantly adverse according to the significance criteria for effects on marine mammals. However, the actual effect of this increased harvest rate, in terms of biomass available, is likely insignificant due to the abnormally low fishing mortality under the comparative baseline (see the discussion regarding the aberrant fishing mortality rate of EBS pollock in 2002 in Section 4.9.8.1.)

Catches of squid and small schooling fish (e.g., fish designated in the forage fish assemblage) in the groundfish fisheries of the BSAI and GOA are low, generally less than 1,000 mt per year. While precise biomass estimates for these groups do not exist, the exploitation rate on these groups in the groundfish fisheries is thought to be very low. For instance, squid biomass in the Bering Sea may be as large as 4 million mt, based on marine mammal food habits, daily ration, and abundance data (Sobolevsky 1996). Similarly, with respect to small schooling fishes, consumption of capelin in the GOA by arrowtooth flounder alone may be as large as 300,000 mt per year (Livingston 1994). Assuming that these crude projections of squid and capelin biomass at least approximate the order of magnitude of the true population levels, then the fisheries removals would amount to only a fraction of one percent of those populations. Fisheries for pollock and Pacific cod do not target fish younger than 3 years of age (Ianelli *et al.* 1999, Dorn *et al.* 1999, Thompson and Dorn 1999, Thompson and Zenger 1994, Fritz 1996). Catches of pollock smaller than 30 centimeters (cm) are small, and thought to be only 1 to 4 percent of the number of one- and two-year olds each year in the EBS and GOA (Fritz 1996).

While fisheries do harvest prey of northern fur seals (i.e., pollock and Pacific cod), the harvest rates of those species in the size range consumed by fur seals tend to be low. Furthermore, the fraction of the northern fur seal diet composed of those species is a smaller fraction of the overall diet as compared, for instance, to Steller sea lions. The overall harvest of northern fur seal prey species is likely to be similar to the baseline condition and is therefore determined to be insignificant under PA.1.

Spatial and Temporal Concentration of the Fishery

Spatial and temporal fishing measures in PA.1 do not deviate from the baseline, thus the effects of the spatial/temporal concentration of the fisheries under the PA.1 are determined to be insignificant to northern fur seals according to the criteria established in Table 4.1-6. However, effects to northern fur seals from spatial/temporal concentration of the fisheries under the strategy defined as the baseline for this environmental analysis were rated conditionally significant adverse in the Steller sea lion SEIS (NMFS 2001b). Therefore, while the spatial/temporal effects of PA.1 are insignificant relative to the baseline, the baseline has been described as having potential adverse effects on northern fur seals.

In recent years, fishing effort for pollock has increased in nearshore areas around the Pribilof Islands (NMFS 2003) where northern fur seals are known to forage. The greatest potential for temporal overlap between northern fur seals and the pollock fishery in the eastern Bering sea is July through November. Under the baseline, pollock fisheries were extended in order to slow the pace of the fishery and may now occur from June through October. This disperses the harvest over a longer time period than in previous seasons, thereby reducing temporal concentration of the fisheries. However, this change also extends the fisheries into the summer months when fur seals are concentrated near the Pribilof Island rookeries and may thus increase the likelihood of localized effects in foraging areas near the Pribilofs (NMFS 2001b). Seasonally, the highest bycatch of small pollock occurs during the summer (May-July) when spawning aggregations have dispersed and pollock are generally less segregated by size (Fritz 1996). Given the expected temporal dispersal of the fisheries under PA.1 and the steadily increasing biomass trends for pollock, the magnitude of harvest and bycatch of species/size classes important to fur seals during the breeding season is not expected to cause localized depletion of prey to the point that the fur seal population as a whole will be affected. Therefore, the spatial/temporal concentration of the fishery under PA.1 is determined to be insignificant to northern fur seals.

Disturbance

Disturbance from the baseline level of fishing activities has not been implicated as a potential cause for the population decline of northern fur seals. PA.1 is expected to produce similar levels of disturbance as the baseline which are unlikely to have population-level effects and are therefore considered insignificant according to the significance criteria established in Table 4.1-6.

Cumulative Effects PA.1 – Northern Fur Seals

A summary of the effects of the past/present with regards to the northern fur seal are presented in Section 3.8.2. (Table 3.8-2). The predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey an spatial and temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. Under PA.1, incidental take and entanglement is not expected to have a population-level effect and is rated as insignificant.

- **Persistent Past Effects**. Past effects of mortality on fur seal population include commercial harvest of young males up to 1985, harvest of females between 1956 and 1968, incidental take in the JV fisheries, foreign fisheries, and annual subsistence harvest on the Pribilof Islands. Commercial harvest of fur seals peaked in 1961 with over 126,000 animals, but was halted in 1985. The harvest of female fur seal on the Pribilof Islands, as many as 300,000 between 1956 and 1968, likely contributed to the decline of the population in the late 1970s and early 1980s (York and Kozloff 1987). This precipitous decline resulted in its depleted status under the MMPA. Entanglements may have contributed significantly to declining trends of the population during the late 1970's (Fowler 1987). Since the cessation of commercial harvest in 1985, fur seal number have steadily declined (NMFS 1993, Angliss and Lodge 2002). The contribution of the earlier harvest of fur seal to the subsequent decline is uncertain, since it has been nearly 20 years since commercial harvest was ended. Subsistence harvests have been one of the major contributors to fur seal mortality in recent years. From 1986 to 1996, the average annual subsistence take was 1,605 from St. Paul and St. George Islands. From 1995 to 2000 this average take dropped to 1,340 seals per year, which represents about 8 percent of the PBR for this species.

- **Reasonably Foreseeable Future External Effects**. These effects include incidental take from foreign fisheries outside the U.S. EEZ where fur seal are widely dispersed. State-managed fisheries take small numbers of fur seals, including the PWS drift gillnet fisheries, Alaska Peninsula and Aleutian Islands salmon gillnet fisheries, and the Bristol Bay salmon fisheries (Angliss *et al.* 2001). Subsistence will continue to be a major source of mortality in the future, but is limited to the Pribilof Islands. Levels of take are expected to be well below ten percent of the PBR for this species. Short-term and long-term climate changes are not considered a direct mortality factor for this species.

- **Cumulative Effects**. The cumulative effects of mortality resulting from internal and external effects are considered insignificant due to the large size of the fur seal population and the low levels of take, which are well below the PBR for this species. The contribution of the groundfish fisheries is very small and approaches zero.

Availability of Prey

- **Direct/Indirect Effects.** The effects of the groundfish fisheries under PA.1 include the removal of northern fur seal forage; however, the size of the fish removed is an important factor in determining whether competitive overlap with fisheries would occur. Overall, the harvest of northern fur seal prey species is rated as insignificant since the harvest rates of those species in the size range consumed by fur seals tend to be low.

- **Persistent Past Effects.** Effects of groundfish harvest in the past has likely occurred from overlap of prey species and fish targeted by the foreign and JV fisheries in the BSAI as well as the State of Alaska and federal fisheries. Climatic and oceanic fluctuations are suspected in past changes in the abundance and distribution of prey.

- **Reasonably Foreseeable Future External Effects**. Effects of fisheries on prey species harvest in the future are expected to include a small overlap in prey species with the state-managed fisheries in nearshore areas. Climate changes and regime shifts could influence prey species abundance and distribution. Climate effects are largely unknown, but could potentially have adverse effects on the availability of prey.

- **Cumulative Effects**. The cumulative effect of prey availability from both the internal contribution of the groundfish fisheries and external effects on prey such as other fisheries and possibly long-term climate change is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Spatial/Temporal Concentration of Harvest

- **Direct/Indirect Effects**. The effects of the spatial and temporal concentration of the fisheries under PA.1 are determined to be insignificant to northern fur seals as they do not deviate from the spatial and temporal measures under the baseline conditions.

- **Persistent Past Effects**. Effects of past fisheries on prey availability are primarily from the foreign and JV fisheries and the state and federal domestic fisheries in the BSAI. There has been concern with regard to displaced/increased fishing effort that is encroaching into nearshore areas of the Pribilof Islands resulting in increased overlap with fur seal foraging habitat. The proportion of the total June-October pollock catch in fur seal foraging habitat increased from an average of 40 percent in 1995-1998 to 69 percent in 1999-2000 (NMFS 2001b). There is a particular concern for the potential impact of this increased fishing pressure on lactating females from St. George Island where catch rates were consistently higher than in areas used by females from St. Paul (Robson *et al.* 2004).

- **Reasonably Foreseeable Future External Effects**. Effects of the spatial and temporal harvest of prey species is primarily from the foreign and federal domestic fisheries outside the EEZ due to the extensive range of the fur seal. State-managed fisheries have very limited overlap with fur seal prey. Climate change was identified as a potential factor in spatial and temporal effects on prey.

- **Cumulative Effects**. The cumulative effect of the spatial/temporal harvest of prey based on the presence of internal and external factors is considered conditionally significant adverse. This rating is based on the fact that the population declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established, and there is uncertainty regarding whether future fisheries harvests will contribute to the decreasing population trend, the potentially adverse cumulative effects on northern fur seal through this mechanism are considered conditional.

Disturbance

- **Direct/Indirect Effects.** Levels of disturbance are not expected to depart substantially from those which occurred to northern fur seals under the baseline conditions. Therefore, the effects of disturbance on northern fur seals are expected to be insignificant under PA.1.

- **Persistent Past Effects**. Persistent past effects on fur seal disturbance include commercial groundfish fisheries harvest by JV fisheries, foreign and federal domestic fisheries, and to a lesser extent, the subsistence harvest of fur seals on the Pribilof Islands. It is unknown whether these past activities have persisted to the present, but the ongoing fisheries continue to result in some level of disturbance to fur seals while they are in the BSAI region. Recent spatial and temporal measures associated with Steller sea lion protective measures have increased the overlap of fishing activity and northern fur seal foraging habitat (NMFS 2001b).

- **Reasonably Foreseeable Future External Effects**. Future disturbance effects on fur seals were identified as state-managed fisheries, general vessel traffic, and subsistence activities on the Pribilof Islands.

- **Cumulative Effects**. The cumulative effects of disturbance from internal and external factors are considered insignificant because there is little to indicate adverse effects occurring on the population level.

Direct/Indirect Effects PA.2 – Northern Fur Seal

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under PA.1 bookend and are considered insignificant.

Fisheries Harvest of Prey Species

Under PA.2, the fishing mortality rate of EBS pollock is expected to increase by an average of 34 percent relative to the comparative baseline. According to the significance criteria for effects on marine mammals the change in the harvest is rated significant assuming that adult pollock are a key northern fur seal prey species (see the discussion regarding the aberrant fishing mortality rate of EBS pollock in 2002 in Section 4.9.8.1).

While fisheries do harvest prey of northern fur seals (i.e., pollock and Pacific cod), the harvest rates of those species in the size range consumed by fur seals tend to be low. Furthermore, the fraction of the northern fur seal diet composed of those species is a smaller fraction of the overall diet as compared, for instance, to Steller sea lions. The overall harvest of northern fur seal prey species was rated insignificant under PA.2.

Spatial and Temporal Concentration of the Fishery

PA.2 includes provisions for future scientific research intended to help refine spatial/temporal protection measures that further reduce impacts of the fisheries on Steller sea lions. While past sea lion protection measures may have increased fishery impacts on northern fur seals by redirecting the fisheries into places and times that overlap with fur seal foraging habitat, PA.2 also includes a management objective to minimize impacts on non-ESA-listed species of marine mammals. Development of new spatial/temporal protection measures would therefore need to be a balance between protecting the interests of different species, including fur seals. Because additional spatial/temporal measures may or not be adopted and would depend on future research, no specific measures have been added or repealed under PA.2. For this analysis, it will be assumed that the spatial and temporal concentration of the fishery will be similar to the baseline or will be modified in such a way as to be relatively beneficial to prey fields of marine mammals in general. The spatial/temporal concentration of the fishery under PA.2 is therefore rated as having insignificant effects on northern fur seal.

Disturbance

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Cumulative Effects PA.2 – Northern Fur Seal

For northern fur seals, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

4.9.8.4 Harbor Seals

Direct/Indirect Effects PA.1 – Harbor Seals

Incidental Take/Entanglement in Marine Debris

According to projected catch levels, incidental takes and entanglements of harbor seals incidental to groundfish fisheries under PA.1 are not expected to result in population-level effects. Increased harvest rates under this management FMP may result in the increased take of one harbor seal relative to the baseline, for a total estimated average of less than five animals per year. This level of incidental take would not result in changes to the population trajectory for this species. Therefore, takes and entanglements of harbor seals incidental to groundfish fisheries are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The major prey of harbor seals in Alaskan waters include fish from the following families: Gadidae, Clupeidae, Cottidae, Pleuronectidae, Salmonidae, Osmeridae, Hexagrammidae, and Trichodontidae. Octopus and gonatid squid are also important. However, overlaps with commercial groundfish fisheries occur primarily with reference to pollock, Atka mackerel, and Pacific cod, which may constitute grounds for indirect interactions, particularly in the GOA and Aleutian Islands. However, the basis for concern is less pronounced than those noted for Steller sea lions, or even for northern fur seals, so that the overall effects are likely to be lower as well. Pollock, Atka mackerel, and Pacific cod constitute approximately 12, 9, and 8 percent, respectively, of harbor seal diet in the Aleutian Islands and Bering Sea (Perez 1990). In the GOA, pollock, octopus and capelin were reported by Pitcher and Calkins (1979) as the most important prey, while Pacific cod was less important and Atka mackerel were absent in the sample. Ashwell-Erickson and Elsner (1981) estimated that harbor seals and spotted seals combined consume approximately 81,600 mt of pollock per year, compared to current Bering Sea pollock biomass estimates (1998) of over 9 million mt. Pollock removals by fisheries are less than 10 percent of the biomass estimate, suggesting that in terms of volume, the unharvested fraction, under baseline conditions, is sufficient to satisfy harbor seal foraging needs.

Under PA.1, the fishing mortality rate of EBS pollock is expected to increase by an average of 23 percent relative to the comparative baseline. According to the significance criteria for the effects on marine mammals, the change in the harvest of this key harbor seal prey species is rated significant (see the discussion regarding the comparative baseline fishing mortality rate in Section 4.9.8.1.) The harvest of EBS pollock under the PA.1 management regime meets the criteria of a significantly adverse impact to harbor seals, but the actual effect in terms of biomass available is likely insignificant due to the unusually low fishing mortality under the baseline.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 23 percent under the PA.1 bookend relative to the comparative baseline over the next five years and rated insignificant at the population level for harbor seals. Under the PA.1, the BSAI Pacific cod fishing mortality rate is expected to decrease by 19 percent, which is determined to be insignificant to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest under the PA.1 bookend is expected to be significantly adverse to harbor seals with a 61 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other and non-target species that are prey for harbor seals (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various FMP alternatives were determined to be insignificant to harbor seals.

Although there is overlap in species/size classes taken by the groundfish fisheries and harbor seal prey, harbor seals also consume a large amount of other prey species. Overall, the combined harvest of harbor seal prey species under PA.1 is not expected to increase substantially from the baseline condition or to result in population-level effects and is therefore considered insignificant.

Spatial and Temporal Concentration of the Fishery

The effects of the spatial and temporal concentration of the fisheries under PA.1 are determined to be insignificant to harbor seals as they do not deviate from the spatial and temporal measures under the baseline conditions.

Disturbance

The potential for disturbance effects caused by vessel traffic, fishing gear, or noise appears limited for harbor seals. These animals are common in inshore waters subjected to considerable levels of anthropogenic disturbances, typical of ports and shipping lanes. Interactions with groundfish fishing gear, such as trawl nets, also appears limited, based on the rare incidence of takes in the groundfish fisheries. Finally, given the near shore distribution of harbor seals, their overlap with fishing activities is more limited than in the case of either Steller sea lions or northern fur seals. Disturbance of harbor seals under PA.1 is not expected to increase relative to the baseline and is rated insignificant.

Cumulative Effects PA.1 – Harbor Seals

A summary of the effects of the past/present with regards to the harbor seal are presented in Section 3.8.4 (Table 3.8-4). The predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance. Indirect effects include availability of prey and spatial and temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. Incidental take and entanglements of harbor seals expected to occur incidentally in the groundfish fisheries under PA.1 are not expected to result in a population-level effect and are considered insignificant.

- **Persistent Past Effect**. Residual effects on local populations from State of Alaska predator control programs (1950s to 1972) and commercial hunts (1963 to 1972) may still exist in some areas, although there are no data on these factors. Foreign and JV groundfish fisheries in the 1960s and 1970s have likely contributed to some level of direct harbor seal mortality from entanglement in gear, but based on the near shore distribution of harbor seals, there was likely minimal direct interaction and mortality. From 1990 to 1996, minimum estimates of harbor seals taken incidentally in groundfish gear in the Bering Sea were four per year and less than one per year in the GOA. In southeast Alaska, four harbors seals are estimated to be killed each year on longlines. Harvest of harbor seals for subsistence purposes is likely the highest cause of anthropogenic mortality for this species, since the cessation of commercial harvests in the early 1970s. Between 1992 and 1998, the state-wide subsistence harvest of harbor seals from all stocks ranged between 2,546 and 2,854 animals, the majority of which are taken in southeast Alaska (Wolfe and Hutchinson-Scarbrough 1999). Harvest of the Bering Sea stock of harbor seals is approximately 161 animals, 42 percent of PBR for this species. For the GOA stock, the subsistence harvest is at approximately 91 percent of the PBR for this stock. For the southeast stock, subsistence harvest is at approximately 83 percent of PBR.

- **Reasonably Foreseeable Future External Effects**. Incidental take of harbor seal in state-managed fisheries such as salmon set and drift gillnet fisheries would be expected to continue at the present low rate. Subsistence take is expected to continue to be the greatest source of human controlled mortality with a relatively high percentage of the PBR in both the GOA and southeast Alaska stock, with a lower take in the BSAI region. Climate changes are not likely factors in the direct mortality of harbor seal, although there would likely be indirect effects.

- **Cumulative Effects**. The combined effects of mortality resulting from internal effects and external sources are determined to be insignificant. The human-caused mortality for all harbor seals is below the PBR for each stock and, therefore, population-level effects are unlikely.

Availability of Prey

- **Direct/Indirect Effects**. The combined harvest of harbor seal prey species under PA.1 is not expected to result in a population-level effect and is considered insignificant.

- **Persistent Past Effects**. Availability of prey for harbor seal in the past has likely been adversely affected by foreign, JV, and federal domestic groundfish fisheries and state-managed salmon and herring fisheries since the fish targeted by these fisheries are prey of the harbor seal. Climates changes regime shifts could have possibly been factors in fluctuations of prey availability in the past.

- **Reasonably Foreseeable Future External Effects**. State-managed salmon and herring fisheries are identified as potential adverse effects on harbor seal prey availability. Climate change regime shifts will continue to be contributing factors, although the effects can be either beneficial or adverse, depending on the direction and magnitude of the change.

- **Cumulative Effects**. The combination of internal effects of the groundfish fisheries and other external fisheries on prey availability were determined to be conditionally significant adverse. This rating is based on the fact that the population has declined substantially in the past for unknown reasons and that decreased prey availability is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on prey availability has not been established, the potentially adverse cumulative effects on harbor seals through this mechanism are considered conditional.

Spatial and Temporal Concentration of the Fishery

- **Direct/Indirect Effects.** The effects of PA.1 on the reproductive success and survivability of harbor seals resulting from the spatial and temporal concentration of the fisheries are rated as insignificant.

- **Persistent Past Effects.** Effects on harvest concentration in the past has likely occurred due to overlap of harbor seal prey species and fish targeted in areas fished by the foreign and JV fisheries in the BSAI, as well as the State of Alaska and federal fisheries. Climatic and oceanic fluctuations are not considered to be factors in past changes.

- **Reasonably Foreseeable Future External Effects**. Future changes in the spatial/temporal harvest could cause competitive overlap in prey species with the state-managed fisheries in nearshore areas, such as salmon and herring. Since these fisheries generally occur in the nearshore areas in comparison to other groundfish fisheries, overlap is more pronounced than with the groundfish fisheries. Effects of climate changes regime shifts on prey species may affect prey abundance and distribution.

- **Cumulative Effects**. The cumulative effect of the spatial/temporal harvest of prey from internal effects of the groundfish fisheries and external effects of other fisheries is considered to be conditionally significant adverse, based primarily on past effects and contributions from state-managed fisheries. This rating is based on the fact that the population has declined substantially in the past for unknown reasons and that localized depletion of prey is a plausible mechanism that could have contributed to the decline. Since the causal link between the population decline and the cumulative effects of all past fisheries on localized depletion of prey has not been established, the potentially adverse cumulative effects on harbor seals through this mechanism are considered conditional.

Disturbance

- **Direct/Indirect Effects.** Disturbance levels under PA.1 are expected to be remain similar to the baseline condition and are rated as insignificant.

- **Persistent Past Effects**. Past disturbances on harbor seals include foreign, JV, and federal domestic groundfish fisheries, and to a lesser extent, the subsistence harvest of harbor seal. It is unknown whether these past effects have persisted into the present population, but the ongoing fisheries activities and subsistence continue to result in some level of disturbance to harbor seal.

- **Reasonablely Foreseeable Future External Effects**. State-managed fisheries, general vessel traffic and subsistence activities would be expected to continue to create some level of disturbance to harbor seal in the foreseeable future.

- **Cumulative Effects**. Cumulative effects were identified for disturbances resulting from internal sources and external factors such as other fisheries. Effects are expected to be similar to the baseline conditions and are considered insignificant.

Direct/Indirect Effects PA.2 – Harbor Seals

Incidental Take/Entanglement in Marine Debris

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Fisheries Harvest of Prey Species

Under PA.2, the fishing mortality rate of EBS pollock is expected to increase by an average of 23 percent relative to the comparative baseline. According to the significance criteria for the effects on marine mammals, the change in the harvest of this key harbor seal prey species is considered to be significant. The harvest of EBS pollock under the PA.2 management regime meets the criteria of a significantly adverse impact to harbor seals, but the actual effect is likely insignificant due the unusually low fishing mortality under the baseline.

The fishing mortality rate of GOA pollock is expected to decrease by an average of 29 percent under the PA.2 bookend relative to the comparative baseline over the next five years, which is determined to be significantly beneficial to harbor seals. Under PA.2, the BSAI Pacific cod fishing mortality rate is expected to increase by 11 percent, which is determined to be insignificant to harbor seals according to the criteria established in Table 4.1-6. Changes in Aleutian Islands Atka mackerel harvest under the PA.2 bookend is expected to be insignificant to harbor seals with a 15 percent increase in F relative to the baseline.

Little difference is expected relative to the baseline and among the alternatives for harvest of other and non-target species that are prey for harbor seals (e.g., cephlapods and forage fish such as capelin). Changes in the harvest of these species under the various alternatives were determined to be insignificant to harbor seals. Overall, the combined harvest of harbor seal prey species under PA.2 is expected to be similar to the baseline and to result in insignificant population-level effects.

Spatial and Temporal Concentration of the Fishery

The PA.2 bookend offers opportunities for additional temporal and spatial protections relative to the baseline condition and may be more precautionary in regards to prey availablity. Under PA.2, additional protection for Steller sea lions, such as fishing closures and areas closed under MPAs or no-take preserves, would potentially offer increased protection to harbor seal foraging areas. These protective measures would be in addition to those that exist for Steller sea lion protection under the baseline conditions, and have the potential to provide beneficial effects to harbor seals based on the assumption that they may result in improvements to the prey field. For this analysis, it will be assumed that the spatial and temporal concentration of the fishery will be similar to the baseline or will be modified in such a way as to be relatively beneficial to marine mammals in general. PA.2 is therefore rated as insignificant for this effect.

Disturbance

Effects do not deviate from those described under the PA.1 bookend and are considered insignificant.

Cumulative Effects PA.2 – Harbor Seals

For harbor seals, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

4.9.8.5 Other Pinnipeds

Direct/Indirect Effects PA.1 – Other Pinnipeds

Incidental Take/Entanglement in Marine Debris

The incidental take rates in commercial fisheries for ice seals, walrus and northern elephant seals are very low. Mean annual mortality of all ice seals combined from 1995 - 1999 was estimated to be 1.8 animals based on NMFS observers on board BSAI groundfish trawl, longline, and pot fishing vessels (Angliss *et al.* 2001) (Table 4.5-60). These rates constitute levels approaching zero according to NMFS standards (Angliss *et al.* 2001) and are not expected to affect the population trajectories of the species included in this category. The take rate walrus and elephant seal qualifies as an insignificant level, approaching zero by NMFS standards (Forney *et al.* 2000) and is not expected to affect population trajectory of these species. Entanglement in marine debris is likewise rare for these species and is considered to have insignificant effects. Of the Federally-managed fisheries in Alaska, only the EBS and Aleutian Islands pollock fishery would be likely to have an impact on ice seals and walrus, because of their northern distribution in the Bering Sea. Because of their distribution in Alaska in the GOA and south of the Aleutian Islands (Stewart and DeLong 1994, LeBoeuf *et al.* 2000), northern elephant seals would be likely to be affected only by the GOA and Aleutian Islands pollock and cod fisheries. Due to the low level of documented interactions between other pinnipeds and the groundfish fisheries, incidental takes and entanglements of other pinnipeds occurring in the groundfish fisheries under PA.1 are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

With the exception of spotted seals, the food habits of the ice seals do not overlap with commercial fisheries targets. Bearded seals consume primarily benthic prey including crabs and clams as well as shrimps and Arctic cod (Kosygin 1966, 1971, Lowry *et al.* 1981a, 1981b). Ringed seals eat Arctic cod, saffron cod, smelt, herring, shrimps, amphipods and euphausiids (Fedoseev 1984, Johnson *et al.* 1966, Lowry *et al.* 1980, McLaren 1958). Ribbon seal diet has been characterized as intermediate between ringed and bearded seals (Shustov 1965). Spotted seals include pollock in their diet when feeding in the central Bering Sea (Bukhtiyarov *et al.* 1984), but their use of that resource in the EBS and Aleutian Islands is unknown. Spotted seal diet in Bristol Bay, the Priblof Islands and the eastern Aleutian Islands is likewise unknown, but if similar to harbor seals in those areas, it is likely to be diverse and may include a small percentage of commercially important species. Fishery harvests of ice seal prey species are expected to be minimal under PA.1 and are therefore determined to be insignificant.

The Pacific walrus diet is composed almost exclusively of benthic invertebrates (97 percent), particularly bivalve molluscs. Fish ingestion has been considered incidental to their normal feeding behavior (Fay and Stoker 1982). Therefore, groundfish removals would have an insignificant effect on walrus prey abundance.

The diet of northern elephant seals in the GOA is unknown; however, this species is known to be a deep diver. This behavior suggests that their foraging may be partitioned by depth from most groundfish fishing activities. The effects of groundfish harvests under PA.1 on prey species for northern elephant seals is determined to be unknown.

Spatial and Temporal Concentration of the Fishery

Due to the limited potential for competitive overlap to occur between other pinnipeds and the groundfish fisheries, the spatial and temporal concentrations of the fisheries are expected to have insignificant effects on species in this category under PA.1.

Disturbance

Disturbance of other pinnipeds under the PA.1 management regime is not expected to change relative to the baseline, which is considered of negligible effect, and is rated as insignificant.

Cumulative Effects PA.1 – Other Pinnipeds

A summary of the effects of the past/present with regards to other pinnipeds are presented in Section 3.8.3 and Section 3.8.5 through Section 3.8.9 (Tables 3.8-3, 3.8-5 through 3.8-9). The predicted direct/indirect effects and cumulative effects under PA.1 are described in Table 4.9-5.

Mortality

- **Direct/Indirect Effects**. Population-level effects are not expected to result from incidental take and entanglement for any of the species in this group under the PA.1. Therefore, PA.1 is rated as insignificant for the mortality of other pinnipeds.

- **Persistent Past Effects**. Past external effects on the populations of other pinnipeds includes low levels of incidental take in the foreign, JV, and domestic groundfish fisheries and low levels of take in the state-managed fisheries (see Sections 3.8.3, and 3.8.5 through 3.8.9). Subsistence is the major human-caused external factor for mortality. Subsistence annual harvest rates include 5,265 spotted seal, 6,788 bearded seal, 100 ribbon seal, 9,567 ringed seal, 1,000 walrus, and zero elephant seal.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries will likely continue to take very small numbers of seals in this group. Subsistence take of these marine mammals will likely continue at a similar rate to the baseline conditions.

- **Cumulative Effect**. The combined effects of mortality within the other pinniped group resulting from internal effects of the groundfish fisheries and external effects, such as subsistence harvest, are considered insignificant. For spotted, ringed, bearded, and ribbon seals, PBRs cannot be calculated. Walrus take is below PBR and population level effects are unlikely. Elephant seal populations are expanding so overall mortality is considered insignificant. Contributions of the groundfish fisheries to overall mortality is very small.

Abundance of Prey

- **Direct/Indirect Effects.** Except for elephant seals, where the amount of prey overlap is unknown, there is very little overlap of species taken in the groundfish fisheries with prey of the pinnipeds in this group and the effects of fisheries harvest on prey species are determined to be insignificant under PA.1.

- **Persistent Past Effects**. Past effect on spotted seal include foreign, JV, and domestic groundfish fisheries and state-managed fisheries for salmon and herring. For the other ice seals, elephant seals and walrus, no persistent past effects were identified due to the lack of overlap with the groundfish fisheries.

- **Reasonably Foreseeable Future External Effects**. Future effects were identified for state-managed fisheries for the spotted seal. Climate changes may be either beneficial or adverse factors for ice seals due to the potential climatic effects on the extent of ice cover in the Bering Sea and associated indirect effects on the abundance and distribution of prey.

- **Cumulative Effects**. The cumulative effect of all fisheries on the abundance of prey for pinnipeds is considered insignificant for all species. Spotted seals have some overlap of prey with the groundfish fisheries but the harvest of prey by the fisheries is not expected to have population level effects. The amount of groundfish fishery overlap with elephant seals is unknown but, since the elephant seal population is expanding, food does not appear to be limiting so cumulative effects on prey availability are considered insignificant. The amount of prey overlap with the other pinniped species is very limited and is considered insignificant for all species in this group.

Spatial and Temporal Concentration of Fisheries

- **Direct/Indirect Effects**. Spatial and temporal fishing measures under PA.1 do not deviate from the baseline, which has insignificant effects on pinniped species.

- **Persistent Past Effects**. Persistent past effect on spotted seal include foreign, JV, and domestic groundfish fisheries and state-fisheries. None are identified for the other pinniped species.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries within the range of spotted seal would be expected to be conducted in the future in a manner similar to the baseline conditions. Future effects of spatial and temporal concentration of fisheries on ice seals and walrus would not be expected.

- **Cumulative Effects.** The spatial/temporal concentration of the groundfish fishery and all other fisheries is considered to have an insignificant cumulative effect on pinniped prey due to limited seasonal overlap. Population-level effects are unlikely for any of the species in this group.

Disturbance

- **Direct/Indirect Effects**. Levels of disturbance similar to the baseline are expected under PA.1 and are considered insignificant.

- **Persistent Past Effects.** Past sources of disturbance on spotted seals have been from the foreign, JV, and the federal domestic groundfish fisheries in the BSAI and state-managed fisheries for salmon. Overlap of fisheries is minimal for most of species. The primary source of external disturbance to the other pinniped category would be related to the subsistence harvest.

- **Reasonably Foreseeable Future Effects**. State-managed fisheries could be expected to continue at a level similar to the baseline condition. Disturbance from subsistence harvest activities in future years would be expected to be similar to the baseline conditions.

- **Cumulative Effect**. The combined effects of disturbance levels resulting from internal and external effects are found to be insignificant for all species based on very limited overlap with the fisheries and the lack of evidence that disturbance has a population-level effect for any of these species.

Direct/Indirect Effects PA.2 – Other Pinnipeds

For species within the other pinniped group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects PA.2 – Other Pinnipeds

For species within the other pinniped group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

4.9.8.6 Transient Killer Whales

Direct/Indirect Effects PA.1 – Transient Killer Whales

Incidental Take/Entanglement in Marine Debris

With regard to incidental take, PA.1 is not likely to result in significant changes to the population trajectory of killer whales. Six commercial fisheries in Alaska that could have interacted with transient killer whales from the western and GOA stock were monitored for incidental take by fishery observers from 1990 to 1999. Of the observed fisheries (BSAI and GOA groundfish trawl, pot, and longline), killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Angliss *et al.* 2001) (Table 4.5-60). In addition to mortalities caused by entanglement, killer whales are susceptible to injury or mortality through vessel strikes. One killer whale was reported to be killed when it struck the propeller of a BSAI groundfish trawl vessel in 1998 (Angliss and Lodge 2002). The mean annual mortality of killer whales incidental to groundfish fisheries from 1995 to 1999 was estimated to be 1.4 whales (Angliss *et al.* 2001). It is not known what proportion of these whales were transients versus residents. Increased harvest rates under PA.1 may result in the increased take of less than one killer whale relative to the baseline, for a total estimated average of less than two animals per year. Interactions which result in the entanglement of killer whales in fishing gear are rare and are not expected to have population-level effects. Therefore, takes and entanglements of killer whales incidental to groundfish fisheries under PA.1 are determined to be insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

The diet of transient killer whales consists of marine mammals. The diet of transient killer whales consists of marine mammals. Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant under PA.1.

Spatial and Temporal Concentration of the Fishery

The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant under FMP 1.

Disturbance

PA.1 retains the area closures contained under the baseline. The management regime under PA.1 is not expected to result in increased disturbance to killer whales relative to the baseline and is rated insignificant.

Cumulative Effects PA.1 – Transient Killer Whales

The past/present effects on the transient killer whales are described in Section 3.8.22 (Table 3.8-22) and the predicted direct/indirect effects of the groundfish fishery under PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance, with the major indirect effects being the change in the prey availability and the change in the spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. With regard to incidental take and entanglement, PA.1 is not likely to result in changes to the population trajectory of transient killer whales and is considered insignificant.

- **Persistent Past Effects**. Mortality has been documented in the JV, domestic groundfish and state-managed fisheries, and intentional shootings have been known to occur. Past incidental take in the groundfish fisheries is less than two animals per year, but its not known if these animals were transients or residents. In addition to mortalities caused by entanglement, killer whales are susceptible to injury or mortality through vessel strikes. The EVOS resulted in the loss of half of the individual killer whales from the AT1 pod in PWS (Matkin *et al.* 1999). This distinct group of whales is being evaluated for recognition as a separate stock and protection as a depleted stock under the MMPA. Contaminant levels in whales in this group were found to be many times higher than others killer whales (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects**. Future mortality is expected from external factors such as state-managed fisheries, intentional shooting, and marine pollution, particularly persistent organic pollutants such as DDT and PCBs (Matkin *et al.* 2001).

- **Cumulative Effects**. Cumulative effects of mortality resulting from internal effects of the groundfish fisheries and external factors are determined to be insignificant. The exception to this finding is in the AT1 transient group in PWS. The cumulative effects of mortality on this group were determined to be significantly adverse due to the past external effects of the EVOS and the subsequent population decline of the AT1 transient group.

<u>Prey Availability</u>

- **Direct/Indirect Effects**. Since the groundfish fisheries kill very few marine mammals through incidental take, the direct effects of groundfish fisheries on the abundance of transient killer whale prey species are determined to be insignificant.

- **Persistent Past Effects**. Since marine mammals are the primary prey of transient killer whales, all of the factors that have been identified as affecting the abundance or distribution of cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include commercial and subsistence harvest, intentional shootings, incidental take in all fisheries, marine pollution, climate change, and regime shifts. In addition, there is the potential for past indirect effects of fisheries on the abundance of Steller sea lions, fur seals, and harbor seals, all of which are important prey species for transient killer whales. Declines in harbor seals in PWS after the EVOS could have affected the AT1 group of transient killer whales through their food supply (Matkin *et al.* 1999).

- **Reasonably Foreseeable Future External Effects**. Future external effects on prey species important to transient killer whales would include state-managed fisheries to a small extent and subsistence harvest of the various marine mammals.

- **Cumulative Effects**. The cumulative effects on different marine mammal species are varied, with some populations declining substantially while others increase. Although some individual whales may specialize on particular prey species, the ability of these top predators to switch prey and forage over vast areas is believed to decrease the importance of any one species or stock of marine mammal prey. The overall availability of prey does not appear to be having population level effects on transient killer whales and therefore the cumulative effect is considered insignificant.

<u>Spatial and Temporal Concentration of the Fishery</u>

- **Direct/Indirect Effects**. The spatial/temporal concentration of the groundfish fisheries does not directly affect the distribution of marine mammals. Therefore, the direct effects of the fisheries on transient killer whale prey are determined to be insignificant.

- **Persistent Past Effects.** All persistent past effects that have been identified for cetaceans, pinnipeds, and sea otters are pertinent in this context. These factors include the potential contribution of the spatial/temporal concentration of past fisheries to have caused localized depletion of prey for Steller sea lions, harbor seals, and northern fur seals with consequent population-level effects on those species.

- **Reasonably Foreseeable Future External Effects**. The future spatial/temporal concentration of external fisheries could have indirect effects on the abundance and distribution of marine mammals that are important prey for transient killer whales.

- **Cumulative Effects**. The cumulative effects of the spatial/temporal concentration of fisheries on different marine mammal species result in changes to the abundance and distribution of prey to transient killer whales. Since transient killer whales. are able to switch prey and forage over vast areas, the potential localized depletion of any one species or stock of marine mammal prey is unlikely to have population level effects on the killer whales. The cumulative effect of the spatial and temporal harvest of fish from all fisheries does not appear to be having population level effects on transient killer whales and is therefore considered insignificant.

Disturbance

- **Direct/Indirect Effects**. Levels of disturbance to killer whales are expected to be similar to baseline conditions and are expected to be insignificant.

- **Persistent Past Effects**. Some levels of disturbance have likely occurred from foreign, JV, and domestic groundfish fisheries, and state-managed fisheries. Vessel traffic external to the fisheries has contributed to overall disturbance of these animals. Effects of the level of disturbance on transient killer whales is largely unknown.

- **Reasonably Foreseeable Future External Effects**. External effects of state-managed fisheries and other vessel traffic on disturbance will likely occur in future years at a level similar to the baseline.

- **Cumulative Effects**. Cumulative effects of disturbance levels on transient killer whales resulting from internal and external factors are considered insignificant and are not likely to have any population-level effects.

Direct/Indirect Effects PA.2 – Transient Killer Whales

For transient killer whales, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects PA.2 – Transient Killer Whales

For the transient killer whales, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under PA.2 are the same as discussed under PA.1.

4.9.8.7 Other Toothed Whales

Direct/Indirect Effects PA.1 – Other Toothed Whales

Incidental Take/Entanglement in Marine Debris

Incidental takes attributed to the fisheries and entanglement in fishing gear and marine debris occur at low levels and are thought to be insignificant to toothed whale populations. The highest incidental take rate for any cetacean is that of Dall's porpoise. From 1995 to 1999 an average of 8.8 Dall's porpoise were estimated to have been taken incidental to groundfish fishing activities. The majority of these were taken in BSAI trawl fisheries while 1.6 and 1.2 animals were taken in BSAI longline and GOA trawl fisheries respectively. Three harbor porpoise moralities were observed incidental to BSAI groundfish trawl fisheries from 1995 to 1998. The mean annual mortality of Pacific white-sided dolphins incidental to groundfish fisheries from 1995 to 1999 was estimated to be less than one animal with reported takes occurring only in the BSAI longline fishery (Angliss *et al.* 2001) (Table 4.5-60). The estimated mean annual mortality of beluga whales, endangered sperm whales, and beaked whales incidental to groundfish fisheries was zero from 1995 to 1999.

Ten non-lethal interactions with endangered sperm whales have been documented in the GOA longline fishery targeting sablefish in management zones 640 and 650 (Hill *et al.* 1999). Two of the three entanglements reported between 1997 and 2000 resulted in release of the animal without serious injury. The extent of the injuries to the third animal was not known though it was alive at the time of release. No sperm whale mortalities have been observed or reported in the BSAI/GOA groundfish fisheries since observers began collecting data in 1990 (Angliss and Lodge 2002).

In the observed fisheries (BSAI and GOA groundfish trawl, pot, and longline), killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Angliss *et al.* 2001). The mean annual mortality of killer whales incidental to groundfish fisheries from 1995 to 1999 was estimated to be 1.4 whales (Angliss *et al.* 2001). It is not known what proportion of these whales were transients versus residents. Interactions which result in the entanglement of killer whales in fishing gear are rare and are not expected to have population-level effects.

The level of incidental takes and entanglement of toothed whales from groundfish fishing under PA.1 is expected to be rare and is not expected to affect the population trajectories of any species, and is therefore insignificant at the population level.

Fisheries Harvest of Prey Species

The effects of the fisheries on toothed whale prey are largely constrained by differences between their prey and the fisheries harvest targets. PA.1 is not expected to increase the level of competitive interactions for prey from the baseline condition and is therefore determined to have insignificant effects on prey of toothed whales.

The beluga whale stocks along the western coast of Alaska from Bristol Bay north, and in Cook Inlet are generally restricted to shallow coastal and estuarian habitats not used by commercial groundfish fisheries. Their diet is predominantly salmonids and small schooling fishes such as eulachon and capelin. These species are taken only in small quantities as bycatch in the groundfish fisheries. Thus, it is unlikely that fishery interactions exist between beluga whales and Alaskan groundfish fisheries.

Similarly, Pacific white-sided dolphins are not commonly observed north of the Aleutian Islands, and appear to be seasonal visitors in parts of the GOA and southeast Alaska. The main body of their population is more commonly found in the central North Pacific Ocean (Ferrero and Walker 1996). With regard to diet, Pacific white-sided dolphins and Dall's porpoise feed mainly on cephalopods and small schooling fishes such as myctophids. These species are taken only in small quantities as bycatch in the groundfish fisheries.

The remaining species consume a wide variety of both fish and invertebrate species, but overlap with commercially important species is limited in most cases. Beaked whales, a diverse group unto itself, are poorly known, but available information suggests that they prey on benthic and epibenthic species including squid, skates, rattails, rockfish, and octopus. Harbor porpoise diet in Alaskan waters is also poorly understood, although forage consumed by stocks in the Pacific Northwest and their tendency toward near shore distribution suggest that they probably consume a variety of coastal species. None of these species are taken in significant quantities in the groundfish fisheries.

Sperm whale diet overlaps with commercial fisheries targets more than any other species in this group, but the degree of overlap is at least partly due to direct interactions with longline gear. In addition to consuming primarily medium to large sized squids, they also consume salmonids, rockfish, lingcod and skates, and in the GOA they have been observed feeding off longline gear targeting sablefish and halibut. The interaction with commercial longline gear does not appear to have an adverse impact on sperm whales since no mortalities have been observed. On the contrary, the whales appear to have become more attracted to these vessels in recent years as reliable and easy sources of food.

Most information regarding resident killer whale consumption of commercially important groundfish results from observations of whales depredating longlines as they are retrieved in locations ranging from the southeastern Bering sea to PWS. In the waters between Unimak Pass and the Priblof Islands, killer whales regularly strip sablefish and Greenland turbot from longlines. Consumption of other groundfish species by resident killer whales not interacting with gear is largely unknown. In general, they are opportunistic feeders with diets that differ both regionally and seasonally. Nishiwaki and Handa (1958) examined killer whale stomach contents from the North Pacific and found squid, fish, and marine mammals. The importance of these prey items in the BSAI or GOA groundfish management areas is uncertain, but there is no evidence to suggest exclusive reliance on commercially important groundfish species.

Spatial and Temporal Concentration of the Fishery

As stated above, groundfish fisheries have little competitive overlap with toothed whales. The spatial and temporal concentration of the fisheries under PA.1 are expected to be similar to the comparative baseline conditions, which are considered to have insignificant effects on endangered sperm whales and other toothed whales at the population level.

Disturbance

Disturbance of endangered sperm whales and other toothed whales under the PA.1 management regime is not expected to change relative to the baseline and is rated insignificant.

Cumulative Effects PA.1 – Other Toothed Whales

The past/present effects on the other toothed whale group are described in Sections 3.8.19 through 3.8.21 and Sections 3.8.23 through 3.8.25 (Tables 3.8-19 through 3.8-25) and the predicted direct/indirect effects of the groundfish fishery under the PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial and temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. The level of mortality for endangered sperm whales and other toothed whale species related to groundfish fishing activities is rare and is not expected to affect the population trajectories of any of these species. Therefore PA.1 is rated as insignificant at the population level.

- **Persistent Past Effects**. Persistent past effects on species within the other toothed whale group include incidental take and entanglement in foreign, JV, Federal domestic groundfish fisheries and state-managed fisheries, and subsistence hunting on beluga whales. The decline of the Cook Inlet beluga population is thought to have been the result of subsistence harvests, which ranged from 21 to 123 animals per year between 1993 and 1998. Only one beluga was harvested in 2001 by hunters from the Native village of Tyonek and one beluga was harvest in 2002 by the Cook Inlet community hunters. Belugas are incidentally taken by the state-managed salmon gillnet fisheries in Bristol Bay and Cook Inlet. However, one beluga was reported to be taken from the EBS in 1996 and seven were reported taken in Bristol Bay in 2000. In the BSAI and GOA groundfish fisheries, no mortality or serious injuries to belugas have been observed. Harbor porpoise have not been taken in the observed groundfish fisheries over a ten year period between 1990 to 1998 (Angliss *et al.* 2001). Salmon gillnet fisheries in southeast Alaska take approximately three individuals per year. Dall porpoise mean annual mortality was 6.0 for the Bering Sea groundfish trawl fishery, 1.2 for the GOA groundfish trawl fishery, and 1.6 for the Bering Sea groundfish longline fishery. The Alaska Peninsula/Aleutian Island salmon drift gillnet fishery has a higher take of Dall's Porpoise, with an estimated 28 porpoises in one year (1990). Thousands of Pacific white-sided dolphins were killed annually between 1978 and 1991 in the high seas driftnet fisheries, which no long occur (Angliss *et al.* 2001). One Pacific white-sided dolphin was taken in the BSAI trawl fishery and one in the BSAI longline fishery during the same time span (Angliss *et al.* 2001). State-managed salmon gillnet fisheries take approximately two dolphins per year.

  Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987. The highest counts occurred in 1968 when 16,357 sperm whales were harvested after which the population became severely depleted. Sperm whale interactions with longline fisheries operating in the GOA are known to occur and may be increasing in frequency. Sperm whales have been known to prey on sablefish caught on commercial longline gear in the GOA. Only three entanglements have been reported in the GOA longline fishery.

  For killer whales, the combined mortality from the observed groundfish fisheries was 1.4 whales per year (Angliss *et al.* 2001). While it is most likely that whales interacting with fisheries are from resident pods (since they eat fish), no genetic testing has been done on whales incidentally taken in the groundfish fisheries to ascertain whether they were from resident or transient stocks.

For beaked whales (Baird's, Cuvier's, or Stejneger's), no incidental take or entanglement in the BSAI and GOA groundfish trawl, longline, and pot fisheries has been documented (Hill and DeMaster 1999).

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and state-managed fisheries were identified as potential sources of mortality in the future. Several of the toothed whale species range outside of the BSAI and GOA during the winter months. Subsistence take of some stocks of beluga whales would be expected to occur in the future. Other species are not taken for subsistence purposes.

- **Cumulative Effect**. Cumulative effects of mortality resulting from internal and external factors are considered insignificant for all non ESA-listed species due to the low level of incidental take in the groundfish fisheries and limited external human-caused mortality.

  For the endangered sperm whale, the cumulative effect was also considered insignificant because the very low level of incidental take in the groundfish fisheries and very limited human-caused mortality from external sources is not expected to delay the recovery of sperm whale populations.

Prey Availability

- **Direct/Indirect Effects**. The groundfish fishery under PA.1 is not expected to increase the level of competitive interactions for toothed whale prey from the baseline condition and is therefore considered to have insignificant effects on toothed whale prey..

- **Persistent Past Effects**. Although this group preys on a wide variety of fish species, past effect on the availability of prey for this group are identified for fisheries in general, and include the foreign, JV, and federal domestic groundfish fisheries, and the state-managed fisheries for salmon and herring. The diversity of diet in this whale group results in limited overlap for most species with the possible exception of sperm whales and resident killer whales.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries were identified as external factors having a potential effect on prey for these species in the future. Climate and regime shifts are identified, but the direction and magnitude of these effects are difficult to predict.

- **Cumulative Effects**. The ability of these whale species to forage over wide areas and on a variety of prey species moderates any potential impacts from fisheries competition. Cumulative effects on prey availability were identified for this group, including a very limited contribution from the groundfish fishery, but the degree of fishery harvest and bycatch of prey important to these whale species is not expected to have population-level effects on any species, including the endangered sperm whale, and is therefore considered insignificant.

Spatial and Temporal Concentrations of the Fisheries

- **Direct/Indirect Effects**. Spatial and temporal fishing measures under PA.1 do not deviate from the baseline, which do not appear to be causing localized depletion of prey for any species of toothed whale, and are thus determined to be insignificant.

- **Persistent Past Effects**. The spatial/temporal concentration of foreign, JV, and domestic groundfish fisheries and the state-managed fisheries are believed to have had minimal effects on the abundance and distribution of toothed whale prey.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries are expected to continue in manner similar to the baseline conditions. Effects of future fishing activities on toothed whale prey are expected to be minimal.

- **Cumulative Effects**. The ability of toothed whales to forage over wide areas and on a variety of prey species moderates any potential impacts from localized depletion of prey from the spatial/temporal concentration of fisheries. Cumulative effects on prey abundance and distribution, including a very limited contribution from the groundfish fishery, are not expected to have population-level effects on any species, including the endangered sperm whale, and are therefore considered insignificant..

Disturbance

- **Direct/Indirect Effects**. Disturbance levels resulting from the groundfish fishery under PA.1 are determined to be insignificant at the population level.

- **Persistent Past Effects**. Past potential disturbance effects on species in this group include foreign, JV, and federal domestic groundfish fisheries; however, there is little indication of a adverse effect at this level of disturbance. General vessel traffic likely contributes to disturbance to these species.

- **Reasonably Foreseeable Future External Effects**. Increases in the general marine vessel traffic and continued fishing activity in the state-managed fisheries were identified as potential sources of disturbance.

- **Cumulative Effects**. The cumulative effect of disturbance from both internal and external factors is found to be insignificant for endangered sperm whales and other toothed whale species based on the lack of evidence that disturbance has a population-level effect for any of these species. For sperm whales, there is growing evidence that the whales are attracted to fishing vessels as reliable and easy sources of food.

Direct/Indirect Effects PA.2 – Other Toothed Whales

For species within the other toothed whales group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects PA.2 – Other Toothed Whales

For species within the other toothed whales group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under PA.2 are the same as discussed under PA.1.

4.9.8.8 Baleen Whales

Direct/Indirect Effects PA.1 – Baleen Whales

Incidental Take/Entanglement in Marine Debris

Take of baleen whales incidental to groundfish fishing activities is rare. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Humpback whales are occasionally taken in the Bering Sea pollock trawl fishery through entanglement in fishing gear. The extent of interaction between bowhead whales and the groundfish fishery is not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. The extent of interaction between gray whales and the groundfish fishery is not known, but some entanglement in gear does occur. Since 1989, no incidental takes of right whales are known to have occurred in the North Pacific.

With respect to incidental take and entanglement in marine debris incidental to groundfish fisheries, PA.1 is not expected to result in significant effects on the population trajectories of any baleen whales, does not conflict with the goals of any recovery plan for endangered whales, and is thus insignificant according to the criteria established in Table 4.1-6.

Fisheries Harvest of Prey Species

Most baleen whale species such as blue, fin, sei, and northern right whale feed primarily on copepods, euphausiids and amphipods. Gray whales feed mostly on epibenthic and benthic invertebrates, while humpbacks and minke whales have a more diverse diet including euphausiids, Atka mackerel, sand lance herring, and capelin. The BSAI and GOA groundfish fisheries do not target these prey items (with the exception of Atka mackerel) and take very small amounts of these prey species as bycatch. Neither the abundance nor distribution of zooplankton are substantially influenced by commercial fishing operations. While a few species of baleen whales do consume herring and juvenile pollock (e.g., humpback and fin whales), changes in removal patterns of these prey species under PA.1 would not be expected to impact their availability to whales, which can forage over vast areas and throughout the water column. The groundfish fisheries under FMP 1 are therefore unlikely to impact baleen whales through competition for prey, including the endangered blue, fin, bowhead, humpback, sei and northern right whales.

Spatial and Temporal Concentration of the Fishery

Spatial and temporal fishing measures under PA.1 do not deviate from the baseline, which does not cause localized depletion of prey for baleen whales, and are therefore determined to be insignificant to both the endangered and non ESA- listed baleen whales according to the criteria established in Table 4.1-6.

Disturbance

The effects of disturbance caused by vessel; traffic, or sound production on baleen whales in the GOA and BSAI are largely unknown. With regard to vessel traffic, most baleen whales appear tolerant, at least as suggested by their reactions at the surface. Observed behavior ranges from attraction to course modification or maintenance of distance from the vessel. Reaction to gear, such as pelagic trawls is unknown, although the rarity of incidental takes suggests either partitioning, or avoidance. Given their distribution throughout the fishing grounds, at least some individuals may be expected to occasionally avoid contact with vessels or fishing gear, which would constitute a reaction to a disturbance. Assuming these instances occur, the effects are likely to be temporary.

Coincident to fishing activity, as well as vessel transit, is the routine use of various sonar devices. The sounds produced by these devices may be audible to baleen whales and suggest disturbance sources. For instance, wintering humpback whales have been observed reacting to sonar pulses by moving away (Maybaum 1990, 1993), although few other cases of reaction have been documented. Given the continued occupation fo the fishing rounds by these animals. And their generally positive population trends, disturbance from sonar, if it occurs in the BSAI or GOA does not appear to have population-level effects. Disturbance of both endangered and non ESA-listed baleen whales under the PA.1 management regime is not expected to change relative to the baseline and is therefore rated insignificant.

Cumulative Effects PA.1 – Baleen Whales

The past/present effects on the other baleen whale group are described in Section 3.8.11 to Section 3.8.18 (Tables 3.8-11 through 3.8-18), and the predicted direct/indirect effects of the groundfish fishery under the PA.1 are described above (Table 4.9-5). Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects of availability of prey and spatial and temporal concentration of the fisheries (Table 4.1-6).

<u>Mortality</u>

- **Direct/Indirect Effects**. The low level of take and entanglement of baleen whales projected to occur under the PA.1 is considered insignificant at the population level.

- **Persistent Past Effects.** Commercial whaling in the last century has had lingering effects on most of the baleen whales in this group, with the possible exception of the minke whale. These include the endangered blue whales, fin whales, sei whales humpback whales, northern right whales and the non-ESA listed gray whale. Subsistence whaling has also affected several of the baleen whales in the past. Gray whales are harvested both in Alaska and in Russia and have a 5-year quota of 620 whales. The 1968-1993 average take for Russian and Alaska Natives combined was 159 whales per year. Bowhead whales are harvested under International Whaling Commission quotas which allow up to 67 strikes per year although actual strikes have been less than the quota since 1978. A single fin whale mortality was reported in the GOA pollock trawl fishery operating south of Kodiak Island and Shelikof Strait in autumn 1999. Fin whales were reported in this region year-round, most often in the summer and autumn (POP 1997). Humpback whales are present year-round in Alaska waters but are most frequently reported during the summer and autumn. In 1997, a dead humpback was found entangled in netting and trailing orange buoys near the Bering Strait. It is often difficult to determine if the entanglement occurred with active or derelict gear, or to identify the fishery the derelict gear originated from. Two mortalities (October 1998 and February 1999) were reported by observers in the Bering Sea pollock trawl fishery operating near Unimak Pass. The extent of interactions between bowhead whales and the groundfish fishery are not known. Bowhead whales are present in the Bering Sea during winter and early spring but are usually associated with ice-covered regions. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Of 236 bowhead whales examined from the Alaskan subsistence harvest (from 1976 to 1992), three had visible ship-strike injuries from unknown sources and six had ropes attached or scars from fishing gear (primarily pot gear), one found dead was entangled in ropes similar to those used with fishing gear in the Bering Sea (Philo *et al.* 1992). Since 1992, additional bowhead whales have been observed entangled in pot gear or with scars from ropes. The extent of interactions between gray whales and the groundfish fishery are not known. Rope entanglement injuries and deaths as well as ship-strike injuries appear to be rare. Since 1997, five entanglements (mostly in pot gear) and one ship strike mortality have been reported in Alaska waters. Since 1989, no incidental takes of right whales are known to have occurred in the North Pacific. Gillnets were implicated in the death of a right whale off the Kamchatka Peninsula (Russia) in October of 1989. Because the right whale population is believed to be very small, any mortality incidental to commercial fisheries would be considered to be significant. Based on the lack of reported mortalities of endangered right whales, the estimated annual mortality rate incidental to commercial fisheries is zero whales per year from this stock.

- **Reasonably Foreseeable Future External Effects.** Foreign fisheries outside the EEZ and state-managed fisheries are expected to continue to take small numbers of baleen whales in the coming years. Entanglement in fishing gear will continue to effect baleen whales throughout their ranges. Subsistence use of gray whales and bowhead will continue to be the largest source of human-caused mortality.

- **Cumulative Effects**. Cumulative effects of mortality resulting from internal effects of the fishery and contributions from external factors are considered conditionally significant adverse for fin, humpback, and northern right whales due to past effects on their population, potential for interactions with fisheries, and their endangered status. Right whales are very rare so even one human-caused mortality could be considered significant. Given the overlap of their preferred habitat with the BSAI fisheries, the chances of future adverse interactions with fishing gear are more than negligible. The adverse rating for these three species is conditional on whether future take or entanglement substantially affects their rates of recovery. Cumulative effects are found to be insignificant for the endangered blue, bowhead, and sei whales. These species rarely interact with the fisheries so population-level effects are not anticipated. Mortality is also considered insignificant for non-ESA-listed minke and gray whales. Population-level effects are not expected for either of these species.

<u>Prey Availability</u>

- **Direct/Indirect Effects**. The effects of PA.1 are determined to have an insignificant effect on baleen whale prey species due the lack of competitive overlap in prey species targeted by the fisheries.

- **Persistent Past Effects**. Persistent past effects on availability of prey were not identified due to the lack of competitive overlap in prey species targeted.

- **Reasonably Foreseeable Future External Effects**. Future external effects were identified as state-managed fisheries such as herring, which are preyed on by humpback whales and fin whales. Other species are not expected to be impacted through their prey.

- **Cumulative Effects**. Cumulative effects on prey availability resulting from internal effects of the fisheries and contributions from external factors are insignificant primarily due to the limited overlap of prey species within the fisheries.

Spatial and Temporal Concentration of the Fishery

- **Direct/Indirect Effects**. Spatial and temporal concentrations under the PA.1 do not deviate substantially from the baseline, thus the effects of the spatial and temporal concentration of the fisheries under PA.1 are determined to be insignificant.

- **Persistent Past Effects**. Persistent past effects associated with spatial/temporal concentration of the fisheries were not identified.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries would be expected to contribute to the change in the spatial/temporal concentration of some prey species within the baleen whales group.

- **Cumulative Effects**. Cumulative effects on the spatial and temporal concentration of harvest of baleen whale prey resulting from internal effects of the fishery and contributions from external factors are considered insignificant for endangered and non-ESA listed species in this group due to the limited overlap of prey species within the fisheries.

Disturbance

- **Direct/Indirect Effects**. Levels of disturbance similar to the baseline condition are expected under PA.1 and are considered insignificant.

- **Persistent Past Effects**. Some level of disturbance has likely occurred from foreign, JV, and domestic groundfish fishing, and state-managed fisheries along with general vessel traffic. For some species, such as the gray whale and bowhead whale, subsistence activities have contributed to disturbance of these animals.

- **Reasonably Foreseeable Future External Effects**. State-managed fisheries and general vessel traffic, from recreational boating and whale watching to commercial vessels, would be expected to continue in future years, as well as subsistence activities.

- **Cumulative Effects**. Cumulative effects of disturbance resulting from internal and external sources are determined to be similar to the baseline condition and not likely to result in a population-level effect for any of the species in this group. Therefore, the cumulative effect is considered to be insignificant for both endangered and non ESA-listed baleen whales.

Direct/Indirect Effects PA.2 – Baleen Whales

For species within the baleen whales group, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects PA.2 – Baleen Whales

For the baleen whale group, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under PA.2 are the same as discussed under PA.1.

4.9.8.9 Sea Otters

Direct/Indirect Effects PA.1 – Sea Otters

Incidental Take/Entanglement in Marine Debris

Sea otter interactions with fishing gear, either passive or active are infrequent. Laist (1997) reported that sea otter entanglement in marine debris is rare. Likewise, incidental takes in fishing gear occur at a rate too low to cause population level effects. While the PBRs for the three sea otter stocks in Alaska were 871 (southeast), 2,095 (southcentral) and 5,699 (southwest), mortalities incidental to commercial fishing were zero, less than one, and less than two per year, respectively (Angliss and Lodge 2002).

In southwest Alaska, the North Pacific Groundfish Observer Program reported eight kills in the Aleutian Islands black cod pot fishery in 1992. No other sea otter kills were reported by NOAA observers in the region from 1990 to 1996. In the 2000 *List of Fisheries,* sea otters were added to the BSAI groundfish trawl as a species recorded as taken in this fishery. The USFWS is currently pursuing information regarding the extent of that possible interaction. The total fishery caused mortality and serious injury for the Alaska sea otter is considered to be insignificant (i.e., will not affect population trajectories). The effects on sea otters under the PA.1 are considered insignificant, with respect to incidental catch and entanglement in marine debris.

Fisheries Harvest of Prey Species

The effect of PA.1 on sea otters is limited by differences between their prey and the species targeted and taken as bycatch by the fisheries.. Sea otters consume a wide variety of prey species, including annelid worms, crabs, shrimp, mollusks (e.g., chitons, limpets, snails, clams, mussels, and octopus), sea urchins, and tunicates. Occasionally, groundfish (e.g., sablefish, rock greenling, and Atka mackerel) may also be consumed, but invertebrates are considered the predominant elements of their diet (Kenyon 1969, USFWS 1994). Given the minor importance of groundfish in their diet, fishery harvests under PA.1 are not expected to have significant effects on the abundance of sea otter prey relative to the baseline and are therefore determined to be insignificant for sea otters.

Spatial and Temporal Concentration of the Fishery

The grounds for suggesting competition for forage between sea otters and commercial fisheries is weak despite the species broad geographical distribution in the GOA and the Aleutian Islands. Sea otters inhabit waters of the open coast, as well as bays and the inside passages of southeastern Alaska. Since their primary prey items are found on the bottom in the littoral zone, to depths of 50 m, the majority of otters feed within one km of the shore (Kenyon 1969). In areas where shallow waters extend far offshore (e.g., Unimak Island), sea otters have been reported as far as 16 km offshore. They are often seen resting and diving for food in and near kelp beds (Kenyon 1969). Because of this habitat preference for shallow areas, they do not overlap spatially with groundfish fisheries. Since the spatial and temporal concentration of the fisheries under PA.1

is expected to be similar to the baseline, which does not appear to affect the localized abundance of sea otter prey, PA.1 is considered to be insignificant for this effect on sea otters.

Disturbance

As noted for many of the other marine mammals, the effects of disturbance caused by vessel traffic, fishing operations, or sound production on sea otters in the GOA and BSAI are expected to be insignificant. Sea otters exhibit considerable tolerance for vessel traffic, and in some cases are attracted to small boats (Richardson *et al.* 1995). Sea otters may be more tolerant of underwater sound relative to other species, owing to the greater amount of time they spend at the surface. Levels of disturbance under PA.1 are expected to be similar to the baseline level and are therefore considered insignificant for sea otters.

Cumulative Effects PA.1 – Sea Otters

The past/present effects on the sea otter are described in Section 3.8.10 (Table 3.8-10) See Table 4.9-5 for a summary of the direct/indirect and cumulative effects. Representative direct effects used in this analysis include mortality and disturbance with the major indirect effects being the change in prey availability and the change in the spatial/temporal concentration of the fisheries (Table 4.1-6).

Mortality

- **Direct/Indirect Effects**. The effects of incidental take and entanglement on sea otters under PA.1 are considered insignificant.

- **Persistent Past Effects.** Commercial exploitation for pelts had a large impact on sea otters dating from the mid-1700s to the late 1800s, causing them to become nearly extinct (Bancroft 1959, Lensink 1962). Protective measures instituted in 1911 have allowed remnant groups to increase and reoccupy much of the historic sea otter range in Alaska (Kenyon 1969, Estes 1980). Residual effects from this early harvest likely persist in several areas. Alaska Natives have hunted sea otters for pelts and meat throughout history. Current harvest levels represent nine percent of PBR for the southwestern stock, 15 percent of PBR for the southcentral stock, and 35 percent of PBR for southeast stock. (USFWS 2002a. 2002b, and 2002c). In 1992, fisheries observers reported eight sea otters taken incidentally by the Aleutian Island black cod pot fishery. During that year, only a third of the fisheries were observed, yielding an estimate of 24 otters killed in cod pot gear. No other sea otter takes were reported from observed fisheries in the range of the southwest stock from 1993 through 2000. In 1997, one sea otter was self-reported to be taken in the BSAI groundfish trawl fishery (USFWS 2002a, 2002b, and 2002c). Oil spills, such as the EVOS, can result in substantial mortality of sea otters. Sea otter numbers have declined dramatically from the Alaska Peninsula to the Bering Sea and this stock is being considered for listing under the ESA.

- **Reasonably Foreseeable Future External Effects.** Low-levels of incidental take in commercial and subsistence fisheries, subsistence hunting, and periodic mortalities from oil spills are likely to continue in the future. Population level effects from killer whale predation may continue in the southwest Alaska stock, depending on the recovery of alternate prey and behavior of transient killer whales.

- **Cumulative Effects**. The cumulative effects of mortality from all sources are different for different stocks of sea otters. The populations of the southeast and southcentral stocks of sea otters appear to be stable or increasing and are not expected to have additional mortality pressure in the future. These stocks are considered to have insignificant cumulative effects from mortality. The rapid decline of the southwest Alaska stock does not appear to be the result of food shortages, disease, or toxic contamination and is likely the result of increased predation by transient killer whales following the collapse of their preferred sea lion prey population in the 1980s (Estes *et al.* 1998). Since the mechanism(s) of the population decline is still under investigation, the cumulative effect on the southwest stock is considered to be conditionally significant adverse for mortality.

Prey Availability

- **Direct/Indirect Effects.** The effects of the PA.1 on sea otters is limited by differences between their prey and the fisheries harvest targets. As such, the effects of harvest of key prey species in groundfish fisheries are determined to be insignificant for sea otters.

- **Persistent Past Effects**. The federal groundfish fisheries have had little effect on the availability of prey in the past due to the limited overlap in prey species of the sea otter and the fish targeted by the groundfish fisheries. There is some minor overlap in state-managed crab fisheries of sea otter prey.

- **Reasonably Foreseeable Future External Effects.** State-managed crab fisheries that take crab from shallow waters are identified as external effects. The overlap primarily occurs in inshore areas or offshore areas with relatively shallow water.

- **Cumulative Effects**. Cumulative effects on prey availability resulting from internal effects of the groundfish fisheries and external factors, such as the crab fisheries, are determined to be insignificant due to the very limited overlap of these fisheries and the sea otter forage species.

Spatial and Temporal Concentration of the Fisheries

- **Direct/Indirect Effects**. Despite the species broad geographical distribution in the GOA and the Aleutian Islands, they do not generally overlap spatially with groundfish fisheries. Therefore, the effects of the spatial and temporal concentration of the fisheries are insignificant for sea otters.

- **Persistent Past Effect**. The limited spatial overlap of groundfish fisheries and other fisheries in the past have limited their interaction with sea otter prey. Past effects of spatial/temporal concentration have likely been in very specific areas and associated with state-managed crab fisheries.

- **Reasonably Foreseeable Future External Effects**. State-managed crab fisheries are likely to continue into the future at a level similar to the baseline conditions.

- **Cumulative Effects**. The cumulative effect of the spatial/temporal harvest of prey in the internal and external fisheries is considered to be insignificant due their limited spatial overlap with sea otter habitat. These fisheries are unlikely to have population-level effects.

Disturbance

- **Direct/Indirect Effects**. Baseline levels of disturbance caused by vessel traffic, fishing operations, or sound production on sea otters in the GOA and BSAI are considered to be insignificant. Levels of disturbance under the PA.1 are expected to be similar to the baseline; therefore, the effects of disturbance on sea otters are expected to be insignificant.

- **Persistent Past Effects**. Past disturbance levels are primarily related to vessel traffic from fisheries and other vessels and disturbance associated with subsistence harvest of sea otters.

- **Reasonably Foreseeable Future External Effects.** State-managed fisheries are expected to continue at a level similar to the baseline conditions. Commercial vessel traffic within sea otter habitat in future years would also be expected to be similar the baseline.

- **Cumulative Effects**. Cumulative effects of disturbance on sea otters resulting from internal effects of the groundfish fisheries and external effects of other fisheries are considered insignificant and are unlikely to result in a population-level effect. Contribution of the groundfish fisheries to the overall cumulative effect is minor.

Direct/Indirect Effects PA.2 – Sea Otters

For sea otters, the analysis and conclusions regarding direct/indirect effects for incidental take and entanglement in marine debris, fisheries harvest of prey species, spatial and temporal concentration of the fishery, and disturbance are the same as discussed under PA.1.

Cumulative Effects

For sea otters, the analysis and conclusions regarding cumulative effects for mortality, prey availability, spatial and temporal concentration of the fishery, and disturbance under PA.2 are the same as discussed under PA.1.

4.9.9 Socioeconomic Preferred Alternative Analysis

This policy alternative would seek to accelerate the existing precautionary management measures through rights-based management and ecosystem-based management principles and, where appropriate and practicable, increase habitat protection and impose additional bycatch constraints. This section contains both quantitative and qualitative analysis of select economic and social effects of PA.1 and PA.2.

In general, the quantitative economic outcomes of this management policy appear nearly identical to those projected under Alternative 1. No significant differences between the two management policies are projected, at least in the variables for which changes are captured by the projection model. Most of the differences between the policies occur in variables that have not been quantified in the analysis such as product prices, harvesting and processing capacity, average costs, and fishing vessel safety.

4.9.9.1 Harvesting and Processing Sectors

The model and analytical framework used in the analysis of the effects of PA.1 on the harvesting and processing sectors are described in Section 4.1.7.

Table 4.9-6 summarizes projected impacts of PA.1 on harvesting and processing sectors. The numbers in the table reflect the five-year average of outcomes projected for 2003 to 2007. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, harvests of this species are estimated to increase by 36 percent, from 218,000 mt to 297,000 mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment, and groundfish payments to labor.

4.9.9.1.1 Catcher Vessels

Direct/Indirect Effects of PA.1

Groundfish Landings By Species Group

A comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 catcher vessel conditions reveals that under PA.1 there would be few significant changes in overall retained harvests of groundfish relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, retained catches of this species are expected to increase by about 54 percent. In addition, an increase in the TAC for sablefish and rockfish will result in a significant increase in the retained harvests of these species. Retained harvests of pollock and flatfish are not expected to change significantly. This leads to direct/indirect effects ratings of insignificant/significantly beneficial for groundfish landings by species group under PA.1.

Ex-Vessel Value

The total ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by the smaller trawl catcher vessels and pot catcher vessels account for much of the increase in groundfish ex-vessel value. Longline vessels are expected to benefit from the increased catches of sablefish and rockfish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to increase under PA.1, but not significantly.

Impacts on Excess Capacity

A conditionally significant decrease in excess capacity in the harvesting sectors is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the decrease is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. One of the primary reasons for expanding the use of rights-based management is to prevent the build-up of excess harvesting and processing capacity or reduce excess capacity that already exists (NMFS 2001a). Excess capacity both contributes to and is the result of the race for fish, with its associated potential adverse impacts on profitability, product quality, and safety. Rights-based systems, whether they allocate shares of the catch to individuals or groups, are incentive adjusting methods in that they attempt to control capacity by creating economic incentives for owners of vessels to decrease their use of labor and capital rather than by directly regulating the level of fishing effort.

The implementation of additional individual or group-based (e.g., community or cooperative) quota systems that end the race for fish and allow transfer of quota shares would be expected to lead to some consolidation of quota to fewer vessels. The degree of consolidation will vary depending on the level of excess capacity, economies of scale and scope in harvesting, and rules that restrict transfer and accumulation of quota shares (NMFS 2001a). Similar consolidation could occur with expanded use of cooperatives or community quota programs. Some excess capacity, in the sense of an ability of vessels and processors to catch and harvest a TAC in less time than a maximum season length would allow, can be expected to persist regardless of what type of additional rights-based measures are put in place. This is generally the case for a number of reasons. It is often not economically efficient to operate at maximum possible production levels, there are typically certain times of the year when it is more efficient and profitable to harvest and process fish, and alternative uses for fishing and processing capital are limited (NMFS 2001a).

Average Costs

A conditionally significant decrease in average costs is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the decrease in average costs is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. Increased rationalization of the fisheries would be expected to reduce the costs of harvesting. Individual vessels will have the opportunity to select the least cost combination of fishing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost-effective harvesting operations. Fixed costs will be reduced by consolidating harvesting operations and retiring or selling-off vessels. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting rights and on the level of excess capacity prior to implementation of remedial measures.

Fishing Vessel Safety

A conditionally significant increase in fishing vessel safety is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the increase in fishing vessel safety is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. Rights-based systems of any kind are expected to improve safety by reducing the pressure to fish under dangerous conditions (NMFS 2001a). The race for fish creates incentives to fish farther from shore or in areas and seasons with more hazardous weather conditions, and requires crew members to work for long stretches with little rest or sleep. Rights-based systems should slow down the pace of fishing and reduce the financial penalty incurred by opting to cease fishing under unsafe conditions. The most important benefit of improved safety will be a decrease in fishery related injuries and loss of life. Other benefits include savings from not having to replace lost vessels and gear. Finally, significant improvements in safety, if they occur, should result in decreased insurance costs for the industry (NMFS 2001a).

At the same time, it is important to recognize that rationalized fisheries do not necessarily guarantee improvements in safety for fishermen. Under an IFQ program, for example, market opportunities or biological conditions (e.g., spawning aggregations) may still encourage fishermen to fish at times or in places that are unsafe.

For a summary of the direct/indirect effects on catcher vessels under PA.1, please see Table 4.9-6.

Cumulative Effects of PA.1

This section assesses the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect. The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125), and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. An insignificant change in retained harvest of groundfish relative to the comparative baseline is projected under PA.1, with the exception of sablefish and rockfish, which are likely to increase significantly.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Given the current downward trends in the commercial salmon and crab fisheries, catcher vessels that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under PA.1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (54 percent), as well as for sablefish and rockfish. Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under PA.1. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations as explained in more detail in Section 4.9.1, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Ex-Vessel Value

- **Direct/Indirect Effects**. The total ex-vessel value of groundfish landed by catcher vessels is not expected to increase significantly under PA.1.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market, which contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in ex-vessel value (9 percent) that are predicted for PA.1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from PA.1.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Changes in ex-vessel value relative to the baseline under PA.1 are insignificant.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (9 percent) under PA.1, is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are projected to increase slightly (9 percent) under PA.1, thereby mitigating some of the reductions in other fisheries. These other fisheries are not expected to contribute to cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under PA.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. Changes in excess capacity are likely to be conditionally significant beneficial under PA.1.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Under PA.1, the extent to which rights-based management would be implemented in groundfish fisheries is uncertain. Should rights-based management be extended to other groundfish fisheries, excess capacity would be expected to be reduced in those fisheries. Excess capacity currently exists in non-groundfish fisheries to a certain extent as well, and may continue to exist unless management measures are taken to reduce it. Assuming that rights-based management is implemented in additional groundfish fisheries, a conditionally significant beneficial cumulative effect is likely for excess capacity under this FMP (see Appendix F-8).

Average Costs

- **Direct/Indirect Effects**. Conditionally significant beneficial effects are expected to occur for average costs under PA.1.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. Should costs in other fisheries increase or decrease, vessels that are dependent on multiple fisheries are often sensitive to these changes. The extent to which rights-based management would be expanded is uncertain. Should rationalization programs be implemented average costs would be reduced. Thus, a conditionally significant beneficial cumulative effect is projected for PA.1 as a result of rights-based management that could be implemented.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Conditionally significant beneficial effects are predicted under PA.1.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Should rights-based management be expanded under PA.1, vessel safety could improve due to the end of the race for fish and less pressure to fish under dangerous conditions. Closures implemented in other fisheries may affect vessel safety in the groundfish fisheries, though these closures are not expected to result in a significant cumulative effect on vessel safety. Thus, a conditionally significant beneficial cumulative effect on fishing vessel safety is projected for PA.1 as a result of rights-based management that could be implemented.

Direct/Indirect Effects of PA.2

Table 4.9-6 summarizes projected impacts of PA.2 on harvesting and processing sectors. The numbers in the table reflect the five-year average of outcomes projected for 2003 to 2007. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, harvests of this species are estimated to increase by 29 percent, from 218,000 mt to 281,000 mt. Changes in the harvests of other groundfish species are not expected to be significant, nor are changes in total groundfish wholesale value of output, groundfish employment, and groundfish payments to labor.

Groundfish Landings By Species Group

A comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 catcher vessel conditions reveals that under PA.2, there would be a number of significant changes in overall retained harvests of groundfish relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, retained catches of this species are expected to increase by about 49 percent. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the retained harvests of these species. Retained harvests of pollock and flatfish are not expected to change significantly. Bycatch of non-target species and PSC is expected to decrease with incentives included in rationalization programs.

Reducing PSC limits for herring, crab, halibut, and salmon in the BSAI could impact the temporal nature of many fisheries. Fisheries which currently close seasonally because they exceed seasonal PSC limits could have even shorter seasons and possibly harvest less of the TAC if PSC limits are reduced. However, other measures implemented under PA.2 such as increased rationalization may lead to a reduction in prohibited species bycatch rates and thereby lessen the constraints of PSC limits on groundfish fisheries, regardless of whether or not the limits are reduced.

Ex-Vessel Value

The ex-vessel value of groundfish landed by catcher vessels is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by the smaller trawl catcher vessels and pot catcher vessels account for much of the increase in groundfish ex-vessel value. Longline vessels are expected to experience a significant reduction in ex-vessel value due to the decrease in catches of rockfish and sablefish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher vessels are expected to decrease under PA.2, but not significantly. Longline vessels account for most of the decrease in employment and payments to labor.

Impacts on Excess Capacity

The comprehensive rationalization program that would be implemented under PA.2 is expected to result in a significant decrease in excess capacity in the harvesting and processing sectors relative to the comparative baseline, leading to a significantly beneficial direct/indirect effect rating. One of the primary reasons for expanding the use of rights-based management is to prevent the build-up of excess harvesting and processing capacity or reduce excess capacity that already exists (NMFS 2001a). Excess capacity both contributes to, and is the result of, the race for fish, with its associated potential adverse impacts on profitability, product quality, and safety. Rights-based systems, whether they allocate shares of the catch to individuals or groups, are incentive adjusting methods, in that they attempt to control capacity by creating economic incentives for owners of vessels to decrease their use of labor and capital rather than by directly regulating the level of fishing effort.

The implementation of additional IFQ programs that end the race for fish and allow transfer of quota shares would be expected to lead to some consolidation of quota to fewer vessels. The degree of consolidation will vary depending on the level of excess capacity, economies of scale and scope in harvesting, and rules that restrict transfer and accumulation of quota shares (NMFS 2001a). Similar consolidation could occur with expanded use of cooperatives or CDQ programs. Some excess capacity, in the sense of an ability of vessels and processors to catch and harvest the TAC in less time than a maximum season length would allow, can be expected to persist regardless of what type of additional rights-based measures are put in place. This is generally the case for a number of reasons. It is often not economically efficient to operate at maximum possible production levels; there are typically certain times of the year when it is more efficient and profitable to harvest and process fish; and alternative uses for fishing and processing capital are limited (NMFS 2001a).

Average Costs

Possible increased area closures to protect habitat as well as restrictions on bottom trawling for pollock are likely to increase average costs. The comprehensive rationalization program is expected to significantly reduce costs, leading to conditionally significant adverse/significantly beneficial direct/indirect effects ratings. The significance of the increase in average costs is conditional because it is uncertain to what extent PA.2 would create marine protected areas and no-take reserves to protect habitat. If additional area closures are implemented, the spatial displacement of fishing effort could be large for some bottom trawl fisheries. Operating costs would be expected to increase as vessels must travel further to fish, and gross revenue may decline as vessels may be required to fish in less productive areas.

Restrictions on bottom trawling for pollock are likely to increase average costs. It is reasonable to assume that, subject to regulatory constraints, harvesters target catch with the gear that maximizes its value either by increasing the value (quality) of the fish or by decreasing the harvesting cost or both. To the extent that the historical fishing gear was used because it has the lowest cost per unit of catch, the prohibition on bottom trawling for pollock in the GOA would result in increased cost per unit of catch for those fishing vessels that switch to pelagic trawling. Moreover, these vessels would have to purchase new gear and learn to use it. For vessels that use bottom trawl gear exclusively, the conversion necessary to fish with pelagic trawl gear would be substantial in some cases. In addition to new trawl gear, the conversion could include a more powerful engine, new gear handling equipment on deck, and new electronics.

Increased rationalization is expected to reduce the costs of harvesting. Individual vessels will have the opportunity to select the least cost combination of fishing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective harvesting operations. Fixed costs will be reduced by consolidating harvesting operations and retiring or selling off vessels. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting rights and on the level of excess capacity prior to implementation of remedial measures.

Fishing Vessel Safety

A significant improvement or a conditionally significant reduction in fishing vessel safety could occur under PA.2 relative to the comparative baseline, leading to a significantly beneficial/conditionally significant adverse direct/indirect effects ratings. The significance of the decrease in vessel safety is conditional because it is uncertain to what extent PA.2 would close additional areas as MPAs or no-take reserves. Furthermore, the net effect of the various measures on fishing vessel safety is uncertain. The comprehensive rationalization program is expected to promote vessel safety by eliminating the race for fish. On the other hand, the spatial closures to protect habitat, if implemented, will limit the areas available for fishing and are likely to force vessels to operate farther from shore and in less than optimal weather conditions.

The implementation of rights-based systems under this FMP is expected to improve safety by reducing the pressure to fish under dangerous conditions (NMFS 2001a). The race for fish creates incentives to fish in areas and seasons with more hazardous weather and sea conditions and requires crew members to work for long stretches with little rest or sleep. Rights-based systems should slow down the fishing and reduce the financial penalty incurred by opting to stop fishing under unsafe conditions. The most important benefit of improved safety will be a decrease in fishery related injuries and loss of life. Other benefits include savings from not having to replace lost vessels and gear. Finally, significant improvements in safety, if they occur, should result in decreased insurance costs for industry (NMFS 2001a). At the same time, it is important to recognize that rationalized fisheries do not necessarily guarantee improvements in safety for fishermen. Under an IFQ program, for example, market opportunities may still encourage fishermen to fish at times or in places that are unsafe.

However, the additional area closures to protect habitat that may be implemented under PA.2 could result in vessels fishing farther from a port. This would decrease fishing vessel safety. Smaller catcher vessels based out of the Alaska Peninsula, Aleutian Islands, and Kodiak communities may be especially exposed to additional risks. These effects could be mitigated somewhat if individual fishing quotas were set aside for smaller vessels to fish in certain nearshore areas.

For a summary of the direct/indirect effects on catcher vessels under PA.2, please see Table 4.9-6.

Cumulative Effects of PA.2

This section assesses the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish ex-vessel value, employment, payments to labor, excess capacity, average costs, and fishing vessel safety.

<u>Groundfish Landings By Species Group</u>

- **Direct/Indirect Effects**. Insignificant cumulative effects are predicted under PA.2 for most species except for Pacific cod which is expected to increase significantly. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the retained harvests of these species.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Although there are currently reductions in the commercial salmon and crab fisheries, the predicted increases in retained harvest of Pacific cod (49 percent) may help mitigate that effect. Reductions in harvest of the A-R-S-O complex (29 percent) are projected to be significant but could be mitigated by the large increases in Pacific cod. Changes in other economic development activities and other sources of municipal and state revenue are expected to be mitigated by the increase in retained Pacific cod harvests. Overall, cumulative effects on groundfish landings by species group are projected to be insignificant under PA.2.

Ex-Vessel Value

- **Direct/Indirect Effects**. The total ex-vessel value of groundfish landed by catcher vessels is not expected to increase significantly under PA.2. Longline vessels are expected to experience a significant reduction in ex-vessel value due to the decrease in catches of rockfish and sablefish.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. While marginal changes in ex-vessel value in other fisheries may occur in the future, these changes are not expected to cumulatively affect groundfish ex-vessel value significantly. Other economic development activities and other sources of municipal and state revenue are not expected to have a significant cumulative effect on ex-vessel value under PA.2.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Changes in employment and payments to labor relative to the baseline under PA.2 are insignificant.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Given the current reductions in the salmon and crab fisheries, and the fact that many fishermen often participate in multiple fisheries, fewer fishermen may be able to support their participation in the groundfish fisheries as a result of these reductions. However, the opposite result may occur where more harvesters are competing for groundfish employment as a result of reductions in other fisheries. Though these changes may occur, they are not expected to result in significant cumulative effects on groundfish employment under PA.2. Payments to labor in other fisheries are not expected to contribute to cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on payments to labor are projected to be insignificant.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. Changes in excess capacity are likely to be significantly beneficial under PA.2.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Under PA.2, the comprehensive rationalization program would significantly reduce excess capacity. Although excess capacity would still remain in other fisheries such as salmon and crab, the program implemented under PA.2 would have such a strong effect that the benefits would far outweigh the effects of overcapacity in other fisheries (see Appendix F-8).

Average Costs

- **Direct/Indirect Effects**. Significantly beneficial or conditionally significant adverse effects are expected to occur for average costs under PA.2.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount while ex-vessel value and product value are variable. As described above, area closures affect average costs through increases or decreases in transit time to fishing areas. If additional closures are implemented under PA.2 to protect habitat, these closures would increase average costs by causing fishermen to travel farther to harvest fish. On the other hand, comprehensive rationalization is likely to significantly reduce average costs. Cost savings depend on the constraints put on the transfer and consolidation of harvesting rights and the level of excess capacity that might still remain in other fisheries. Therefore, significantly adverse or beneficial cumulative effects are possible under PA.2.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Significantly beneficial or conditionally significant adverse effects are predicted for fishing vessel safety under PA.2.

- **Persistent Past Effects**. The persistent past effects include foreign fisheries exploitation, over-harvesting, expansion or development of commercial services and marine infrastructure in coastal communities, development of JV fisheries leading to the development of domestic fish harvesting and processing capacity, increased global demand for seafood, the collapse of Atlantic cod in the 1990s, and the development of the Japanese surimi market. These contributed to increased demand for groundfish species (see Section 4.5.9).

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, and of distance to fishing areas and sea conditions relative to vessel size. Under PA.2, vessel safety could improve due to the end of the race for fish and rationalization. However, possible additional area closures implemented under PA.2, plus any closures implemented in other fisheries, may adversely affect vessel safety causing vessels to travel farther and in potentially dangerous weather conditions. Therefore, significantly beneficial or adverse cumulative effects are possible under PA.2.

4.9.9.1.2 Catcher Processors

Direct/Indirect Effects of PA.1

Groundfish Landings By Species Group

Comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 catcher processor conditions reveals that under PA.1 there would be few significant changes in overall groundfish catches relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 30 percent. Catches of pollock, flatfish, and A-R-S-O species are not expected to change significantly.

Groundfish Gross Product Value

The overall wholesale product value of groundfish outputs of catcher processors is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by head-and-gut trawl catcher processors, pot catcher processors, and longline catcher processors account for much of the increase in product value. The harvest of Pacific cod by surimi trawl catcher processors and fillet trawl catcher processors is limited by AFA sideboard measures that restrict the participation of AFA-eligible vessels in other groundfish fisheries to some level of historic participation.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under PA.1, but not significantly.

Product Quality and Product Utilization Rate

A conditionally significant increase in product quality and product utilization rates is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the increase in product quality and utilization is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. The race for fish creates incentives to maximize profits per unit of fishing time rather than per unit of fish. Consequently, it may induce wasteful practices or reduce the incentives to increase recovery rates if those increases are costly either in out-of-pocket costs or opportunity costs of time. Even when increased or full utilization is profitable in terms of the value and costs of product, there may be an implicit cost due to storage space limitations that will force more frequent unloading.

For the most part, rights-based systems should give individuals and groups the incentive to get the maximum value out of each unit of catch. Consequently, product quality and utilization rates are expected to increase under this FMP bookend should rights-based management be extended to additional fisheries. Some increases in value can be expected as a result of the improved quality that can be achieved by more careful harvesting and handling practices. In a race for fish these time-consuming practices may be neglected because the opportunity costs are too high. For example, vessels may choose to make shorter tows to reduce the crushing of fish in the codend or may spend more time searching for larger, more valuable fish. The value of production will increase because processors have the time and incentive to make products of higher value, and to retain fish they had previously discarded. For example, in rationalized fisheries head-and-gut trawl catcher processors may be more likely to retain male rock sole and small yellowfin sole because retention of those fish would no longer put vessels at a competitive disadvantage compared to vessels that discard.

Excess Capacity

As with catcher vessels, a conditionally significant decrease in excess capacity in the harvesting and processing sectors is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in excess capacity depends on the extent to which PA.1 extends rights–based management to additional groundfish fisheries.

Average Costs

As with catcher vessels, a conditionally significant decrease in average costs is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in average costs depends on the extent to which PA.1 extends rights-based management to additional groundfish fisheries.

Fishing Vessel Safety

As with catcher vessels, a conditionally significant increase in fishing vessel safety is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The increase in fishing vessel safety depends on the extent to which PA.1 extends rights-based management to additional groundfish fisheries.

For a summary of the direct/indirect effects on catcher processors under PA.1, please see Table 4.9-6.

Cumulative Effects of PA.1

This section assesses the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on catcher processors are presented in detail in Section 3.9 (Table 3.9-125), and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

<u>Groundfish Landings By Species Group</u>

- **Direct/Indirect Effects**. Overall, insignificant effects are expected for retained harvests of groundfish species except for Pacific cod which is expected to result in significant increases of the number of landings (30 percent).

- **Persistent Past Effects**. For details on persistent past effects, see Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects**. Given the current downward trends in the commercial salmon and crab fisheries, catcher processors that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. However, this cumulative effect may not result in significant changes in groundfish landings under PA.1. An increase in TAC for Pacific cod in the BSAI and GOA is expected (30 percent). Overall, reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under PA.1. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations as explained in more detail in Section 4.9.1, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

<u>Groundfish Gross Product Value</u>

- **Direct/Indirect Effects**. The gross product value is not expected to result in significant changes from the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (6 percent) that are predicted for PA.1 may mitigate some of the current declines in other fisheries. For these reasons, insignificant cumulative effects on gross product value are expected to result from PA.1.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Insignificant changes in employment and payments to labor are predicted for catcher processors under PA.1.
- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.
- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue. Details on these future external effects are listed at the beginning of Section 4.5.9.
- **Cumulative Effects**. The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (7 percent) under PA.1, is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are projected to increase slightly (6 percent) under PA.1, thereby, mitigating some of the reductions in other fisheries. These other fisheries are not expected to contribute to significant cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under PA.1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects**. Conditionally significant beneficial effects in product quality and product utilization rates are expected under PA.1 relative to the baseline.
- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.
- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).
- **Cumulative Effects**. Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has made significant differences in product quality and utilization; however, any continuation of this harvest strategy in fisheries may hinder some of these improvements. To the extent that rights-based management is extended to other fisheries under PA.1, increases in product quality and utilization are expected. Furthermore, increases in product quality and utilization are likely in the long-term given the trend towards improved fishing and preservation techniques. Thus, conditionally significant beneficial cumulative effects are projected under PA.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. Conditionally significant beneficial effects in excess capacity are expected under PA.1 relative to the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (see Appendix F-8). Cumulative effects are conditionally significant beneficial because to the extent that a rights-based management regime is extended to other groundfish fisheries under PA.1, excess capacity would be reduced.

Average Costs

- **Direct/Indirect Effects**. Conditionally significant beneficial effects in average costs are expected under PA.1 relative to the comparative baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Average costs in the groundfish fisheries are often associated or shared with other fisheries. Fixed costs are somewhat independent of the fisheries in that loan payments and general office and accounting expenses remain at a certain amount, while ex-vessel value and product value are variable. Catcher processors that are dependent on multiple fisheries are often sensitive to changes in other fisheries. Assuming rights-based management extends to other groundfish fisheries under PA.1, average costs would be reduced. Thus, conditionally significant beneficial cumulative effects are predicted on excess capacity under PA.1.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Conditionally significant beneficial effects for fishing vessel safety are expected under PA.1.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, distance to fishing areas and sea conditions relative to vessel size. Additional closures that may result from other fisheries management measures may increase the risk to fishermen; however, these effects are not expected to be significant under PA.1. The extent to which rights-based management is implemented under PA.1 will affect vessel safety. As there are no predicted increases in area closures under PA.1, and assuming rights-based management is extended to other groundfish fisheries, cumulative effects on vessel safety are conditionally significant beneficial compared to the baseline condition.

Direct/Indirect Effects of PA.2

Groundfish Landings By Species Group

A comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 catcher processor conditions reveals that under PA.2 there would be few significant changes in overall groundfish catches relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 22 percent. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the retained harvests of these species. Retained harvests of pollock and flatfish are not expected to change significantly. Bycatch of non-target species and PSC is expected to decrease with incentives included in rationalization programs.

Groundfish Gross Product Value

The overall wholesale product value of groundfish outputs of catcher processors is expected to increase relative to the comparative baseline, but not significantly. Increased Pacific cod harvests by head-and-gut trawl catcher processors, pot catcher processors, and longline catcher processors account for much of the increase in product value. The harvest of Pacific cod by surimi trawl catcher processors and fillet trawl catcher processors is limited by AFA sideboard measures that restrict the participation of AFA-eligible vessels in other groundfish fisheries to some level of historic participation.

Employment and Payments to Labor

Total groundfish employment and payments to labor by catcher processors are expected to increase under PA.1, but not significantly.

Product Quality and Product Utilization Rate

A significant improvement or a conditionally significant reduction in product quality and utilization rates could occur under PA.2 relative to the comparative baseline, leading to significantly beneficial and conditionally significant adverse direct/indirect effects ratings. The significance of the decrease in product quality and utilization is conditional because it is uncertain to what extent PA.2 would establish additional area closures to protect habitat. Furthermore, the net effect of the various measures on fishing vessel product quality and utilization is uncertain.

The implementation of a comprehensive rights-based management program will tend to improve product quality and utilization rates. The race for fish creates incentives to maximize profits per unit of fishing time rather than per unit of fish. Consequently, it may induce wasteful practices or reduce the incentives to increase recovery rates if those increases are costly either in out-of-pocket costs or opportunity costs of time. Even when increased or full utilization is profitable in terms of the value and costs of product, there may be an implicit cost due to storage space limitations that will force more frequent unloading. For the most part, rights-based systems should give individuals and groups the incentive to get the maximum value out of each unit of catch. Some increases in value can be expected as a result of the improved quality that can be achieved by more careful harvesting and handling practices. In a race for fish these time-consuming practices may be neglected because the opportunity costs are too high. For example, vessels may choose to make shorter tows to reduce the crushing of fish in the codend or may spend more time searching for larger, more valuable fish. The value of production will also increase because processors have the time and incentive to make products of higher value, where previously they had focused on products that could be produced quickly or with lower quality fish. For instance, we might expect to see more fillet production in place of round or headed-and-gutted product.

On the other hand, the additional area closures that are implemented under PA.2 may contribute to lower product quality. However, this effect is not likely to offset the gains from rationalization. It is reasonable to assume that, subject to regulatory constraints, harvesters target catch in areas that maximizes its value either by increasing the quality of the fish or by decreasing the harvesting cost or both. Consequently, a measure that prohibits vessels from using historical fishing grounds may result in a decline in product quality (e.g., fish may be smaller or a less uniform size).

Excess Capacity

As with catcher vessels, the comprehensive rationalization program that would be implemented under PA.2 is expected to result in a significant decrease in excess capacity in the harvesting and processing sectors relative to the comparative baseline, leading to a significantly beneficial direct/indirect effect rating. Because the number of catcher processors that are not AFA-eligible out number the vessels that are AFA-eligible, the reduction in excess capacity resulting from rationalization should be significant.

Average Costs

As with catcher vessels, possible increased area closures to protect habitat as well as restrictions on bottom trawling for pollock are likely to increase average costs. The comprehensive rationalization program is expected to significantly reduce costs, leading to conditionally significant adverse/significantly beneficial direct/indirect effects ratings. The significance of the increase in average costs is conditional because it is uncertain to what extent PA.2 would create MPAs and no-take reserves to protect habitat. Furthermore, the net effect of the various measures on average costs is uncertain.

Fishing Vessel Safety

As with catcher vessels, a significant improvement or a conditionally significant reduction in fishing vessel safety could occur under PA.2 relative to the comparative baseline, leading to conditionally significant adverse and significantly beneficial direct/indirect effects ratings. The significance of the decrease in vessel safety is conditional because it is uncertain to what extent PA.2 would close additional areas as MPAs or no-take reserves. Furthermore, the net effect of the various measures on fishing vessel safety is uncertain. The comprehensive rationalization program is expected to promote vessel safety by eliminating the race for fish. On the other hand, the spatial closures to protect habitat, if implemented, will limit the areas available for fishing and are likely to force vessels to operate farther from shore and in less than optimal weather conditions.

For a summary of the direct/indirect effects on catcher processors under PA.2, please see Table 4.9-6.

Cumulative Effects of PA.2

This section assesses the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on catcher processors are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. Overall, insignificant changes in groundfish harvests are expected under PA.2; however, significant increases in Pacific cod and significant decreases in sablefish and rockfish are predicted for this FMP.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.

- **Cumulative Effects**. As stated under PA.1, the current downward trends in the commercial salmon and crab fisheries are adversely affecting catcher processors that rely on a mix of fisheries harvests. However, this cumulative effect may not result in significant changes in groundfish landings under PA.2. An increase in TAC for Pacific cod in the BSAI and GOA is expected (22 percent). Harvests of pollock and flatfish are not expected to change significantly. Overall, the reductions in other fisheries, in combination with some increases in certain groundfish landings by species group, are expected to result in insignificant cumulative effects under PA.2. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects**. The gross product value is not expected to result in significant changes from the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described under PA.1, insignificant cumulative effects on groundfish gross product value are expected to result from PA.2.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Insignificant changes in employment and payments to labor are predicted for catcher processors under PA.2.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Total employment and payments to labor are expected to increase under PA.2. As with catcher vessels, reductions in the salmon and crab fisheries, and the reliance many fishermen have on participation in multiple fisheries may elevate the importance of participation in the groundfish fisheries. The increase, although slight, in groundfish employment (5 percent) under PA.2 may mitigate some of the reductions in other fisheries. Similarly, payments to labor are also projected to increase slightly (5 percent) under PA.2. Catcher processors that participate in the halibut fishery may be less sensitive to reductions in salmon and crab. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under PA.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects**. A significantly beneficial or conditionally significant adverse effect on product quality and product utilization rates is possible under PA.2.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has made significant differences in product quality and utilization; however, the additional closures that may be implemented under this FMP may result in a decline in product quality (e.g., fish may be smaller or a less uniform size). Overall, significant beneficial or adverse cumulative effects are possible for product quality and utilization under PA.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. A significantly beneficial effect in excess capacity is expected under PA.2 relative to the baseline. Excess capacity is predicted to decrease significantly.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As with PA.1, comprehensive rationalization in the groundfish fishery will help reduce excess capacity. Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (see Appendix F-8). Assuming that these programs continue in other fisheries and are expanded in the groundfish fisheries under PA.2, significant beneficial cumulative effects are expected for excess capacity.

Average Costs

- **Direct/Indirect Effects**. Various measures under PA.2 are likely to both increase and decrease average costs. The net effect of PA.2 on average costs is unknown (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described in more detail under PA.1, average costs in the groundfish fisheries are often associated or shared with other fisheries and include both fixed costs and variable costs. The effects of comprehensive rationalization under this FMP are likely to reduce costs. However, area closures affect average costs through increases in transit time to fishing areas. It is uncertain to what extent PA.2 would establish additional area closures. Therefore, significantly beneficial or adverse cumulative effects are possible under PA.2.

Fishing Vessel Safety

- **Direct/Indirect Effects**. Significant beneficial or conditionally significant adverse effects for fishing vessel safety are possible under PA.2. The net effect of this FMP on vessel safety is uncertain (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Vessel safety is primarily a function of the race for fish, distance to fishing areas, and sea conditions relative to vessel size. Under PA.2, vessel safety could improve due to the end of the race for fish and rationalization. However, possible additional area closures implemented under PA.2, plus any closures implemented in other fisheries, may adversely affect vessel safety causing vessels to travel farther and in potentially dangerous weather conditions. Therefore, significant beneficial or adverse cumulative effects on vessel safety are possible under PA.2.

4.9.9.1.3 Inshore Processors and Motherships

Direct/Indirect Effects of PA.1

Groundfish Landings By Species Group

A comparison of the five-year average of outcomes projected for the 2003-2007 period to 2001 inshore processor and mothership conditions reveals that under PA.1 there would be few significant changes in overall groundfish catches relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 50 percent. In addition, an increase in the TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant increase in the harvests of these species. Harvests of pollock and flatfish are not expected to change significantly.

Groundfish Gross Product Value

The wholesale product value of groundfish processed by inshore processors and motherships is expected to increase relative to the comparative baseline, but not significantly. Increased deliveries of Pacific cod to Bering Sea pollock shore plants, Alaska Peninsula, and Aleutian Islands shore plants, Kodiak shore plants, and floating inshore processors account for much of the increase in groundfish product value. Southeast Alaska shore plants and southcentral Alaska shore plants are expected to benefit from the increased catches of sablefish and rockfish.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore processors and motherships are expected to increase under PA.1, but not significantly.

Product Quality and Product Utilization Rate

As with catcher processors, a conditionally significant increase in product quality and product utilization rates is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The significance of the increase in product quality and utilization is conditional because it is uncertain to what extent PA.1 would extend rights-based management to additional groundfish fisheries. With additional fisheries operating under rights-based management rather than the race for fish, inshore processors will likely be able to slow their overall throughput and focus on obtaining the highest value per fish rather than the most fish per unit of time.

Excess Capacity

A conditionally significant decrease in excess capacity in the harvesting and processing sectors is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in excess capacity depends on the extent to which PA.1 extends rights-based management to additional groundfish fisheries. In contrast to the harvesting sector; however, rights-based management measures can increase the excess capacity of inshore processors in the short run. For example, when the IFQ program was established for the sablefish and halibut longline fisheries additional fresh-market processors and buyers entered the fisheries. In addition, existing processors that had increased capacity to cope with the fish gluts that occurred under race for fish found that they had more capacity than was necessary under the slower-paced IFQ fisheries. In contrast, in the BSAI pollock fishery under the AFA, processing capacity increases were specifically limited by restricting entry into the pollock fishery and sideboard restrictions imposed on AFA catcher vessels. In the long-run; however, excess processing capacity is expected to significantly diminish in rationalized fisheries.

Average Costs

As with catcher vessels, a conditionally significant decrease in average costs is expected under this FMP relative to the comparative baseline, leading to a conditionally significant beneficial direct/indirect effect rating. The decrease in average costs depends on the extent to which PA.1 extends rights-based management to additional groundfish fisheries.

Increased rationalization is expected to reduce the costs of processing. Individual processing facilities will have the opportunity to select the least cost combination of processing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective processing operations. Fixed costs will be reduced by consolidating processing operations and retiring or selling-off processing equipment. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting and processing rights and on the level of excess capacity prior to implementation of remedial measures.

For a summary of the direct/indirect effects on inshore processors and motherships under PA.1 (Table 4.9-6).

Cumulative Effects of PA.1

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on inshore processors and motherships are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. Overall, retained harvests of groundfish species are expected to be insignificant except for Pacific cod, which are expected to have significant effects.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.

- **Cumulative Effects**. Inshore plants and motherships that rely on a mix of groundfish, salmon, and crab may experience a reduction in harvest levels. Those that process halibut may be less sensitive to these reductions in other fisheries. The combination of increases in halibut, reductions in salmon and crab and relatively stable projections (except for significant increases in Pacific cod) for groundfish, may result in insignificant cumulative effects under PA.1. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate changes may result in potential increases or decreases in fish populations (see Section 4.9.1), these changes are not expected to result in significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects**. The gross product value is expected to increase, but not significantly from the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (7 percent) that are predicted for PA.1 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from PA.1.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Employment and payments to labor are expected to increase but not significantly under PA.1.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Processors that rely on salmon and crab may continue to experience reductions in employment and payments to labor. Groundfish employment and labor income projections under PA.1 are not significant (7 percent) but may mitigate some of the reductions due to salmon and crab. Processors may experience increases if they process halibut and groundfish due to recent increases in the halibut fishery. The combination of reductions and increases in these multiple fisheries are likely to result in insignificant cumulative effects on employment and payments to labor are expected under PA.1.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects**. A conditionally significant increase in product quality and utilization rate are expected under PA.1 relative to the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As with catcher processors, advances in technology have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has made significant differences in product quality and utilization; however, any continuation of this harvest strategy in fisheries may hinder some of these improvements. Overall, increases in product quality and utilization are likely in the long-term given the trend towards improved fishing and preservation techniques. Thus, conditionally significant beneficial cumulative effects are projected under PA.1.

Impacts on Excess Capacity

- **Direct/Indirect Effects**. A conditionally significant beneficial effect in excess capacity is expected under PA.1 relative to the baseline. Capacity is expected to decrease.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Although excess capacity still remains in other fisheries as well as the groundfish fishery, measures such as LLP and an end to the race for fish help mitigate this effect (see Appendix F-8). Should rights-based management extend to additional groundfish fisheries, excess capacity would be further reduced. Therefore, a conditionally significant beneficial cumulative effect is expected to occur for excess capacity under this FMP, particularly if other fisheries do not change their licensing programs.

Average Costs

- **Direct/Indirect Effects**. A conditionally significant beneficial effect in average costs are expected under PA.1 relative to the comparative baseline. Average costs are expected to decrease.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described under catcher vessels and catcher processors, average costs in the groundfish fisheries are often associated or shared with other fisheries and include both fixed and variable costs. Vessels that are dependent on multiple fisheries are often sensitive to changes in costs in other fisheries. As rights-based management may be extended to other fisheries under PA.1, a conditionally significant beneficial cumulative effect on average costs in the groundfish fisheries is expected.

Direct/Indirect Effects of PA.2

Groundfish Landings By Species Group

A comparison of the 5-year average of outcomes projected for the 2003-2007 period to 2001 inshore processor and mothership conditions reveals that under PA.2 there would be a number of significant changes in overall harvests of groundfish relative to the comparative baseline. As a result of a projected increase in the TAC for Pacific cod in the BSAI and GOA, catches of this species are expected to increase by about 44 percent. The implementation of a more conservative TAC for sablefish and rockfish (components of the A-R-S-O species group) will result in a significant reduction in the harvests of these species. Harvests of pollock and flatfish are not expected to change significantly. Bycatch of non-target species and PSC is expected to decrease with incentives included in rationalization programs.

Groundfish Gross Product Value

The overall wholesale product value of groundfish processed by inshore processors and motherships is expected to increase relative to the comparative baseline, but not significantly. Increased deliveries of Pacific cod to short plants in the Bering Sea (pollock), Alaska Peninsula, Aleutian Islands, Kodiak, and floating inshore processors account for much of the increase in groundfish product value. Decreased deliveries of rockfish and sablefish will have a significant adverse impact on the product value of shore plants southeast and southcentral Alaska. The product value of shore plants in the Alaska Peninsula, the Aleutian Islands, and Kodiak will be adversely affected by this decrease, but less so.

Employment and Payments to Labor

Total groundfish employment and payments to labor by inshore processors and motherships are expected to increase under PA.2, but not significantly.

Product Quality and Product Utilization Rate

As with catcher processors, a significant improvement or a conditionally significant reduction in product quality and utilization rates could occur under PA.2 relative to the comparative baseline. The net effect of the various measures on product quality and utilization is uncertain. The implementation of a comprehensive rights-based management program will tend to improve product quality and utilization rates. However, a large portion of the product currently produced by inshore processors and motherships is already produced in rationalized fisheries (e.g., sablefish longline fishery and BSAI pollock fishery). Furthermore, the additional area closures considered under PA.2 may cause product quality to decrease. Pacific cod and Alaska pollock are fragile fish whose quality deteriorates rapidly the longer the time from harvest to processing. As such, any factors that will increase the length of time to processing will, in general, lower the quality of the product produced. To the extent that PA.2 results in catcher vessels traveling farther distances from (inshore) processors, and thereby lengthening the time between harvest and processing, the quality of surimi, fillets, and roe will be adversely affected.

Excess Capacity

As with catcher vessels and catcher processors, the comprehensive rationalization program that would be implemented under PA.2 is expected to result in a significant decrease in excess capacity in the processing sectors relative to the comparative baseline in the long-term. In the short-term, however, a comprehensive rationalization may create excess capacity that would continue during the transition from the race for fish to rights-based management.

Average Costs

The net effect of PA.2 on average costs relative to the baseline is uncertain. If implemented, the area closures to protect habitat are likely to contribute to higher average costs for processors. On the other hand, a comprehensive rationalization program is expected to contribute to lower average costs. This leads to conditionally significant adverse and significant beneficial direct/indirect effects ratings for average costs under PA.2.

Although it is uncertain to what extent PA.2 would establish additional area closures to protect habitat, this FMP could include measures that result in considerable spatial displacement of fishing effort. The result could be substantial increases in average costs. However, an expanded rationalization program is expected to reduce the costs of processing. Individual processing facilities will have the opportunity to select the least cost combination of processing inputs. At the industry level, costs will fall because production is expected to shift over time toward the most cost effective processing operations. Fixed costs will be reduced by consolidating processing operations and retiring or selling off processing equipment. The cost savings will depend both on the constraints put on the transfer and consolidation of harvesting and processing rights and on the level of excess capacity prior to implementation of remedial measures.

Cumulative Effects of PA.2

This section will assess the potential for the direct/indirect effects to interact with persistent past effects and other reasonably foreseeable future events, resulting in a cumulative effect (Table 4.9-6). The persistent past effects on catcher vessels are presented in detail in Section 3.9 (Table 3.9-125) and the predicted direct/indirect effects are described above. Representative indicators for direct/indirect effects include groundfish landings by species group, groundfish gross product value, employment, payments to labor, excess capacity, product quality, product utilization rate, average costs, and fishing vessel safety.

Groundfish Landings By Species Group

- **Direct/Indirect Effects**. Projected increases in Pacific cod are expected under PA.2; however, sablefish and rockfish will decrease significantly. Pollock and flatfish harvests are not expected to change significantly.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue and are described in detail in Section 4.5.9.1.

- **Cumulative Effects**. Current downward trends in the commercial salmon and crab fisheries may put pressure on processors who do not rely on mixed harvests. Those processors that rely on groundfish and halibut catch may experience some increases in landings under PA.2. The significant increases in Pacific cod and the current increasing trends in halibut may counteract the reductions in other fisheries. Insignificant cumulative effects on groundfish landings are expected to result under PA.2. Other economic development activities and other sources of municipal and state revenue are not expected to contribute to cumulative effects on groundfish landings by species group. While climate change may result in potential increases or decreases in fish populations as explained in more detail in Section 4.9.1, these changes are not expected to have significant cumulative effects on groundfish landings by species group.

Groundfish Gross Product Value

- **Direct/Indirect Effects**. The gross product value is expected to increase from the baseline, but not significantly. Decreased deliveries of rockfish and sablefish will have a significant adverse impact on the product value of shore plants in southeast and southcentral Alaska. The product value of shore plants in the Alaska Peninsula, Aleutian Islands, and Kodiak will be adversely affected by this decrease but less so than southeast and southcentral Alaska.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described with catcher processors, changes in revenue streams that affect the ability of communities to provide municipal services, fund capital projects, borrow money, and retire or service debt have the greatest potential for cumulative effects on landing tax revenues from groundfish and non-groundfish fisheries (such as salmon, crab, and halibut). During recent years, state municipal revenue sharing, power cost equalization, and contribution to education programs have been decreasing. Marginal increases in gross product value (4 percent) that are predicted for PA.2 may mitigate some of the declines in other fisheries. For these reasons, insignificant cumulative effects on ex-vessel value are expected to result from PA.2.

Employment and Payments to Labor

- **Direct/Indirect Effects**. Insignificant effects are predicted for catcher processors under PA.2.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. The current reductions in the salmon and crab fisheries, and the fact that many fishermen rely on participation in multiple fisheries may elevate the importance of the groundfish and halibut fisheries. The increase, although slight, in groundfish employment (5 percent) under PA.2 is likely to mitigate some of the reductions in other fisheries. Similarly, payments to labor are projected to increase slightly (4 percent) under PA.2, thereby mitigating some of the reductions in other fisheries. Changes in other fisheries are not expected to contribute to cumulative effects on payments to labor in the groundfish fisheries. Therefore, cumulative effects on employment and payments to labor are expected to be insignificant under PA.2.

Product Quality and Product Utilization Rate

- **Direct/Indirect Effects**. A significant improvement or a conditionally significant reduction in product quality and utilization rates could occur under PA.2 relative to the baseline.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Technological advances have improved product quality and utilization for various fisheries throughout the world. The end of the race for fish has made significant differences in product quality and utilization; however, the possible increase in area closures may counteract any improvements in product quality achieved by better handling. Overall, increases in product quality and utilization are likely in the long-term given the trend towards improved fishing and preservation techniques. Thus, significant beneficial or adverse cumulative effects are possible under PA.2.

Impacts on Excess Capacity

- **Direct/Indirect Effects.** Significantly beneficial changes in excess capacity are possible under PA.2 relative to the baseline. The net effect of these measures on capacity is unknown (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. Although excess capacity still remains in other fisheries as well as the groundfish fishery, comprehensive rationalization and an end to the race for fish help mitigate this effect (see Appendix F-8). Assuming that these programs continue in other fisheries, as they do in the groundfish fisheries under PA.2, the cumulative effects on excess capacity are likely to be significantly beneficial compared the baseline.

Average Costs

- **Direct/Indirect Effects**. Both significantly beneficial and conditionally significant adverse effects are possible under this FMP. If implemented, spatial closures to protect habitat are likely to increase costs; however, comprehensive rationalization would decrease costs.

- **Persistent Past Effects**. For details on persistent past effects, see the beginning of Section 4.5.9.

- **Reasonably Foreseeable Future External Effects** include other fisheries, other economic development activities, and other sources of municipal and state revenue (see Section 4.5.9).

- **Cumulative Effects**. As described for catcher vessels and catcher processors, average costs in the groundfish fisheries are often associated or shared with other fisheries and include fixed and variable costs. Increases in closure areas increase costs whereas decreases in closures usually decrease costs. The cumulative effect on average costs under PA.2 is uncertain because it is unknown to what extent the FMP would create MPAs and no-take reserves to protect habitat. Furthermore, any cost increases that occur as a result of implementation of area closures could be offset to some extent by the cost reductions that are expected to occur as a result of comprehensive rationalization of the groundfish fisheries (see the direct/indirect effects discussion in this section). Significant beneficial or adverse cumulative effects are possible under PA.2.

4.9.9.2 Regional Socioeconomic Effects

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described below (Table 4.9-6). The past/present effects on regions that participate in the groundfish fishery are described in Section 3.9 (and summarized in Table 3.9-126) and below. These regions (illustrated in Figures 3.9-9 through 3.9-14) include the Aleutian Islands/Alaska Peninsula (comprised of the Aleutians East Borough and the Aleutians West Census Area, which includes the communities of Unalaska, Nikolski, Atka, Adak and the Pribilof Islands), Kodiak Island (Kodiak Island Borough, which includes the City of Kodiak) southcentral Alaska (the Kenai Peninsula Borough, Matanuska-Susitna Borough, Municipality of Anchorage (which includes the cities of Eagle River, Chugiak, and Girdwood), the Valdez-Cordova Census Area (which includes the PWS region), southeast Alaska (all of the southeastern part of the state, from Yakutat Borough to Dixon Entrance), Washington inland waters (all counties bordering Puget Sound and the Strait of Juan de Fuca), and the Oregon coast (Lincoln, Tillamook, and Clatsop counties, the three northernmost Oregon coastal counties). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case.

Due to the linkages of potential effects on regions that participate in the groundfish fishery to changes in harvest and processing levels under each of the policy alternatives and illustrative bookends, the direct and indirect effects of each alternative are based on an economic model that distributes potential effects to each of the participating regions. The indicators used to assess potential regional effects include the following:

- In-region Processing and Related Effects.

- Regionally Owned At-Sea Processors.

- Extra-regional Deliveries of Regionally Owned Catcher Vessels.

- In-region Deliveries of Regionally Owned Catcher Vessels.
- Total Direct, Indirect, and Induced Labor Income and full-time equivalents (FTEs).

As discussed earlier, these indicators reflect changes in other important regional characteristics such as secondary economic activity associated with the support of fishing, state and municipal revenue generated by fishing, and indirectly population, to the extent that it is related to employment opportunities (see Section 4.1.7).

Direct/Indirect Effects of PA.1

Under PA.1, in general there is a net overall increase in fishery socioeconomic indicator values over baseline conditions for all regions. For example, total value of processing sales increases over baseline conditions, while total processing and harvesting related income and employment increase for all regions combined. These changes typically do not rise to the level of significance. Overall, the pattern of change is driven by the same factors seen under FMP 1 (but the caveat of inaccurate distribution indicator values associated the A-R-S-O species group between the southcentral and southeast Alaska regions applies). The following subsections provide a region-by-region summary of change under PA.1 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under PA.1, total in-region groundfish processing value would increase (with increases occurring in the BSAI values), as would in region processing associated labor income and FTE jobs, but none of these increases would be considered significant. Regionally owned at-sea processing value (and associated payments to labor and FTEs) would increase in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease, but by a less than significant amount. Catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries would decrease for in-region deliveries, catcher vessel payments to labor. FTEs would decrease, but all of these changes are less than significant, and for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes. The total regional direct, indirect, and induced labor income, and FTE employment would increase under this alternative, but this increase would not be significant. Under Alternative PA.1, the more closely sector defined impacts may be considered less than significant on a local sector as well as a regional and most likely a multiple community basis. However, this alternative may result in a number of other types of impacts that could be significant under certain conditions.

Under PA.1 some structural changes in the fishery and support sector enterprises will accrue to this and other regions as a result of the rights-based and community based management, but in the absence of program specifications, it is not possible to identify those changes in a straightforward manner. In general, with a decline in the race for fish, consolidation is likely to occur within processing and harvesting sectors and across communities. However, rights-based programs may build in caps and/or community or regional protection measures to act as a governor on consolidation, and the impacts to particular communities or regions will depend on the nature and efficacy of those caps or restrictions. Also, in general terms, the number of processing and harvesting entities will decline, as will overall employment. Support sector businesses and some coastal communities that have large support sectors deriving benefits from seasonal peaks and the economic inefficiencies of current race-for-fish fisheries will experience adverse impacts, at least in the short-term during a transition to a lower, if more stable level of employment, and in general, higher labor income per remaining position. For example, the relatively well developed support service sector in Unalaska/Dutch Harbor derives marked benefits from the current economic inefficiency within the fishery. It is relatively expensive to provide services in the community, but under conditions where it is important to minimize down-time during a fishing season, services that cost more are often utilized. Under a rationalized fishery, cost considerations become relatively more important, giving service purchasers more options to the possible detriment of providers in relatively remote locations. These types of impacts will perhaps be most apparent or severe in this region due to a relative lack of diversification in local economies, although they will likely be seen in other regions as well, especially Kodiak. The economic modeling that generated the regional impact numbers accounted for the structural changes in the fishery, but did not account for potential community protection measures. As a result, impacts may be considered conditionally significant adverse, and dependent upon the specific yet-to-be-designed protection measures.

Kodiak Island. Total in-region groundfish processing value would increase, with higher values for GOA and BSAI values are not a significant portion of the regional total. Associated labor income and FTE jobs would increase, but none of these increases would be large enough to be significant. Regionally owned at-sea processing value would increase with the majority of the increase attributable to changes in the BSAI values. Associated labor income and FTEs would increase, and the increase in total value would be significant. In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales, and regionally owned at-sea processing accounts for about one-quarter of the total. Labor income and FTEs distribution between these processing sectors follow a similar pattern. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase, as would catcher vessel payments to labor and FTE jobs associated with extra-regional deliveries, but these increases would not be significant. For in-region deliveries, catcher vessel payments to labor would increase and FTEs would decrease, but these changes would be less than significant and over a smaller base than seen for extra-regional deliveries. On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was observed in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would increase, as would FTE employment under this alternative, but none of these changes would be considered significant. For the Kodiak Island region, Alternative PA.1 would not result in significant impacts on a local sector basis, or on a regional or community basis. As noted under the Alaska Peninsula and Aleutian Islands region discussion, there could be some adverse impacts to Kodiak Island region support services due to changes associated with the rationalization of the fishery, but Kodiak could also be the beneficiary of service business displaced from more remote locations, so the net impact is unknown.

Southcentral Alaska. Total in-region groundfish processing value would increase by 36 percent (all are attributable to GOA increases), as would associated labor income and FTE jobs. Regionally owned at-sea processing value would increase by 28 percent with relatively large increases in the BSAI values and smaller increases in the GOA values. Associated labor income and FTEs would each also increase by 28 percent. In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales, and regionally owned at-sea processing accounts for about one-fifth of the total. Labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector. The value of extra-regional deliveries by regionally owned catcher vessels would increase, but by an insignificant amount, while in-region deliveries would increase by 44 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would each also increase by about 44 percent. In this region, catcher vessel-associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase by about 28 percent, and FTE employment would increase by 21 percent. For the southcentral Alaska region, Alternative PA.1 would have significantly beneficial impacts on a local sector basis, but it is important to recognize that some of these changes may be overstated and some understated for the southeast Alaska region. Impacts to the region as a whole and participating communities may be less significant than would otherwise appear to be the case, given the diversified nature of the local economies and the relative lack of dependence on groundfish related activities.

Southeast Alaska. Total in-region groundfish processing value would decrease by a negligible amount; all are attributable to GOA decreases. Associated labor income and FTE jobs would decrease but both have relatively low base values. Regionally owned at-sea processing value would increase by 25 percent with increases in both BSAI and GOA values, and associated labor income and FTEs would each also increase by 25 percent. In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales, and regionally owned at-sea processing accounts for about three-tenths of the total. Labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector. The value of extra-regional deliveries by regionally owned catcher vessels would increase by a slightly less than significant amount, and in-region deliveries would decrease by a negligible amount. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would increase and in-region deliveries, catcher vessel payments to labor and FTEs would remain about the same. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution, as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would increase as would FTE employment, but these changes would be less than significant. The impacts from Alternative PA.1 is significant beneficial for some local sectors, but impacts on a regional basis for southeast Alaska are less than significant, and are likely to be so for the involved communities, given the local economic diversity and relatively light dependence on the groundfish fishery.

Washington Inland Waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small fluctuations in the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes not significant. Regionally owned at-sea processing value would increase with increases in both BSAI and GOA values, although GOA values are comparatively small. Associated labor income and FTEs would both increase, but these changes would be less than significant. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase, as would catcher vessel payments to labor and FTE jobs associated with extra regional deliveries, and those associated with in-region deliveries. However, none of these changes would rise to the level of significance. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase as would FTE jobs, but these changes would not be significant. Alternative PA.1 would have consistently beneficial effects in the Washington inland waters region, but these gains would not rise to the level of significance on a local sector, regional, or community basis.

Oregon Coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this alternative. Similarly, there are currently no regionally owned at-sea processors under baseline conditions and none foreseen under this alternative, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase, as would associated labor income and FTE jobs, but these increases would not be significant. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this alternative. The total regional direct, indirect, and induced labor income would increase, as would FTE employment, but these changes would not be significant. Alternative PA.1 would have consistently beneficial impacts for the Oregon coast region, but these would not rise to a level of significance for local sectors, the region, or individual communities.

Cumulative Effects of PA.1

See Table 4.9-6 for a summary of the cumulative effects on regions and communities under PA.1.

In-Region Processing and Related Effects

- **Direct/Indirect Effects**. For PA.1, direct/indirect effects are considered insignificant for most regions except the southcentral Alaska region where a significantly beneficial increase is expected to occur.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, Alternative 1, Section 4.5.9.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts (see Section 4.5.9).

- **Cumulative Effects.** Under PA.1, cumulative effects on in-region processing and related characteristics, such as municipal revenue and secondary economic development, are generally insignificant, although for different reasons in different regions. The influence of external factors is adverse for many of the in-region processors based in Alaska and their associated regions. Trends in multi-species fisheries and other sources of municipal and state revenue, primarily due to the continued crab closures, downturn in salmon and reductions in state and municipal revenue result in adverse effects on in-region processing and municipal revenue. These adverse external effects are somewhat offset by increases in Alaska in-region processing, resulting in a finding of insignificant cumulative effect except in portions of the Alaska Peninsula/Aleutian Islands Region. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant, and there are no reasonably foreseeable events that would have a significant contribution, resulting in a finding of insignificant cumulative effect.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects**. Under PA.1, direct/indirect effects are considered significantly beneficial for Kodiak Island, southcentral Alaska, and southeast Alaska regions. Direct/indirect effects are generally insignificant for the Alaska Peninsula/Aleutian, Washington inland waters, and Oregon coast regions.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue (see Section 4.5.9).

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts (see Section 4.5.9).

- **Cumulative Effects**. Under PA.1, cumulative effects on regionally owned at-sea processing and on related characteristics, such as municipal revenue and secondary economic development, are generally insignificant. While direct/indirect effects are beneficial for Kodiak Island, southcentral Alaska, and southeast Alaska, the size and diversity of the southcentral Alaska regional economy, and offsetting adverse external factors related to other fisheries result in insignificant cumulative effects. Direct/indirect effects are insignificant in the Alaska Peninsula/Aleutian Islands, Washington inland waters, and Oregon coast regions. As indicated previously, with a more diversified economy and population base, cumulative effects on the at-sea processors in Kodiak will be insignificant for the Washington inland waters, and Oregon coast regions, as are effects for the Alaska Peninsula/Aleutian Islands.

Extra-regional Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects**. Under PA.1, direct and indirect effects are insignificant for all regions.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut (see Section 4.5.9).

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects**. Under PA.1, extra-regional deliveries increase and direct/indirect effects are insignificant for all six regions. Given the size and diversity of regional economies in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. Extra-regional deliveries decrease to the Alaska Peninsula/Aleutian Islands; adverse external effects related to other fisheries and revenue sharing results in a conditionally significant adverse cumulative effect for some communities within this region.

In-Region Deliveries of Regionally Owned Catcher Vessels

- **Direct/Indirect Effects**. Under PA.1, direct/indirect effects are insignificant with slight increases or decreases for all regions except southcentral Alaska, where the increase is significantly beneficial.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects**. Under PA.1, the direct/indirect effects range from beneficial to mostly insignificant. Given the size and diversity of regional economies in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. Extra-regional deliveries decrease to the Alaska Peninsula/Aleutian Islands; adverse external effects related to other fisheries and revenue sharing results in a conditionally significant adverse cumulative effect for some communities within this region.

Total Direct, Indirect, and Induced Labor Income and FTE's

- **Direct/Indirect Effects**. Under PA.1, direct/indirect effects on labor income and employment are significantly beneficial for the southcentral Alaska region, and insignificant for the rest of the regions.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects**. Under PA.1 direct/indirect effects on labor income and employment are insignificant for all regions, except southcentral Alaska, which is significantly beneficial. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Adverse trends in other fisheries (particularly salmon) and reductions on municipal revenue, decrease regional labor income and employment benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Island, and southeast Alaska regions. Cumulative effects are generally insignificant in all regions, except for portions of the Alaska Peninsula/Aleutian Islands, where effects are conditionally significant adverse.

Direct/Indirect Effects of PA.2

Under PA.2, in general, there is more variation of gains and losses in socioeconomic indicator values across regions than seen in the previous alternatives. While total value of processing sales increases over baseline conditions by a less than significant amount, and while total processing and harvesting related income and employment increase for all regions combined by a less than significant amount, there are a variety of increases and decreases behind these totals. A more conservative TAC for sablefish and rockfish has a disproportionate, adverse impact on the southcentral and southeast Alaska regions, and on the Kodiak region. The western GOA area experiences a relative decline of Pacific cod related values. On the highest level of aggregation, the Alaska Peninsula and Aleutian Islands, Washington inland waters, and Oregon coast regions experience a net beneficial impact under Alternative PA.2, whereas the Kodiak, southcentral, and southeast Alaska regions experience a net adverse impact in socioeconomic terms. Under this alternative there are many local area closures and it is to be expected (but not apparent in the data) that the smaller catcher vessels with less effective range and less inherent geographic flexibility would feel disproportionate impacts in all regions. The rationalization that occurs under this alternative would likely serve to ameliorate the adverse impacts of area closures for most of the fleet, but inherent limitations associated with size would render these offsetting benefits less viable for the small vessels of the fleet. For all vessels, the beneficial impacts of rationalization are conditional on being able to find fish outside of the closed areas. These pragmatic challenges may push adverse impacts from borderline to significant for some communities, depending the composition of the local fleet, particularly in the southcentral and southeast Alaska regions. The following subsections provide a region-by-region summary of change under Alternative PA.2 as compared to the baseline.

Alaska Peninsula and Aleutian Islands. Under Alternative PA.2, total in-region groundfish processing value would increase, with increases in the BSAI portion somewhat offset by decreases in the much smaller GOA portion of the total. Regional processing associated labor income and FTE jobs would increase as well, but these increases would be insignificant. Regionally owned at-sea processing value and associated payments to labor and FTEs would increase in percentage terms, but this is a very small sector in this region, with negligible impact on a regional basis. The value of extra-regional deliveries by regionally owned catcher vessels would decrease by 17 percent, while in-region deliveries by regionally owned catcher vessels would decrease by 22 percent. Catcher vessel payments to labor would decrease 17 percent and FTE jobs associated with extra-regional deliveries would decrease by about 23 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 22 and 23 percent, respectively, but for both extra-regional and in-region catcher vessel deliveries, the absolute values for this region are relatively small. With respect to the relative importance of the different sectors to net regional impacts, the in-region processing related activity accounts for the vast majority of fishery associated labor income and FTEs, so the increases seen in processing values would be disproportionately important in relation to changes seen in the other sectors. Further, in-region processing value may be taken as a proxy for regionally important municipal and borough revenues generated by local fish taxes. The total regional direct, indirect, and induced labor income would increase as would FTE employment, but these changes would be less than significant. In terms of quantitative output, the impacts of Alternative PA.2 on the Alaska Peninsula and Aleutian Islands region are a mixture of adverse and beneficial when examined on a local sector basis, but are in and of themselves not likely to illustrate significant impacts on the regional level. Community level quantitative data are largely unavailable due to confidentiality restrictions. There are two other types of regional or community impacts likely under this alternative that are not apparent in the quantitative data.

In general, as noted under PA.1, with a decline in the race for fish, consolidation is likely to occur within processing and harvesting sectors and across communities. However, rights based programs can include caps and/or community or regional protection measures to act as a governor on consolidation, and the impacts to particular communities or regions will depend on the efficacy of those caps or restrictions. Also in general terms, the number of processing and harvesting entities will decline, as will overall employment. Support sector businesses and some coastal communities that have large support sectors, that derive benefits from seasonal peaks and the economic inefficiencies of current race-for-fish fisheries will experience adverse impacts, at least in the short-term during a transition to a lower if more stable level of employment and, in general, higher labor income per remaining position. These types of impacts will be seen in other regions as well, especially Kodiak, but will perhaps be most apparent in this region due to a relative lack of diversification in local economies. The economic modeling that generated the regional impact numbers accounted for the structural changes in the fishery, but does not account for potential community protection measures. As a result, impacts may be considered conditionally significant, and dependent upon the future protection measures.

Another type of impact that is not captured by the economic output model is likely to be important for some communities in the Alaska Peninsula and Aleutian Islands region. Under PA.2, more areas are set aside for MPAs, and the impact of these on communities, especially communities with relatively small vessel fleets with limited range and flexibility to move between major fisheries, may be relatively large. However, the ultimate determinant of the level of impact of this type of management approach will be the efficacy of the counterbalancing alternative features designed to respect traditional fishing grounds and maintain open area access for coastal communities. It is not possible to assess this balance in advance of having either the MPA areas or the community protection measures specified. As a result, impacts of this nature are likely to be conditionally significant. The small vessel fleets within this region are particularly vulnerable. Further, communities within this region that have both support service sectors that may experience decline as a result of rationalization and small vessel fleets may experience interactive impacts that are not apparent from quantitative modeling outputs.

Kodiak Island. Total in-region groundfish processing value would decrease and associated labor income and FTE jobs would decrease, but none of these changes would be significant. Regionally owned at-sea processing value would increase with the vast majority of the increase attributable to changes in the BSAI values. Associated labor income and FTEs would increase, but none of these changes would rise to the level of significance. In this region under baseline conditions, in-region processing accounts for about three-quarters of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-quarter of the total. Labor income and FTE distribution between these processing sectors follow a similar pattern. The value of extra-regional deliveries by regionally owned catcher vessels would increase as would catcher vessel payments to labor associated with extra-regional deliveries, but all of these changes would be less than significant, and FTE jobs would remain about the same. For in-region deliveries, the total value would remain generally the same while catcher vessel payments to labor and FTEs would decrease by insignificant amount, and over a smaller base than seen for extra-regional deliveries. On a regional basis, catcher vessel activity is a relatively more important component of fishery associated labor income and FTEs than was seen in the Alaska Peninsula/Aleutian Islands region, but processing activity still dominates these categories in the regional totals. The total regional direct, indirect, and induced labor income would decrease as would FTE employment, but all of these changes would be minimal. For the Kodiak Island region, Alternative PA.2 will have less than significant impacts on a local sector basis, as well as on a regional and community of Kodiak basis. As was the case for the Alaska Peninsula and Aleutian Islands region, there may be conditionally significant impacts that accrue to the support service sector as a result of the rationalization features of this alternative and the smaller vessels in the fleet due to the inherent lack of flexibility in dealing with extensive MPA set asides and, perhaps, the inability to take advantage of the potentially ameliorating nature or features of rationalization.

Southcentral Alaska. Total in-region groundfish processing value would decrease with all being attributable to GOA decreases. Associated labor income and FTE jobs would decrease, but these decreases would not be considered significant. Regionally owned at-sea processing value would decrease with decreases in the BSAI values and GOA values. Associated labor income and FTEs would decrease, but these changes would be less than significant. In this region under baseline conditions, in-region processing accounts for about four-fifths of the combined processing total value of sales and regionally owned at-sea processing accounts for about one-fifth of the total; labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector. The value of extra-regional deliveries by regionally owned catcher vessels would decrease and in-region deliveries increase, but not significantly. Catcher vessel payments to labor would decrease a less than significant amount and FTE jobs associated with extra regional deliveries would decrease by about 19 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would increase, but not significantly. In this region, catcher vessel associated FTE jobs far surpass processing FTEs in the regional totals, but payments to labor for processing still surpass those for catcher vessels. Processing labor income figures for this region should be treated with caution as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease as would FTE employment, but none of these changes would appear significant. For southcentral Alaska, PA.2 would not result in significant impacts at either the local sector or the regional level. However, there may be conditionally significant impacts to some community small vessel fleets, but that cannot be ascertained prior to the development of specific features of the rationalization and MPA management approaches.

Southeast Alaska. Total in-region groundfish processing value would decrease by 33 percent and is attributable to GOA decreases. Associated labor income and FTE jobs would also decrease by 33 percent, but both are relatively low values. Regionally owned at-sea processing value would increase, with increases in both BSAI values and GOA values. Associated labor income and FTEs would decrease, but none of these changes are significant. In this region under baseline conditions, in-region processing accounts for about seven-tenths of the combined processing total value of sales and regionally owned at-sea processing accounts for about three-tenths of the total. Labor income follows a similar pattern, but FTE employment is somewhat more heavily weighted toward the at-sea sector. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would decrease by 24 and 35 percent, respectively. Catcher vessel payments to labor and FTE jobs associated with extra regional deliveries would both decrease by about 24 percent. For in-region deliveries, catcher vessel payments to labor and FTEs would decrease by about 35 and 34 percent, respectively. For this region, catcher vessel FTE employment far outpaces processing related employment, but payments to labor for processing still outpace those for catcher vessels. Processing labor income figures for this region should be treated with caution as the model tends to overstate actual payments due to the relative proportion of high value species processed. The total regional direct, indirect, and induced labor income would decrease by about 22 percent and FTE employment would decrease by about 22 percent. For the southeast Alaska region, Alternative PA.2 would have significant impacts on some local sectors, but a caveat on this data is that impacts to the southcentral Alaska region may be somewhat overstated in a beneficial direction, and the impacts to southeast Alaska may be somewhat overstated in a adverse direction. Overall, impacts on the regional level or even on the involved community level are unlikely to be significant given the overall diversity of community economies in this region, and the relative lack of dependency specifically on groundfish. On the other hand, there could be conditionally significant impacts that accrue to the local small vessel fleet as a result of specific rationalization and MPA features that are unknown at this time, as noted in earlier regional sections.

Washington Inland Waters. Total in-region groundfish processing value changes are negligible on a regional basis due to low baseline values and small changes from the baseline. Associated labor income and FTE jobs would increase by large percentages, but their overall low value render these changes insignificant. Regionally owned at-sea processing value would increase with increases in both BSAI and GOA values, although GOA values are comparatively very small. Associated labor income and FTEs would decrease, but these increases would be less than significant. The value of extra-regional and in-region deliveries by regionally owned catcher vessels would increase by less than significant amounts. Catcher vessel payments to labor associated with extra regional deliveries would increase and FTE jobs would decrease, but these changes would not be significant. For in-region deliveries, catcher vessel payments to labor and FTEs would increase, but not significantly. In this region, processing dominates the regional labor income and FTE employment totals when compared to analogous catcher vessel figures, but it is important to note that catcher vessel totals are still far higher for this region than for any other. The total regional direct, indirect, and induced labor income would increase, but these changes would be less than significant. The total regional direct, indirect, and induced FTE employment would decrease slightly, but not significantly. In general, the impacts of Alternative PA.2 would not be significant for the Washington inland waters region. Impacts to local sectors are likely to be less than significant, and as are impacts to communities, given the size and nature of local economies, and the relative lack of groundfish dependency on the community or regional level. The concerns regarding small vessel fleets and MPAs under this alternative do not apply to the Washington inland waters region in the same way that they do to the Alaska regions, nor do concerns regarding unintentional consequences of rationalization on support sector businesses. Washington inland waters region support sector enterprises are likely to be the beneficiaries of increased efficiency within the fishery, and a reallocation or redistribution of support functions away from remote locations closer to the grounds.

Oregon Coast. Total in-region groundfish processing value changes are zero, along with associated labor income and FTE jobs, as there is no activity under baseline conditions or under this alternative. Similarly, there are no regionally owned at-sea processors under baseline conditions or foreseen under this alternative, so all processing values, labor income, and FTE job values are zero. The value of extra-regional deliveries by regionally owned catcher vessels would increase, as would associated labor income and FTE jobs, but these increases would not be significant. There is no in-region activity by catcher vessels owned in this region, so all values for product, labor income, and FTE jobs are zero under both baseline conditions and this alternative. The total regional direct, indirect, and induced labor income would increase as would FTE employment, but these changes would be considered less than significant. Under PA.2, Oregon coast local sectors would experience beneficial but less than significant impacts. Regional and community impacts would be considered beneficial, but less than significant. This region would not experience adverse impacts to the small vessel fleet from MPAs and rationalization as may be seen in the Alaska regions, nor is it likely to lose or gain significantly in the changes in support sector businesses that may accompany further rationalization of the fishery.

Cumulative Effects of PA.2

In-Region Processing and Related Effects

- **Direct/Indirect Effects.** For PA.2, direct/indirect effects are considered insignificant for all regions except the southeast Alaska region, which would see a significantly adverse decrease.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the analysis for in-region processing, Alternative 1, Section 4.5.9.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts (see Section 4.5.9).

- **Cumulative Effects.** Under PA.2, in terms of direct/indirect impacts, the Alaska Peninsula and Aleutian Islands, Washington inland waters, and Oregon coast regions experience a net beneficial impact, whereas the Kodiak Island, southcentral, and southeast Alaska regions experience a net adverse impact. Within these latter three Alaska regions, decreases in processing values are exacerbated by the adverse external effects in other fisheries, economic development and state and municipal revenue. Southcentral Alaska has a relatively diversified economy and cumulative effects would be insignificant. Cumulative effects for Kodiak Island, southeast Alaska and portions of the Alaska Peninsula and Aleutian Islands are likely to be conditionally significant adverse. For the Washington inland waters and Oregon coast regions, direct/indirect effects are insignificant and there are no reasonably foreseeable events that would have a significant contribution; the cumulative effects on these regions are therefore insignificant.

Regionally Owned At-Sea Processors

- **Direct/Indirect Effects.** For PA.2, direct/indirect effects are insignificant for all regions (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and to a lesser extent, trends in state and municipal revenue (see Section 4.5.9).

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts (see Section 4.5.9).

- **Cumulative Effects.** Under PA.2, direct/indirect effects are insignificant for all six regions. Cumulative effects are also insignificant for PA.2, for the same reasons discussed under PA.1.

<u>Extra-regional Deliveries of Regionally Owned Catcher Vessels</u>

- **Direct/Indirect Effects.** Under PA.2, direct and indirect effects are insignificant for all regions, except Alaska Peninsula/Aleutian Islands and southeast Alaska regions where they are significantly adverse (see the direct/indirect effects discussion in this section).

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. Catcher vessels are affected by changes that have occurred in the groundfish industry related to allocation and AFA sideboards, and by their participation in multi-species fisheries, particularly salmon, crab, and halibut (see Section 4.5.9).

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities. other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects.** Under PA.2, cumulative effects are insignificant for four of the six regions, but adverse for Alaska Peninsula/Aleutian Islands and southeast Alaska regions. Given the size and diversity of regional economies in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. In southeast Alaska and the Alaska Peninsula/Aleutian Islands, adverse external effects are likely to result in conditionally significant adverse cumulative effects.

<u>In-Region Deliveries of Regionally Owned Catcher Vessels</u>

- **Direct/Indirect Effects.** Under PA.2, direct/indirect effects are insignificant for the Kodiak Island, southcentral Alaska, Washington inland waters, and Oregon coast regions. Effects are significantly adverse for the Alaska Peninsula/Aleutian Islands and southeast Alaska regions. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives; for more detail see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects.** Under PA.2, direct/indirect effects of in-region deliveries range from mostly insignificant to significantly adverse. Given the size and diversity of regional economies in southcentral Alaska, Washington inland waters, the Oregon coast, and to a lesser extent Kodiak Island, potential adverse external effects are offset and cumulative effects are insignificant. In the Alaska Peninsula/Aleutian Islands and southeast Alaska regions, significant adverse direct/indirect effects combine with adverse external effects in other fisheries and revenue sharing to result in a conditionally significant adverse cumulative effect.

<u>Total Direct, Indirect, and Induced Labor Income and FTE's</u>

- **Direct/Indirect Effects.** Under PA.2, direct/indirect effects on labor income and employment are insignificant for all regions except southeast Alaska, which is significantly adverse. Refer to the previous section for a more detailed discussion of direct/indirect effects.

- **Persistent Past Effects**. The persistent past effects include trends and developments in fisheries, trends in state and municipal revenue, and public infrastructure and facility projects. Fishing is a major component of income and employment in many small Alaskan coastal communities. Federal, state, and local revenue has funded public infrastructure and facility projects that generate income and employment in many regions and communities. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects that are external to the proposed action include other state and federal fisheries, other economic development activities, other sources of municipal and state revenue, and effects of long-term climate changes and regime shifts. These effects are the same for all indicators of effect for all alternatives. For more detail, see the discussion of persistent past effects under in-region processing in Alternative 1, Section 4.5.9.2.

- **Cumulative Effects.** Under PA.2, employment decreases in all Alaska regions, but is insignificant except in southeast Alaska where effects are significantly adverse. Within southcentral Alaska, Washington inland waters, and Oregon coast regions, fisheries are a small part of the regional economies and effects are dwarfed by other trends. Adverse trends in other fisheries, particularly salmon, and reductions on municipal revenue, decrease regional labor income and employment benefits, particularly in the Alaska Peninsula/Aleutian Islands, Kodiak Islands, and southeast Alaska regions. Cumulative effects are generally insignificant in all regions, except for portions of the Alaska Peninsula/Aleutian Islands and southeast Alaska regions, where effects are conditionally significant adverse.

4.9.9.3 Community Development Quota Program

The predicted direct and indirect effects of the groundfish fishery under the PA.1 and PA.2 are described below (Table 4.9-6). The past/present effects on CDQ are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicator used in this analysis is allocation of catch to CDQ groups. It should be noted that allocation reflects potential revenue to CDQ groups, and indirectly the potential funds that are available for approved economic development activities in CDQ communities.

Direct/Indirect Effects of PA.1 and PA.2

Under PA.1, the CDQ program would continue to operate as it does under baseline conditions. Under PA.1, no adverse changes to the CDQ program or region in comparison to baseline conditions are foreseen.

Under PA.2, the CDQ program would continue to operate as it does under baseline conditions. Under PA.2, no adverse changes to the CDQ program or region in comparison to baseline conditions are foreseen. Refer to Table 4.9-6 for a summary of the direct/indirect effects on CDQ programs under PA.1 and PA.2.

Cumulative Effects of PA.1 and PA.2

<u>CDQ Allocations</u>

- **Direct/Indirect Effects**. The direct/indirect effects of both PA.1 and PA.2 would be insignificant.

- **Persistent Past Effects.** The past/present effects on the CDQ program for groundfish fisheries include establishment of the CDQ program; FMP amendments that further added or defined CDQ in 1992, 1995, 1996, and 1998; establishment of multi-species CDQ programs, and persistent limitations on economic development and associated employment activities. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, other economic development activities, other sources of municipal and state revenue all have the potential to affect the CDQ program adversely or beneficially. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects**. Under PA.1 and PA.2, a cumulative effect is identified for the CDQ program, and the effect is judged to be insignificant. With guaranteed CDQ shares through the CDQ program continuing to operate, no significantly adverse cumulative impacts to the CDQ program are expected.

4.9.9.4 Subsistence

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described below (Table 4.9-6). The past/present effects on subsistence are described in Section 3.9 and below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, sport and personal use, and long-term climate changes and regime shift.

Direct/Indirect Effects of PA.1 and PA.2

Potential impacts to subsistence fall into four main categories: subsistence use of groundfish, subsistence use of Steller sea lions, salmon bycatch issues, and indirect impacts on other subsistence activities, including loss of income that would otherwise be directed toward subsistence pursuits and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. Under this alternative, no changes in the commercial fishery are anticipated that would result in impacts to baseline subsistence groundfish fishing conditions. There is no indication that this alternative would have a adverse impact on Steller sea lion subsistence activities or take over baseline conditions. Salmon bycatch would likely be decreased under PA.1 and PA.2 due to a moderate reduction in PSC limits and rationalization incentives under PA.2, but available information does not suggest that such reductions, while presumably beneficial for salmon subsistence resource use, would result in significant increases in salmon returns to salmon subsistence fishery areas. Catcher vessel activity and labor income are anticipated to increase under this alternative; therefore, no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

Cumulative Effects of PA.1 and PA.2

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described above (Table 4.9-6). The past/present effects on subsistence are described in Section 3.9 (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case. Representative indicators used in this analysis are the same as those used in the direct/indirect analysis and include subsistence use of groundfish, subsistence use of Steller sea lions, subsistence use of salmon, and indirect impacts on other subsistence activities such as income and joint production opportunities.

Subsistence Use of Groundfish

- **Direct/Indirect Effects**. Under this alternative, no changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline subsistence groundfish fishing conditions.

- **Persistent Past Effects.** Foreign, JV, domestic, and state-managed fisheries have decreased populations of some species of groundfish used for subsistence. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects**. Other fisheries and long-term climate change have a potential to adversely contribute to subsistence use of the groundfish fisheries. Economic development and sport and personal use are not likely to adversely contribute to subsistence use of the groundfish fisheries. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.1 and PA.2, a cumulative effect is identified for subsistence use of groundfish, but is judged to be insignificant. The external impacts of other fisheries, other economic development activities, and sport and personal use of groundfish are not likely to contribute to significantly adverse cumulative effects on the groundfish fisheries. However, other state-managed fisheries could have adverse impacts to the subsistence use of groundfish due to direct competition for the same species, but are not considered to be significant. The long-term climate change could adversely effect groundfish stocks.

Subsistence Use of Steller Sea Lions

- **Direct/Indirect Effects**. There is no indication that this alternative would have an adverse impact on Steller sea lion subsistence activities or take over baseline conditions.

- **Persistent Past Effects**. The past/present effects on subsistence use of Steller sea lions include the following: a long-term decline in population of Steller sea lions due to a number of factors; a long-term decline in relative importance of marine mammals in local diets; commercial groundfish fishing taking prey species utilized by Steller sea lions; and Steller sea lion protection measures designed to assist in population recovery instituted in 2000. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, economic development, and long-term climate change have a potential to adversely contribute to Steller sea lion subsistence activities. Sport and personal use of groundfish is not likely to adversely contribute to subsistence use of Steller sea lions. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.1 and PA.2, while an adverse cumulative effect is identified for subsistence use of Steller sea lions, the effect is judged to be insignificant. However, the cumulative effects of take, the continuing endangered status, and long-term decline in abundance are likely having population-level effects, but not enough to have significant indirect impacts to subsistence. The external impacts of other fisheries, other economic development activities of subsistence use of Steller sea lions are not likely to contribute adversely to the groundfish fisheries, and cumulative effects are insignificant.

Subsistence Use of Western Alaskan Salmon and Bycatch in the Groundfish Fishery

- **Direct/Indirect Effects**. Salmon bycatch would likely be decreased due to a moderate reduction in PSC limits under PA.1 and significantly reduced under PA.2, but available information does not suggest that such reductions, while presumably beneficial for salmon subsistence resource use, would result in significant increases in salmon returns to salmon subsistence fishery areas.

- **Persistent Past Effects**. The past/present effects on subsistence use of salmon include the following: utilization for subsistence since pre-contact times; and Area M closures implemented to decrease intercept of salmon; these factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects**. Other fisheries, other economic development activities and long-term climate changes and regime shift could all adversely contribute to salmon subsistence activities. Sport and personal use is not likely to adversely contribute to salmon subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.1 and PA.2, a cumulative effect is identified for subsistence use of salmon, and is judged to be insignificant. There may be benefits to subsistence use from reduced bycatch in the groundfish fisheries. However, given the depressed stock status of salmon runs in western Alaska, adverse contributions from external factors, and the salmon bycatch in the BSAI and GOA, sustainability of depressed salmon stocks could be adversely impacted, but are considered insignificant.

Indirect Impacts on Other Subsistence Activities

- **Direct/Indirect Effects**. Under both PA.1 and PA.2, catcher vessel activity and labor income are anticipated to increase insignificantly; therefore, no adverse indirect impacts to subsistence through a decline in income or joint production opportunities are expected to occur.

- **Persistent Past Effects**. The past/present effects on the indirect impacts on other subsistence activities include joint production as a part of local groundfish and other commercial fishery development from the outset; income from fishing used for investment in subsistence is similar to use of income from other activities. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, other economic development activities, and long-term climate changes and regime shift could all adversely or beneficially contribute to indirect subsistence activities. Sport and personal use is not likely to adversely contribute to indirect impacts on other subsistence activities. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.1 and PA.2, a cumulative effect is identified for indirect subsistence use, and the effect is judged to be insignificant. Income catcher vessel activity, and joint production opportunities are not expected to be affected adversely. However, the external impacts of other fisheries, other economic development activities, and long-term climate changes and regime shift could potentially contribute adversely to the indirect subsistence use.

4.9.9.5 Environmental Justice

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described below. The past/present effects on environmental justice are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The external effects used in this analysis are other fisheries such as foreign, JV, domestic, and state-managed fisheries, other economic development activities, other sources of municipal/state revenue, and long-term climate changes and regime shift.

Direct/Indirect Effects of PA.1

Potential impacts that drive environmental justice issues include employment/municipal revenue and taxes in communities with significant percentages of special populations (Alaska Native and minority processing workforce); revenue to Native owned catcher vessels; revenue to Native owned catcher processors; subsistence activities associated with groundfish, Steller sea lions, and salmon; and the loss of income from fishing that would be otherwise directed toward subsistence pursuits; and the loss of access to commercial fishing vessels and gear that would otherwise be available for joint production opportunities. The regions that could experience potential impacts include the Alaska Peninsula and Aleutian Islands, Kodiak Island, southcentral Alaska, southeast Alaska, Washington inland waters, Oregon coast, the CDQ regions, and western Alaska communities that harvest salmon for subsistence purposes.

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominantly Alaska Native populations. Also, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 250 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $498 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities, and no associated environmental justice impacts would occur. In this region, the ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under this alternative, the total value of catcher vessel operations would decrease as would corresponding labor income and employment; therefore, an apparent environmental justice impact would result. However, as described above, these apparent declines are likely to be attributable in large part to a shortcoming in the model regarding distribution of western GOA catch to Alaska Peninsula and Aleutian Islands region vessels. So the actual environmental justice impact is likely to be insignificant, given current data.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 12 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $81 million to $83 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the City and the Kodiak Island Borough. Given local and regional demographics, this is not likely to be an environmental justice issue. Ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the City of Kodiak itself; therefore, the local fleet associated population is not likely to be predominantly Alaska Native or comprised of other identified minority populations. Under this alternative, the total value of catcher vessel operations would increase as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be relevant as an environmental justice issue.

Southcentral Alaska. As described in existing conditions, environmental justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and it is unlikely that environmental justice issues will be associated with any employment change. In general, under this alternative overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns. Similarly, processing value increases, but these changes are not relevant to environmental justice concerns.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is more predominantly Alaska Native than the other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but otherwise overall environmental justice concerns appear not to apply in this region. In general, under this alternative overall combined direct, indirect, and induced labor income and FTEs increase, but this change is not linked to environmental justice concerns.

Washington Inland Waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, environmental justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under this alternative, at-sea processing labor income and FTEs both increase, so there are no environmental justice impacts associated with this change.

Oregon Coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region, and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under this alternative overall combined direct, indirect, and induced labor income and FTEs increase, as do catcher vessel related values, but these changes are not linked to environmental justice concerns.

CDQ Region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve environmental justice concerns. Under this alternative, the structure of the CDQ program would not change from baseline conditions and, as noted above, no adverse impacts to the program are anticipated. Therefore, no environmental justice impacts are likely to occur.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations. In a few cases such as Steller sea lion subsistence, exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve environmental justice concerns. Effects from reduced by-catch of salmon and Steller sea lion subsistence activities are likely to beneficial, but insignificant. As described above, adverse impacts to subsistence activities are not foreseen under this alternative; therefore no associated environmental justice impacts are anticipated.

Cumulative Effects of PA.1

The predicted direct and indirect effects of the groundfish fishery under PA.1 are described above. The past/present effects on environmental justice are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case (Table 4.9-6). The representative indicator used in this analysis is the same as that used in the direct/indirect analysis.

- **Direct/Indirect Effects**. Under PA.1 bookend, direct/indirect impacts are generally insignificant. Reductions in catcher vessel activity in the Alaska Peninsula/Aleutian Islands and reduction in the processing workforce in several regions are adverse, but are not significant. There would be some beneficial, but insignificant effects on subsistence harvest of salmon and Steller sea lions. No changes in the commercial fishery are anticipated that would result in significantly adverse impacts to baseline environmental justice issues.

- **Persistent Past Effects**. Persistent past effects include trends and developments in fisheries and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, other economic development activities, and long-term climate changes and regime shift have the potential to adversely or beneficially affect environmental justice issues. Other sources of municipal state revenue has the potential to adversely affect environmental justice issues. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects**. Under PA.1, insignificant cumulative effects are identified for environmental justice. The direct/indirect effects on income for subsistence pursuits, and participation and employment opportunities for Alaska Natives in the fishery are generally beneficial. Reductions in revenues to local communities in the Alaska Peninsula/Aleutian Islands, in conjunction with the external effects from the crab closures and downturn in the salmon industry, could potentially affect environmental justice issues, but not of a magnitude to be significant. Effects from reductions in bycatch of salmon and Steller sea lion subsistence activities are beneficial but insignificant. The effects on income and joint production activities related to subsistence in the Alaska Peninsula/Aleutian Islands region are adverse, but cumulatively insignificant.

Direct/Indirect Effects of PA.2

Alaska Peninsula and Aleutian Islands. As described in existing conditions, this region encompasses a number of groundfish fishing communities, of which a number have predominantly Alaska Native populations. Also as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would increase over baseline conditions by about 265 jobs; therefore, no environmental justice impacts would result. Total in-region groundfish processing value would increase from $464 million to $500 million. Increased in-region processing value would correspond to additional municipal revenue and taxes to the local communities, therefore, no associated environmental justice impacts would occur. In this region, the ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the home port communities, so local fleets from at least a few communities in this region are likely to be owned and crewed by Alaska Native residents. Under this alternative, the total overall net value of catcher vessel operations would decrease. Similarly, the corresponding labor income and employment would also decrease. Therefore, an apparent environmental justice impact would result, but as discussed under other alternatives, this may, in part, be an artifact of the model. The impacts to the local fleets that are conditionally significant adverse, resulting from MPA and rationalization design features, could be an environmental justice issue in this region. There could be adverse impacts to Alaska Native communities with support service businesses, but those would be in the form of conditional impacts, depending on the ultimate design of the programs.

Kodiak Island. As described in existing conditions, groundfish processing and catcher vessel activity in this region is highly concentrated in the City of Kodiak. Although the city is ethnically diverse, it does not have a predominantly Alaska Native population as do some of the groundfish fishing communities in the Alaska Peninsula/Aleutian Islands region. However, as described under existing conditions, the in-region processing workforce is predominantly a minority population. In-region processing employment would decrease over baseline conditions by about 45 jobs, which may result in an environmental justice impact. Total in-region groundfish processing value would decrease from $81 million to $75 million. Decreased in-region processing value would correspond to reduced municipal revenue and taxes to the City and the Kodiak Island Borough, and but given local and regional demographics, this is not likely to be an environmental justice issue. Ownership and crews of the catcher vessels are assumed to mirror the demographic composition of populations of the City of Kodiak itself, and therefore the associated population to the local fleet is not likely to be predominantly Alaska Native (or comprised of other identified minority populations). Under this alternative, the total value of regionally-owned catcher vessel operations would decrease as would corresponding labor income and employment, but given demographic assumptions, this is unlikely to be an environmental justice issue.

Southcentral Alaska. As described in existing conditions, environmental justice concerns are much less salient in this region than in the Alaska Peninsula/Aleutian Islands or Kodiak Island regions. The communities most directly engaged in the groundfish fishery, particularly with respect to the processing sector, are largely non-Native communities, and have relatively large populations and diversified economic opportunities. Further, there is a relatively low level of groundfish-related processing employment overall. Catcher vessel related employment is assumed to mirror community demographics, and it is unlikely that environmental justice issues will be associated with any employment change. In general, under this alternative overall combined direct, indirect, induced labor income, and FTEs decrease, but this change is not linked to environmental justice concerns. Similarly, processing value decreases, as do catcher vessel associated values, but these changes are not tied to environmental justice concerns.

Southeast Alaska. The situation in this region is similar to that seen in southcentral Alaska, with the possible exception of the community of Yakutat, which is predominantly Alaska Native compared to other regionally important groundfish communities. Data confidentiality constraints preclude a discussion of Yakutat alone, but overall environmental justice concerns appear not to apply in this region. In general, under this alternative overall combined direct, indirect, induced labor income, and FTEs decrease, but this change is not linked to environmental justice concerns. Similarly, processing value decreases as do analogous catcher vessel associated values, but this change is not associated with environmental justice concerns.

Washington Inland Waters. The greater Seattle area is the regional community most engaged in the groundfish fishery, and it is a demographically and economically diverse major metropolitan area. In-region processing does not occur, and while a number of other communities in the region outside of Seattle are home to groundfish catcher vessels, there is no indication that these communities or the associated vessel owners and crew are comprised of minority populations. As described in existing conditions, environmental justice concerns for this region are concentrated in the at-sea processing sector, due to the predominance of minority representation within this workforce. Under this alternative, at-sea processing labor income and FTEs both increase, if not significantly, so there are no environmental justice impacts associated with this change.

Oregon Coast. This region is engaged in the commercial groundfish fishery through its regionally owned catcher vessel fleet. This fleet is concentrated in a limited number of communities in the region and there is no indication that these are minority communities, nor is there any indication that the population directly associated with fleet ownership and/or crew is either a minority population or a low-income population. In general, under this alternative overall combined direct, indirect, induced labor income, and FTEs increase, as do catcher vessel related values, but these changes are not linked to environmental justice concerns.

CDQ Region. The CDQ region is predominantly comprised of Alaska Native communities that have relatively limited commercial economic opportunities, so any adverse impacts to this program and region are likely to involve environmental justice concerns. Under this alternative, the structure of the CDQ program would not change from baseline conditions, and as noted above, no adverse impacts to the program are anticipated. Therefore, no environmental justice impacts are likely to occur.

Subsistence. Subsistence activities typically disproportionately involve Alaska Native communities and populations. A few cases, such as Steller sea lion subsistence activities, exclusively involve Alaska Native individuals and groups. As a result, adverse impacts to subsistence pursuits are likely to involve environmental justice concerns. Effects from reduced bycatch of salmon and Steller sea lion subsistence activities are likely to be beneficial, but insignificant. As described above, adverse impacts to subsistence activities are not foreseen under this alternative, therefore no associated environmental justice impacts are anticipated.

Cumulative Effects of PA.2

The predicted direct and indirect effects of the groundfish fishery under PA.2 are described above. The past/present effects on environmental justice are described below (Table 3.9-126). This section will assess the potential for these effects to interact with other reasonably foreseeable future events and activities in the cumulative case (Table 4.9-6). The representative indicator used in this analysis is the same as the direct/indirect analysis.

- **Direct/Indirect Effects.** Under PA.2 direct/indirect impacts on environmental justice issues in the Alaska Peninsula/Aleutian Islands region are conditionally significant adverse. This is due to reductions in catcher vessel activity and associated effects on opportunities for Alaska Natives to participate in groundfish fisheries, and on income and joint production opportunities related to subsistence. There would be some beneficial, but insignificant effects on subsistence harvest of salmon and Steller sea lions.

- **Persistent Past Effects**. Persistent past effects include trends and developments in fisheries, and trends in state and municipal revenue. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects.** Other fisheries, other economic development activities, and long-term climate changes and regime shift have the potential to adversely or beneficially affect environmental justice issues. Other sources of municipal and state revenue have the potential to adversely affect environmental justice issues. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects.** Under PA.2, direct/indirect effects related to environmental justice are generally insignificant for most regions. Beneficial effects are expected for subsistence harvests; however, conditionally significant adverse effects due to reductions in catcher vessel activity are expected in the Alaska Peninsula/Aleutian Islands. The external effects from the crab closures and downturn in the salmon industry and reductions in employment funded by public revenue, and reductions in revenue to Native communities are adverse, primarily in the Alaska Peninsula/Aleutian Islands, where cumulative effects are conditionally significant adverse for environmental justice issues. Effects from reduction bycatch of salmon and Steller sea lion subsistence activities are beneficial, but insignificant. Direct/indirect effects on income and joint production activities related to subsistence in the Alaska Peninsula/Aleutian Islands region are adverse but insignificant. Cumulative effects are conditionally significant adverse due to downturns in other fisheries and decreased income and opportunities for joint production.

4.9.9.6 Market Channels and Benefits to United States Consumers

The predicted direct and indirect effects of the groundfish fishery under PA.1 and PA.2 are described below (Table 4.9-6). The past/present effects on market channels and benefits to U.S. consumers are described in Section 3.9 and below (Table 3.9-127). This section will assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case (Table 4.9-6). The representative indicator used in this analysis is benefits to U.S. consumers.

Direct/Indirect Effects of PA.1 and PA.2

Neither PA.1 nor PA.2 are expected to have significant effects on benefits to U.S. consumers of groundfish products relative to the comparative baseline. Under both PA.1 and PA.2, the BSAI and GOA groundfish fisheries are expected to continue to provide high and relatively stable levels of seafood products to domestic and foreign markets. An estimate of the final market value of BSAI and GOA seafood products is not available; however, it would be substantially greater than $1.5 billion, the projected five-year mean of the wholesale product value of BSAI and GOA groundfish after primary processing under both PA.1 and PA.2. This wholesale product value mean is higher than the comparative baseline, but the increase is not significant.

The rationalization of groundfish fisheries occurring under PA.2 could increase consumer benefits by resulting in an increase in the quality of groundfish products available to consumers relative to the comparative baseline. Moreover, rationalization has the potential to increase the proportion of Alaska groundfish products that are purchased by U.S. consumers because there will be more incentive to create the fresh and value-added products that are popular in the domestic market. With current technology and tastes, the greatest gains for U.S. consumers are likely to result from a greater supply of fresh and value-added products from Pacific cod and rockfish. However, these species currently account for less than one-third of all Alaska groundfish production. Furthermore, it is unlikely that all Pacific cod and rockfish will be sold to U.S. consumers. Consequently, the increased benefits to U.S. seafood consumers are not expected to be significant.

Cumulative Effects of PA.1 and PA.2

See Table 4.9-6 for a summary of the cumulative effects on market channels under PA.1 and PA.2.

- **Direct/Indirect Effects**. Under this alternative, increases in benefits to U.S. consumers of groundfish products are expected to occur, but are insignificant.

- **Persistent Past Effects**. These effects on benefits to U.S. consumers of groundfish products include: Alaska Seafood Marketing Institute product promotion activities, research and public awareness regarding the health benefits of seafood consumption, aquaculture development increasing overall availability and demand for seafood products, competition from aquaculture products, and changes in processing technology increasing seafood quality.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable effects include other fisheries (supply of product) and long-term climate changes and regime shift. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects**. Under PA.1 and PA.2, a cumulative effect is identified for benefits to U.S. consumers of groundfish products, and the effect is judged to be insignificant. The external impacts of other fisheries have the potential to contribute adversely or beneficially to U.S. consumers of groundfish products and groundfish market channels. However, the wholesale groundfish product value in conjunction with products from other fisheries is not expected to change benefits to U.S. consumers. Long-term climate changes and regime shift could adversely effect availability for market channels due to natural fluctuations in groundfish stocks.

4.9.9.7 The Value of the Bering Sea and Gulf of Alaska Marine Ecosystems (including Non-Consumptive and Non-Use Benefits)

The predicted direct and indirect effects of the groundfish fisheries under PA.1 and PA.2 on the level of benefits that marine ecosystems and associated species provide to the U.S. general public are described below (Table 4.9-6). This section will also assess the potential for these effects to interact with other reasonably foreseeable future events in the cumulative case. The representative indicators used in this analysis are the benefits, including non-consumptive and non-use benefits, the public derives from the Bering Sea and GOA marine ecosystems and associated species.

Direct/Indirect Effects of PA.1 and PA.2

PA.1 is predicted to have no significant effects on the level of benefits the Bering Sea and GOA marine ecosystems and associated species provided relative to the comparative baseline. These findings are based on the assessment of the direct and indirect effects of PA.1 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.9.10 of the draft Programmatic SEIS.

The Bering Sea and GOA marine ecosystems and species associated with them provide a broad range of benefits to the American public. Some of the goods and services these ecosystems produce are not exchanged in normal market transactions but have value nonetheless. While there are difficulties in estimating the value that the public places on protecting ecological conditions, Section 3.9.7 provides a qualitative discussion of possible benefits provided by the Bering Sea and GOA marine ecosystems. In addition to supporting commercial fisheries, these ecosystems support an array of recreational fishing and subsistence activities as well as non-consumptive activities such as wildlife viewing. Furthermore, some people can not directly interact with the Bering Sea and GOA marine ecosystems and the various species associated with them, but derive satisfaction from knowing that the structure and function of these ecosystems are protected.

The focus of this analysis includes direct and indirect effects of the alternatives on ecosystem benefits other than those that accrue to members of society who make a living harvesting, processing, and distributing BSAI and GOA groundfish products or who purchase and consume these products. The direct and indirect effects of the alternatives on firms and communities that derive value from the commercial harvest and processing of groundfish are described elsewhere in the draft Programmatic SEIS. Similarly, the effects of the alternatives on consumers of groundfish products are discussed in a separate section of the draft Programmatic SEIS.

The non-monetary or social value that people assign to those marine ecosystem benefits that are unrelated to commercial groundfish fisheries are thought to be considerable. For example, the value of protecting the Steller sea lion alone could be substantial. As discussed in Section 3.9.7, a contingent valuation study suggests that there is a significant willingness to pay on the part of the American public for an expanded federal Steller sea lion recovery program. At this time, there is insufficient information to provide a comprehensive measure of the benefits derived from these ecosystems and the various species associated with them.

PA.1 would maintain current management measures that mitigate the adverse effects of the groundfish fisheries on the Bering Sea and GOA marine ecosystems and associated species. These measures include a network of spatial and temporal closure areas that disperse fisheries geographically and seasonally, a prohibition on the use of non-pelagic trawl gear to fish for pollock in the BSAI, bycatch reduction measures such as the full retention requirement for Pacific cod and pollock, and measures to reduce the incidental catch of seabirds. Furthermore, as discussed in Section 4.7.11, PA.1 is not expected to result in a significant change in the quantitative measures of any indicators of fishing impacts on marine ecosystems relative to the baseline. Consequently, the change in the level of benefits these ecosystems provide is not expected to be significant.

PA.2 is predicted to lead to a conditionally significant increase in the level of benefits the Bering Sea and GOA marine ecosystems and associated species provide relative to the comparative baseline. The significance of the increase in benefits is conditional because it is uncertain to what extent PA.2 would close additional areas as MPAs or no-take reserves. These findings are based on the assessment of the direct and indirect effects of PA.2 on the environment with respect to the ecosystem issues of predator-prey relationships, energy flow and balance, and diversity. This assessment of ecosystem effects is presented in Section 4.7.11 of the draft Programmatic SEIS.

PA.2 would maintain current management measures that mitigate the adverse effects of the groundfish fisheries on the Bering Sea and GOA marine ecosystems and associated species. In addition, under PA.2 the establishment of additional area closures is considered. If implemented, these closures would close off up to 20 percent of the EEZ as MPAs and no-take marine reserves across a full range of marine habitats within the 1000 m bathymetric line (see Figure 4.2-5). The closures would aim to provide protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species.

Furthermore, PA.2 would undertake a comprehensive rationalization of all fisheries. By extending rights-based management to additional groundfish fisheries and thereby ending the race for fish in those fisheries, this FMP bookend has the potential to provide increased protection to the Bering Sea and GOA ecosystems.

If rights-based management systems include individual quotas on bycatch, they provide strong incentives to reduce bycatch because they internalize the cost of that bycatch. In turn, a reduction in bycatch can help protect bycatch species from overexploitation and maintain the overall ecosystem of which they could be an important part. Moreover, the experience with cooperatives in the BSAI pollock fishery shows that fishing could be spread out temporally as a result of rights-based management systems. This dispersal of fishing effort would reduce the potential for local depletions of fish stocks and the associated adverse impacts on marine mammals and other species.

As discussed in Section 4.7.11, the measures implemented under PA.2 are expected to have significantly or conditionally significant beneficial consequences for predator-prey relationships and diversity. In turn, these beneficial effects on the Bering Sea and GOA marine ecosystems and associated species are expected to lead to a conditionally significant increase in the levels of some of the benefits these ecosystems and species provide.

Cumulative Effects of PA.1 and PA.2

See Table 4.9-6 for a summary of the cumulative effects on the value of ecosystems under PA.1 and PA.2.

- **Direct/Indirect Effects**. Under this PA.1 and PA.2, the adverse effects that the Alaska groundfish fishery could have on marine ecosystems are reduced. PA.1 is predicted to have a beneficial but insignificant impact on the levels of benefits these ecosystems and associated species generate. PA.2 is predicted to have a conditionally significant beneficial impact.

- **Persistent Past Effects**. Persistent past effects on the level of benefits, including non-consumptive and non-use benefits, that marine ecosystems and associated species provide to the public include: an increase in public awareness of marine ecosystems; increased participation in recreational fishing and eco-tourism activities; and persistent past effects on ecosystems, as described in Section 4.9.10. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Reasonably Foreseeable Future Effects**. Reasonably foreseeable future effects include other fisheries, long-term climate changes and regime shifts, and other factors, as described in Section 4.9.10.2. These factors do not vary among alternatives; for more detail see the analysis in Alternative 1.

- **Cumulative Effects**. Under PA.1 and PA.2, a cumulative effect is identified for benefits the public derives from marine ecosystems and associated species, including non-consumptive and non-use benefits, and the effect is judged to be insignificant and conditionally significantly beneficial, respectively. The external impacts of other fisheries, long-term climate changes and regime shifts, and other factors have the potential to contribute adversely to benefits the public derives from marine ecosystems and associated species.

4.9.10 Ecosystem Preferred Alternative Analysis

Ecosystems are populations (consisting of single species) and communities (consisting of two or more species) of interacting organisms and their physical environment that form a functional unit with a characteristic trophic structure (food web) and material cycles (movement of mass and energy among the groups). The following analyses of potential direct/indirect and cumulative effects of PA.1 and PA.2 apply to the BSAI and GOA ecosystems. Where available information allows, each ecosystem is addressed separately. In most cases, however, information is insufficient to allow individual consideration, and the two ecosystems are treated as a single entity.

As explained in Section 4.5.10, the analyses include numerous indicators representing potential direct, indirect, and cumulative effects of the alternative and of specific bookends, where applicable. Significance criteria and thresholds for the effect categories are presented in Table 4.1-7.

Direct/Indirect Effects PA.1 and PA.2 – Ecosystem

This section assesses the potential direct/indirect effects of PA.1 and PA.2 on the BSAI and GOA ecosystems.

Change in Pelagic Forage Availability

Pelagic forage availability is assessed primarily by evaluating population trends in pelagic forage biomass for species with age-structured population models. These include walleye pollock in the GOA (Figure H.4-17 of Appendix H), Bering Sea walleye pollock, and Aleutian Islands Atka mackerel (Figure H.4-18 of Appendix H). For other forage species (herring, squid, and the forage species group), bycatch trends are used as measures of the potential impact of the BSAI and GOA groundfish fisheries on forage availability (Figures H.4-19 and H.4-20 of Appendix H). Table 4.5-81 summarizes the average values from 2003 through 2008 for these measures and the percent change in the average values from the baseline amounts. Under PA.1, the estimated pelagic forage biomass for the age-modeled populations declines from the baseline in the BSAI and increases over the baseline in the GOA. Twenty-year biomass projections show similar trends. Average biomass, however, remains within the bounds of estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species increases in the BSAI and declines in the GOA. Estimates of forage biomass from food web models of the EBS indicate that this level of bycatch is probably a small proportion of the total forage biomass (Aydin *et al.* 2002), although because population-level assessments are lacking for some members of the forage species group, corresponding biomass estimates for these species are not available. Because average biomass projections for the age-modeled forage species remain within the estimated historical boundaries, and bycatch-based estimates for other forage species are small in relation to total forage biomass, PA.1 is determined to have insignificant effects on the BSAI and GOA ecosystems with respect to pelagic forage availability.

Under PA.2, pelagic forage biomass for the age-modeled species again declines from the baseline in the BSAI and increases over the baseline in the GOA. Twenty-year biomass projections show similar trends. As with PA.1, the estimated average biomass resides within the range of the estimated biomass that occurred historically before a target fishery emerged. Bycatch of other forage species increases in the BSAI and declines in the GOA, although again, the lack of population-level assessments for some members of the forage species group prevents biomass projections for these species. Also, the extensive fishing closure areas proposed under both PA.1 and PA.2 may alter bycatch estimates in ways that cannot be accurately predicted. Because average biomass projections for the age-modeled forage species remain within the estimated historical boundaries, and bycatch-based estimates for other forage species are considered to be small in relation to total forage biomass (Aydin *et al.* 2002), PA.2 is determined to have insignificant effects on the BSAI and GOA ecosystems with respect to pelagic forage availability.

Spatial and Temporal Concentration of Fishery Impact on Forage

The spatial and temporal concentration of fishery impacts on forage species is assessed qualitatively by considering the potential for the alternative to concentrate fishing on forage species in regions utilized by predators that are tied to land, such as pinnipeds and breeding seabirds. Additionally, the possibility for concentrated fishing effort to result in an ESA listing or in the lack of recovery of a species that is already listed is also considered. PA.1 would continue the existing closures around Steller sea lion rookeries, trawl and fixed gear closures in nearshore and critical habitat areas, the ban on directed fishing for forage fish, and the spatial/temporal allocation of TAC for some BSAI and GOA species, resulting in an insignificant effect on forage species. In the GOA, identification of salmon savings areas along with establishing PSC limits are proposed measures under PA.1. In addition, BSAI pollock fisheries have shown increasing catch in northern fur seal foraging habitat, but more research is required to evaluate whether the amounts of pollock removed are having a population-level effect on fur seals. This type of catch trend data may be useful in the development of ecosystem indicators for future use in TAC-setting processes, as put forth under PA.1.

PA.2 would continue the existing closures around Steller sea lion rookeries with the possibility of designating critical habitat areas based on scientific information. In addition, modified Steller sea lion closures in the Aleutian Islands are also proposed. The existing ban on forage fish and spatial/temporal allocation of TAC for some BSAI and GOA species would continue. Maintaining current closed/restricted areas, with the potential for some of these areas to qualify as MPAs, could provide increased protection of northern fur seal foraging habitat from potential fishing effects. PA.2 proposes the prohibition of pollock bottom trawling in the GOA as well as continuing the existing ban in the BSAI. For these reasons, PA.2 is determined to have a conditionally significant beneficial effect on the spatial/temporal availability of forage, particularly for some marine mammals. Additional seabird avoidance measures in longline and trawl fisheries are proposed under PA.2, with emphasis on cooperation between NOAA Fisheries and USFWS to develop revised fishing methods that reduce incidental take for all seabird species. Although these measures may not result in significant changes in the spatial/temporal availability of forage to seabirds, it will be difficult to determine the potential effectiveness of the improved methods until they have been fully implemented.

Removal of Top Predators

Removal of top predators, either through directed fishing or bycatch, is assessed by evaluating the trophic level of the catch relative to the trophic level of the groundfish biomass (Figures H.4-21 through H.4-24 of Appendix H), bycatch levels of sensitive top predator species such as birds and sharks (Figures H.4-25 and H.4-26 of Appendix H), and a qualitative evaluation of the potential for catch levels to cause one or more top-level predator species to fall below biologically acceptable limits (MSST for groundfish; for other species, ESA listing or preventing recovery of an already-listed species). Trophic level of the catch in both the BSAI and GOA is a very stable property, changing less than 3 percent on average from the baseline, and trophic level of the groundfish species for which we have age-structured models changes less than one percent on average.

The above indicators result in no change in the evaluation of the importance of this effect relative to the baseline. The baseline determination shows that historical whaling has resulted in low present-day abundance of whale species in the North Pacific Ocean. PA.1 and PA.2 would not further impair the recovery of these species through direct takes. Similarly, it is not expected that levels of seabird and pinniped bycatch in groundfish fisheries would lead to an ESA listing for any of those populations or prevent any of the listed species from recovery under the ESA. Additional seabird avoidance measures in longline and trawl fisheries are proposed under PA.2, with emphasis on cooperation between NOAA Fisheries and USFWS to develop revised fishing methods that reduce incidental take for all seabird species. Although these measures may not result in significant changes to seabird populations, it will be difficult to determine the potential effectiveness of improved methods until implementation has taken place. Sections 4.9.7 and 4.9.8 discuss the potential effects of groundfish fishery direct takes on specific seabird and marine mammal populations under PA.1 and PA.2.

The effect of shark bycatch on shark populations is currently unknown, and further research focusing on population assessments and establishing reliable biomass estimates for these sensitive (late maturing, low fecundity, low natural mortality) species is needed to identify potential effects from the groundfish fisheries. As proposed in PA.2, breaking sharks (and additional species groups) out of the other species complex for TAC-setting purposes may result in an increased level of protection through a more species-specific TAC. As a result of implementing specific TAC-setting measures for species that have traditionally been included in the other species TAC category, improved management of these individual species may minimize potential population-level impacts resulting from bycatch mortality. In addition, improved observer coverage and species identification for non-target species, as proposed in PA.2, may provide improved bycatch data, further supporting the need for more comprehensive management of particular species within the other species group. Section 4.9.3 contains detailed information regarding potential cumulative effects of PA.1 and PA.2 on sharks, skates, and other cartilaginous fishes.

Stability in trophic level of the catch indicates that minimal effects have resulted from fishing impacts on target and PSC species top predators (Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut). PA.1 maintains current PSC limits for halibut in the BSAI and GOA while considering reducing these limits by 1 to 10 percent in the BSAI, if practicable. Further reduction in PSC limits for halibut are suggested under PA.2 for both the BSAI and GOA. Section 4.9.1 and 4.9.2 discuss direct, indirect, and cumulative effects associated with PA.1 and PA.2 for target species and Pacific halibut. Overall, potential effects of PA.1 and PA.2 on top predators are predicted to be insignificant and unknown.

<u>Introduction of Non-Native Species</u>

The introduction of non-native species through ballast water exchange and hull-fouling organism release from fishing vessels could potentially disrupt the Alaskan marine food web structure (Fay 2002). There have been 24 non-indigenous plant and animal species documented in Alaskan marine waters, primarily in shallow-water nearshore and estuarine ecosystems, with 15 of those species recorded in PWS. It is possible that most of these introductions were from tankers or other large commercial vessels that have large volumes of ballast exchange. However, exchange via fishery vessels that take on ballast from areas where invasive species have already been established and then transit through Alaskan inshore waters has been identified as a threat in a recently developed State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). Consequently, this effect is evaluated as conditionally significant adverse in the baseline condition.

Total groundfish catch levels are used as an indicator of potential changes in the amount of these releases by groundfish fishery vessels (Figures H.4-27 and H.4-28 of Appendix H and Table 4.1-7). Under PA.1 and PA.2, catch levels increase in the BSAI. PA.2 results in decreasing catch levels in the GOA relative to the baseline, while GOA catch under PA.1 increases. These projected catch levels are similar to recent catches in these areas, indicating a similar level of effort and resulting in a similar potential for fishing vessel introduction of non-native species through ballast water exchange or hull-fouling organism release.

Consequently, potential effects of PA.1 and PA.2 on the introduction of non-native species from fishing vessels and gear are insignificant compared to the baseline condition.

Energy Flow and Balance

As discussed in Section 3.10, fishing may alter the amount and flow of energy in an ecosystem by removing energy and altering energetic pathways through the return of discards and fish processing offal to the sea. The recipients, locations, and forms of this returned biomass may differ from those in an unfished system. Baseline energy removals, in the form of total catch, were less than one percent of the total system energy as determined by mass-balance modeling of the system and were determined to have an insignificant impact on the ecosystem baseline. Predicted catch removals under PA.1 (Figures H.4-27 and H.4-28 of Appendix H, Table 4.5.-142) are similar to those modeled in FMP 3.1 and are determined to be insignificant with respect to the potential for producing changes in system biomass, respiration, production, or energy cycling that are outside the range of natural variability (Table 4.9-7). Predicted catch removals under PA.2 are presumed to show similar trends to FMP 3.2 (Figures H.4-27 and H.4-28 of Appendix H, Table 4.5-81), thus increasing by an estimated one percent in the BSAI and decreasing by an estimated 7 percent in the GOA relative to the baseline. These changes are also determined to be insignificant.

Energy re-direction, in the form of discards, fishery offal production, or unobserved gear-related mortality, can potentially change the natural pathways of energy flow in the ecosystem. Animals damaged when passing through the meshes of trawls may later die and be consumed by scavengers. Bottom trawls can expose benthic organisms and make them more vulnerable to predation. Discards and offal production can cause local enrichment and changes in species composition or water quality if discards or offal returns are concentrated in confined areas such as estuaries, bays, and lagoons. These effects were determined to be insignificant at the ecosystem baseline level. It is expected that trends in total discards for PA.1 will be similar to those shown under FMP 3.1 (Table 4.5-81, Figures H.4-29 and H.4-30 of Appendix H). These result in increases of less than one percent in the BSAI and decreases by approximately 8 percent in the GOA relative to the baseline. Trends in total discards (Table 4.5-81, Figures H.4-29 and H.4-30 of Appendix H) under PA.2 are presumed to decrease approximately 20 to 25 percent in the BSAI and 40 and 50 percent in the GOA relative to the baseline, as observed under FMP 3.2. These changes are considered minimal in comparison to historical amounts of discards and are insignificant to ecosystem-level energy cycling characteristics.

Change in Species Diversity

As explained in Section 3.10, commercial fishing can alter different facets of diversity. Species diversity, defined as the number of different species in an ecosystem, can be altered if fishing results in removal of one or more species from the system. Fishing can also alter functional diversity in terms of both trophic and structural habitat characteristics. Functional diversity can be altered with respect to trophic characteristics if removal or depletion of a trophic guild member occurs. Changes to distribution of biomass within a trophic guild may also result. From a structural habitat standpoint, functional diversity can be altered or damaged if benthic fishing methods such as bottom trawling remove or deplete organisms that provide structural habitat for other species (e.g., corals, sea anemones, sponges). Impacts to genetic diversity from fishing can occur by selectively removing faster-growing fish or removing spawning aggregations that may exhibit genetic characteristics that are different from other spawning aggregations. Larger, older fishes may be more heterozygous (i.e., demonstrating wider genetic differences or diversity), and some stock structures may have a genetic component (see review in Jennings and Kaiser 1998). Consequently, one would expect a decline in genetic diversity within biological populations receiving heavy exploitation by fisheries.

Significance thresholds for effects of fishing on species diversity are defined as catch removals resulting in the biomass of one or more species (target or non-target) falling below, or not recovering from levels already below, minimum biologically acceptable limits (MSST for target species, ESA listing for non-target) (Table 4.1-7). For sensitive species groups (those having low population turnover rates) that lack population estimates (e.g., skates, sharks, grenadiers, and sessile invertebrates inhabiting HAPC), bycatch data indicate the potential for fishing impacts to affect species diversity (Table 4.5-81, Figures H.4-31 and H.4-32 of Appendix H). Closed areas provide protection to these groups, particularly to less-mobile species like HAPC biota. Baseline determinations were insignificant for target and non-target species, and unknown for species groups lacking population estimates and bycatch data, including HAPC species.

Under PA.1, currently closed areas (including Steller sea lions closures) would be maintained, identification and designation of EFH and HAPC are proposed, and current no-trawl zones and fixed-gear restrictions would stay in place. Although it is unknown whether bycatch amounts of HAPC biota would be at levels high enough to reduce these species to minimum population thresholds, area closures would likely be effective in preventing population-level impacts on these sessile animals. Under PA.2, the estimated bycatch of HAPC biota is expected to decrease in the BSAI and GOA (Table 4.5-81). This FMP would also provide substantial increases in closed areas such as no-trawling MPAs and no-take reserves across a range of habitat types, review of all existing closures for qualification as MPAs, establishment of an Aleutian Islands management area to protect coral and other living habitat species, and modification of 2002 Steller sea lion with designation of critical habitat according to scientific data and assessment information. These measures may further reduce the bycatch of HAPC biota. In addition, the adoption and use of key ecosystem indicators to modify TAC-setting processes may provide further protection to sensitive groups such as HAPC biota until more life history information becomes available. Although forage species population levels are not known, their relatively high population turnover rates, along with the ban on directed fisheries for forage species in PA.1 and PA.2, are considered effective protection measures for minimizing potential population-level effects.

On the basis of the preceding considerations, potential effects of PA.1 and PA.2 on species diversity are considered insignificant and unknown. More comprehensive survey data and life history parameter determinations for skates, sharks, grenadiers, and other species groups may help to determine population status and establish additional protection measures that could minimize adverse impacts from fishing.

Change in Functional Diversity

Functional (either trophic or structural habitat) diversity can be altered through fishing if selective removal of one member of a functional guild results in increases in other guild members. A functional guild is a group of species that utilize resources within the ecosystem in similar ways. Significance thresholds are characterized by catch removals resulting in a change in functional diversity outside the range of natural variability observed for the system (Table 4.1-7). Indicators for the magnitude of this effect include qualitative evaluation of guild or size diversity changes relative to fishery removals, changes in bottom gear effort that would provide a measure of benthic guild disturbance, and bycatch amounts of HAPC biota, a structural habitat guild. Members of the HAPC biota guild serve important functional roles in providing fish and invertebrates with structural habitat and refuge from predation. The abundance level of these structural species necessary to provide protection is not known, and it may be important to retain populations of these organisms and maintain wide spatial distribution to enable them to fulfill their various functional roles. Some of these organisms have life-history traits that make them very sensitive to population-level impacts resulting from fishing. The long-lived nature of corals, in particular, makes them susceptible to permanent eradication in fished areas. Present and proposed Steller sea lion trawl closures are spread throughout the Aleutian Islands, but these closures may be further inshore than most of the coral. For this reason, the area closures proposed under PA.1 and PA.2 may not be sufficient to provide additional protection for these sensitive organisms in all areas throughout the BSAI and GOA.

Under PA.1, species composition and amounts of removals, bottom gear effort, and bycatch of HAPC biota (Table 4.5-81, Figures H.4-31 and H.4-32 of Appendix H) would remain similar to the comparative baseline, in which fishing impacts on functional guild diversity are determined to be insignificant for trophic diversity and conditionally significant and adverse for structural habitat diversity. Some of the area closures for PA.2 have been developed with corals and other living habitat species in mind. If implemented, these measures may improve protection throughout their broad spatial distribution, particularly in the Aleutian Islands. Thus, PA.2 is determined to have significantly beneficial effects on structural habitat diversity relative to the baseline, whereas PA.1 would result in an insignificant change from the baseline condition. In addition, possible effects of PA.2 on trophic diversity, species composition, and removal of target species relative to the baseline are regarded as insignificant.

Change in Genetic Diversity

Genetic diversity can be affected by fishing through heavy exploitation of certain spawning aggregations or systematic targeting of older age classes that tend to have greater genetic diversity. Under PA.1 and PA.2, target species are not expected to fall below their respective MSST, spatial/temporal management of TAC would not change, and similar catch and selectivity patterns in the fisheries would apply. The PA would result in insignificant impacts to genetic diversity. However, a baseline condition for genetic diversity remains unknown for many species, and the potential effects of fishing on genetic diversity under PA.1 and PA.2 are also largely unknown.

Cumulative Effects Analysis PA.1 – Ecosystems

The following section describes the potential cumulative effects of PA.1 on the ten ecosystem indicators explained in Section 4.5.10. These potential cumulative effects are summarized in Table 4.5-89. Data and calculations supporting the energy removal analyses for all alternatives are presented in Table 4.5-81.

Change in Pelagic Forage Availability

- **Direct/Indirect Effects.** The direct/indirect effects of PA.1 on pelagic forage availability are expected to be insignificant. Fishery-induced changes, including bycatch-related effects on forage species, are predicted to remain within the natural level of abundance or variability for prey species relative to predator demands (Table 4.9-7).

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries and targeted domestic catches of pollock and Atka mackerel are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed from 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and these effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS of 1989 suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population sizes, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability is expected in the event of a large petroleum spill. The conditions under which this effect may be significant relate to the areas affected by, and seasonal timing of, the spill. If these conditions coincide with spawning locations and times, a significantly adverse cumulative effect on pelagic forage availability would most likely result. Additive or interactive contributions from State of Alaska commercial fisheries and subsistence fish harvests are not expected to be significant. A future climatic regime shift would not appreciably offset, but could intensify, this potential cumulative effect if the productivity of pelagic forage species is reduced.

Spatial and Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** The direct/indirect effects of the spatial and temporal concentration of fishing effort under PA.1 on pelagic forage availability are expected to be insignificant. PA.1 would continue the existing closures around Steller sea lion rookeries, the ban on forage fish, and the spatial/temporal allocation of TAC for pollock and Atka mackerel, which together would result in insignificant impacts to forage species.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, the State of Alaska directed herring fishery, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may persist presently and into the future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been correlated with changes in recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may persist on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and locations that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlap with the groundfish fishery is more likely to be temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial and temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this potential cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning would most likely produce population declines and adversely affect other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial and temporal distributions of pelagic forage species in ways that are synergistic with spatial and temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could result in the future from synergistic interactions between spatial and temporal concentrations of the BSAI and/or GOA groundfish fishing effort. The conditions under which this potential effect may become significant relate to location and timing. If the fishing efforts of the State of Alaska directed fisheries (primarily herring fisheries) and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could become significantly depressed, leading to impairment of the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.5-89). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial and temporal distributions of pelagic forage species in ways that might reduce or intensify this potential Cumulative Effects.

<u>Removal of Top Predators</u>

- **Direct/Indirect Effects.** The implementation of PA.1 is predicted to have insignificant direct/indirect effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This FMP would not impair the continued recovery of whale populations still reduced through direct take in the past. Predicted levels of seabird and marine mammal bycatch in the groundfish fisheries are not expected to lead to the listing of these species or prevent their recovery under the ESA. Because there is little available information on shark bycatch, the direct/indirect effect of this FMP on shark populations is unknown.

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of sharks, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the currently depressed abundance of whale species in the North Pacific Ocean. State of Alaska directed groundfish fisheries have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than those observed in the past. Adverse effects from these past harvests may persist on some populations today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove sustainable numbers of Pacific halibut, a top predator. The current management plan is likely to continue in the future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). Seabird bycatch and resulting direct mortality are expected to continue annually in North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-3.7.19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish harvests in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future, with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea may result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on populations of top predators could result primarily from continued seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. The conditions under which this cumulative effect may become significant include the continuation of seabird bycatch in conjunction with a large fuel or oil spill, along with incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and this could intensify or reduce this potential cumulative effect by influencing recruitment.

Introduction of Non-Native Species

- **Direct/Indirect Effects.** Under PA.1, projected catch levels would maintain a potential for fishing-vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms similar to that which currently exists under baseline conditions. Therefore, the potential direct/indirect effect of PA.1 on predator-prey relationships through the introduction of exotic species is evaluated as insignificant.

- **Persistent Past Effects.** For decades, the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan marine waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including disease and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in the State of Alaska directed fisheries will continue to be potential sources for exotic species introductions. In addition, commercial shipping, including cruise ships, barges, and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapees and releases of farmed Atlantic salmon from Washington and British Columbia net-pens could eventually establish runs in the GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could affect wild stocks. A future regime shift or long-term warming trend may deplete the current protection that colder conditions provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with PA.1, it is conceivable that viable populations could become established in the BSAI and/or GOA, producing a conditionally significant adverse cumulative effect on indigenous species (Table 4.5-89). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that would allow exotic species currently limited by low seawater temperatures to establish viable populations in the BSAI and/or GOA. External sources that could contribute to this potential cumulative effect in the future include fishing vessels participating in the IPHC and State of Alaska commercial fisheries and commercial ships such as tankers and cruise ships, all of which can introduce non-native species through the release of ballast water and hull-fouling organisms (Fay 2002). In addition, Atlantic salmon released or escaped from coastal net-pen farms could establish viable runs throughout coastal areas of Alaska in the future (ADF&G 2002a).

Energy Removal

- **Direct/Indirect Effects.** The direct/indirect effects of PA.1 on energy removal are expected to be insignificant when compared to current baseline conditions. Therefore, estimated energy removals under PA.1 would not have the potential to produce changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.9-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch. These removals are regulated and mitigated and continue today (Section 3.10). Aggregate levels of biomass removed by unregulated past human activities may have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased, and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (donut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that they are viewed as only partly comparable systems. Their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of PA.1 is predicted to have an insignificant cumulative effect on energy removal in the future. The overall biomass removal from internal and external fisheries is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.5-89).

Energy Redirection

- **Direct/Indirect Effects.** The direct/indirect effects of PA.1 on energy redirection are expected to be insignificant. Predicted effects are minimal relative to the baseline, and fishery discarding and offal production practices under PA.1 would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.9-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process, and it is difficult to know whether past changes in energy cycling and in pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than they were 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of PA.1 is predicted to have an insignificant cumulative effect on energy redirection. The predicted direct/indirect effects under PA.1 in combination with external sources is not expected to depart from the comparative baseline condition sufficiently to produce long-term changes outside the range of natural variability. The discharge of offal from fish processing facilities and of graywater and other refuse from marine vessels into Alaskan waters is regulated through USEPA and ADEC permitting programs, respectively.

<u>Change in Species Diversity</u>

- **Direct/Indirect Effects.** The expected direct/indirect effects of PA.1 on species diversity are rated as unknown for skates, sharks, grenadiers, and other non-managed species and insignificant for other species groups. It is unknown whether bycatch of HAPC biota would result in levels high enough to bring these species to minimum population thresholds, but area closures would likely be sufficient to prevent species removal for these sessile animals. Predicted catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate species (including HAPC species) are susceptible to impacts from bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, reducing populations of some seabird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated for some declines through bycatch. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show beneficial correlations with prey abundance, and cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, the rates are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapes from net-pen farms, invertebrates and plants introduced through ballast water discharge and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotic species to establish viable populations.

- **Cumulative Effects.** Under PA.1, a conditionally significant adverse effect on species diversity could result from high levels of seabird bycatch in the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, one or more introduced exotic species may, at some time in the future, establish viable populations that could alter species diversity by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of harvest effort on particularly accessible subpopulations of marine mammals from year to year (e.g., belugas) could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate the establishment of viable populations by one or more exotic species. Under some combination of these conditions, the biomass of one or more species could fall below, or be kept from recovering from levels already below, minimum biologically acceptable limits (Table 4.5-89).

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** Under PA.1, the predicted direct/indirect effects of the groundfish fisheries on trophic diversity are rated as insignificant because they are expected to be similar to the comparative baseline conditions, for which fishing effects on trophic diversity are also rated as insignificant.

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly affected the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, research on this type of effect in the BSAI and GOA has been minimal.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead trout (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Exotic species introduced to BSAI and GOA waters from fishing vessels and commercial shipping could also lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by expanding some trophic levels and contracting others. In addition, a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic species populations.

- **Cumulative Effects.** The implementation of PA.1 could produce a conditionally significant adverse effect on trophic diversity. The primary condition for this effect is largely speculative: a climatic regime shift could result in a trophic guild containing one or more groundfish fishery target species becoming more vulnerable to fishing pressure. A regime shift in the future, similar to well-documented examples that have occurred in the past (Sections 3.3 and 3.10.1.5), may affect species diversity within a trophic guild by reducing the productivity or shifting the distributional range of one or more member species. If this climatic effect went undetected and without compensatory adjustments to fishing effort, the continued removal of particular target species, especially slow-growing species such as rockfish, could decrease their representation within trophic guilds (Heifitz *et al.* 2001).

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to functional diversity is the removal, by bottom gear, of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures for habitat by other species, including economically important groundfish species and their prey. Present (comparative baseline) trawl closures to protect Steller sea lion habitat are spread throughout the Aleutian Islands, but these closures are in nearshore waters that may not include all areas of living structural habitat species. Under PA.1, the species composition and biomass levels of removals, bottom gear effort and resulting bycatch amounts of HAPC biota, and areas closed to trawling relative to coral distribution are similar to the baseline. Therefore, the change from baseline conditions that would result from implementation of this FMP is evaluated as insignificant with respect to structural habitat diversity.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years.

  Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill could affect areas where these sensitive bottom-dwelling organisms live and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** Direct/indirect effects of PA.1, rated insignificant, could contribute to a conditionally significant adverse cumulative effect on structural habitat diversity under any of the following three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could add to the direct/indirect effects of bottom trawling by the groundfish fisheries on HAPC biota. Second, a large petroleum spill could also damage these sensitive organisms. Third, a change in seawater temperature resulting from a climatic regime shift in the future could reduce the productivity, and thus the population size, as well as the distribution, of bottom-dwelling invertebrates that provide structural habitat.

Change in Genetic Diversity

- **Direct/Indirect Effects.** Under PA.1, target species are not expected to fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to the comparative baseline conditions. Consequently, the direct/indirect effects of the groundfish fisheries on genetic diversity are expected to be insignificant under this FMP. However, baseline genetic diversity remains unknown for many species, and the actual direct/indirect effects that fishing may have on genetic diversity are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was significantly altered. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (i.e., dating from an earlier period when fishing was less intensive), then genetic diversity tends to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be determined in the absence of reliable data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapees from coastal net-pen farms in Washington and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Future climate changes could alter the productivity and distribution of individual species and enable exotic species to establish viable populations.

- **Cumulative Effects.** The implementation of PA.1 is predicted to have an insignificant cumulative effect on genetic diversity. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, exotic species introduced through commercial shipping traffic, and climatic facilitation of viable exotic populations, have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would affect the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. For this reason, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the reasonably foreseeable future.

Cumulative Effects Analysis PA.2 – Ecosystems

The following section briefly discusses the potential cumulative effects of PA.2 on the ten ecosystem indicators explained in Section 4.5.10. The cumulative effects conclusions are summarized in Table 4.5-89. Data and calculations supporting the energy removal analyses for the alternatives are presented in Table 4.5-81.

<u>Change in Pelagic Forage Availability</u>

- **Direct/Indirect Effects.** The direct/indirect effects of PA.2 on pelagic forage availability are expected to be insignificant. Fishery-induced changes, including bycatch-related effects on forage species, would remain within the natural level of abundance or variability for prey species relative to predator demands (Table 4.9-7).

- **Persistent Past Effects.** Past effects of forage fish bycatch by the BSAI pollock and GOA rockfish domestic fisheries, and targeted domestic catches of pollock and Atka mackerel, are likely to have affected forage fish populations in ways that may persist into the present and future (Section 3.10.1.4). From about 1925 to 1941, Alaska herring harvests for oil and meal ranged from about 50,000 to 150,000 mt per year, and a large foreign herring fishery removed between 30,000 to 150,000 mt per year during the 1960s and 1970s (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been shown to affect forage fish populations (Section 3.10.1.5), and effects may persist.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska manages herring fisheries on a sustainable basis and has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20 percent. Fisheries are closed if stock size falls below MSST. Lower exploitation rates are applied when herring stocks decline to near-threshold levels (ADF&G 2003a). This management approach is expected to continue for the indefinite future. Subsistence harvests will continue to remove an increment of pelagic forage biomass each year. Relative to the BSAI and GOA groundfish fisheries, however, the additional contribution of subsistence fisheries to the annual removal of pelagic forage biomass is likely to be very small. The EVOS suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning would most likely produce population declines, and other pelagic forage species (such as eulachon, which spawn on beaches) might also be adversely affected. Finally, future climate change, especially a regime shift, would likely affect the productivity, and thereby the population size, of pelagic forage species (Section 3.10.1.5).

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could occur in the event of a large petroleum spill. The conditions under which this effect could be significant relate to the areas affected by, and seasonal timing of, the spill. If these conditions coincide with spawning locations and times, a significantly adverse effect on pelagic forage availability would most likely result. A future climatic regime shift would not appreciably offset, but could intensify, this potential cumulative effect if the productivity of pelagic forage species is reduced.

Spatial and Temporal Concentration of Fishery Impact on Forage

- **Direct/Indirect Effects.** PA.2 would continue the existing closures around Steller sea lion rookeries, with the possibility of designating critical habitat areas based on scientific information. In addition, modified Steller sea lion closures in the Aleutian Islands are also proposed. The existing ban on forage fish and spatial/temporal allocation of TAC for some BSAI and GOA species would continue. These measures would not produce a significant change in the spatial/temporal availability of forage to seabirds, but they would be notable improvements over the baseline for top-predator fish and marine mammals. Maintaining current closed/restricted areas, with the potential for some of these areas to qualify as MPAs, could provide increased protection to northern fur seal foraging habitat from potential fishing effects. PA.2 proposes the prohibition on Pollock bottom trawl in the GOA as well as the existing ban in the BSAI. For these reasons, PA.2 is predicted to have a conditionally significant beneficial effect on the spatial/temporal availability of forage, particularly for some marine mammals, but insignificant effects on forage availability to seabirds.

- **Persistent Past Effects.** Geographic and seasonal concentrations of past forage fish bycatch from the BSAI pollock and GOA rockfish fisheries, herring bycatch, and targeted catches of pollock and Atka mackerel have affected forage fish populations in ways that may persist presently and into the future (Section 3.10.1.4). Past herring fisheries have followed a stable pattern of timing and location dictated by the spawning behavior of the fish (ADF&G 2003a). Past climatic changes, including inter-decadal oscillations and ENSO events, have been correlated with changes in recruitment rates and distribution patterns of forage fish populations (Section 3.10.1.5). Such effects may persist on forage fish populations, although evidence is not sufficient to allow quantification.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska directed herring fishery will exert fishing pressures on herring and other forage fish populations at particular times and locations that could overlap with fishing pressures from the groundfish fisheries. Because the herring fishery is mainly inshore, overlap with the groundfish fishery is more likely to be temporal than spatial. Subsistence harvest patterns are not coordinated with commercial fishing effort and will sometimes overlap with spatial and temporal patterns of the groundfish fishery, but the incremental contribution of subsistence to this cumulative effect will continue to be negligible. The EVOS of 1989 suggests that a large oil or fuel spill coinciding in space and time with herring or capelin spawning would most likely produce population declines and adversely affect other pelagic forage species (such as eulachon, which spawn on beaches). Finally, future climate change, especially a regime shift, could alter the spatial and temporal distributions of pelagic forage species in ways that are synergistic with spatial and temporal concentrations of fishing effort in the BSAI and GOA groundfish fisheries.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on pelagic forage availability could result in the future through synergistic interactions between spatial and temporal concentrations of the BSAI and/or GOA groundfish fishing effort. The conditions under which this effect could be significant relate to location and timing. If the fishing efforts of State of Alaska directed fisheries (primarily herring fisheries) and subsistence fish harvests converge in space and time with a fuel or oil spill, forage fish populations could be significantly depressed, thereby impairing the long-term viability of ecologically important top predators such as seabirds and marine mammals (Table 4.5-89). Future climate change, consistent with effects observed in the recent past (Section 3.10.1.5), could alter the spatial and temporal distributions of pelagic forage species in ways that might reduce or intensify this potential cumulative effects.

<u>Removal of Top Predators</u>

- **Direct/Indirect Effects.** The implementation of PA.2 is predicted to have insignificant direct/indirect effects on top predators such as whales, other marine mammals, seabirds, and top predatory fish species such as Greenland turbot, arrowtooth flounder, sablefish, Pacific cod, and Pacific halibut. This FMP would not impair the continued recovery of whale populations still reduced through direct take in the past. Predicted levels of seabird and marine mammal bycatch in the groundfish fisheries would not lead to listing of these species or prevent recovery of currently listed species under the ESA. Because there is little available information on shark bycatch, the effect of this FMP on shark populations is unknown.

- **Persistent Past Effects.** Before passage of the MSA in 1976, groundfish fisheries in the BSAI and GOA produced much higher than present bycatch levels of shark, seabirds, and marine mammals. Historical whaling, resulting in high mortality levels in the 1960s (Section 3.10.1.3), produced a sustained effect on these slowly reproducing populations that is reflected in the currently depressed abundance of whale species in the North Pacific Ocean. State of Alaska directed groundfish fisheries have annually removed top predators such as sablefish and Pacific cod at levels safely above MSST (ADF&G 2003b). These fisheries also produced shark, seabird, and marine mammal bycatch in the past, although quantitative data are lacking on past and current bycatch levels in these fisheries. Past and present groundfish fisheries operating outside of U.S. jurisdiction in the western Bering Sea have also contributed to the bycatch of top predators, in some cases at high levels (Sections 3.7.1 and 3.10.1). Marine mammals continue to be removed for subsistence, although at much lower levels than those observed in the past. These past harvests may have persistent effects on some populations today. Finally, there is evidence that past climatic variability may have affected the recruitment and distribution of some top predator fish species (Section 3.10.1.5; Hollowed *et al.* 1998).

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fishery will continue to remove sustainable numbers of Pacific halibut, a top predator. The current management plan is likely to continue in the future, although a modified approach has been proposed to produce a yield similar to the present policy while reducing variations in annual yield due to changes in stock abundance, assessment methods, and estimated removals by other fisheries (Clark and Hare 2003). Seabird bycatch and resulting direct mortality are expected to continue annually in North Pacific Ocean longline fisheries operating outside of the EEZ. Available data and estimates for the annual incidental take of individual bird species by these external fisheries are provided and discussed in Sections 3.7.1-3.7.19. The State of Alaska directed groundfish fisheries, operating in state waters of the eastern GOA and southeast Alaska, Cook Inlet, PWS, Kodiak, and the Alaska Peninsula, and in all state waters for lingcod, sablefish, and Pacific cod, will continue to remove targeted top predatory fish species in small numbers relative to the domestic groundfish fisheries in federal waters (ADF&G 2003b). Subsistence harvests of marine mammals will continue in the future, with an increasing trend toward co-management by NOAA Fisheries and Alaska Native organizations. The Protected Resources Division of NOAA Fisheries will continue to develop management and conservation programs to ensure that annual subsistence harvests are sustainable (NOAA Fisheries 2003). A large fuel or oil spill at sea may result in direct mortality of marine mammals, with mortality levels depending on the location, size, and timing of the spill. Finally, a future climatic regime shift could alter total numbers of top predators in the BSAI and GOA ecosystems by increasing or limiting recruitment.

- **Cumulative Effects.** A conditionally significant adverse cumulative effect on populations of top predators could result primarily from the contribution of continued seabird bycatch by North Pacific Ocean longline fisheries operating outside the EEZ. The conditions under which this potential cumulative effect could become significant include continued bycatch of seabirds in conjunction with a large fuel or oil spill and incremental removals of top predators by the IPHC longline fishery, State of Alaska directed groundfish fisheries, and subsistence harvests of marine mammals. As determined from recent climatic studies (Section 3.3), a climatic regime shift is probable in the future, and this could intensify or reduce this potential cumulative effect by influencing recruitment.

<u>Introduction of Non-Native Species</u>

- **Direct/Indirect Effects.** Under PA.2, the predicted catch levels indicate that this FMP would have the same potential for fishing-vessel introduction of non-native species through ballast water exchange or release of hull-fouling organisms that currently exists under baseline conditions. Therefore, the effect of PA.2 on predator-prey relationships through the introduction of exotic species is evaluated as insignificant.

- **Persistent Past Effects.** For decades, the annual arrival of groundfish fishing vessels from ports outside of Alaska has made it possible for non-native species to enter Alaskan waters through the release of ballast water and hull-fouling organisms. Commercial shipping has provided a similar means for the introduction of non-native species (Fay 2002). There have been 24 non-indigenous species of plants and animals documented in Alaskan marine waters, with 15 of these recorded in PWS, where most of the research has been conducted. Although oil tankers, through the release of ballast water, have been speculated to be the primary source for these introductions, cruise ships and fishing vessels coming from areas where invasive species have already been established have also been identified as a threat in the State of Alaska Aquatic Nuisance Species Management Plan (Fay 2002). From 1991 to 2001, 396,522 accidental escapes of Atlantic salmon were reported from British Columbia fish farms (ADF&G 2002a). Concerns have been expressed regarding the potential effects of introduced Atlantic salmon on native Pacific salmon populations, including disease and parasites, colonization, interbreeding and hybridization, predation, habitat destruction, and competition, particularly in locations where depressed stocks of Pacific salmon species provide a potential niche for the Atlantic species (Brodeur and Busby 1998, ADF&G 2002a). In the past, Alaska's northern climate, geographic isolation, and small human population, among other factors, may have prevented the establishment of viable populations by non-native species introduced from more temperate regions (Fay 2002).

- **Reasonably Foreseeable Future External Effects.** IPHC longline fishery vessels, international longline and groundfish fleets operating outside the EEZ, and vessels participating in State of Alaska directed fisheries will continue to act as potential sources for exotic species introductions. In addition, commercial shipping, including cruise ships, barges, and tankers with high-volume ballast water releases, will continue to bring non-native species into Alaskan waters on a recurring basis, maintaining a continuing pressure on indigenous populations (Fay 2002). Escapees and releases of farmed Atlantic salmon from Washington and British Columbia net-pens could eventually establish runs in the GOA coastal streams and rivers. Introduced pathogens and parasites associated with farmed Atlantic or Pacific salmon could affect wild stocks. A future regime shift or long-term warming trend may deplete the current protection that colder conditions may provide against exotic species, allowing viable non-native populations to become established.

- **Cumulative Effects.** When sources of exotic species external to the domestic groundfish industry are considered in combination with PA.2, it is conceivable that viable exotic populations could eventually become established in the BSAI and/or GOA, producing a conditionally significant adverse effect on indigenous species (Table 4.5-89). One possible, but unproven, condition for this outcome would be a future climatic regime shift or long-term warming trend that enables exotic species, currently limited by low seawater temperatures, to establish viable populations in the BSAI and/or GOA. External sources that could contribute to this potential cumulative effect in the future include fishing vessels participating in the IPHC and State of Alaska commercial fisheries, and commercial ships such as tankers and cruise ships, all of which can introduce non-native species through the discharge of ballast water and release of hull-fouling organisms (Fay 2002). In addition, Atlantic salmon released or escaped from coastal net-pen farms could establish viable runs in coastal areas of southeast Alaska in the future (ADF&G 2002a).

Energy Removal

- **Direct/Indirect Effects.** The direct/indirect effects of PA.2 on energy removal are expected to be insignificant. Baseline energy removals, in the form of total catch, are less than one percent of the total ecosystem energy, as estimated by mass-balance modeling, and were determined to have an insignificant impact on the ecosystem baseline. Estimated energy removals under PA.2 would not exhibit potential for producing significant changes to system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.9-7).

- **Persistent Past Effects.** The domestic groundfish fisheries, State of Alaska commercial fisheries, IPHC longline fisheries, commercial harvests of marine mammals, and subsistence harvests have all removed biomass from the BSAI and GOA ecosystems, either as targeted species or as bycatch. These removals are regulated and mitigated and continue today (Section 3.10). Aggregate levels of biomass removed by unregulated past human activities may have been influenced by climatic effects on overall system productivity, with biomass removals increasing as productivity increased and decreasing with climate-related productivity declines.

- **Reasonably Foreseeable Future External Effects.** The IPHC longline fisheries, State of Alaska commercial fisheries, subsistence fish harvests, and subsistence marine mammal harvests will continue to remove biomass from the BSAI and GOA ecosystems in the future. It should be noted that Russian and other fisheries operating in the western Bering Sea and in international waters of the central Bering Sea (donut hole) will also remove biomass in the future, but these regions show sufficient differences from the EBS with respect to production regimes and topographic and hydrographic features that they are viewed as only partly comparable systems. Their interactive components with the EBS, where present, have not yet been characterized (Aydin *et al.* 2002).

- **Cumulative Effects.** The implementation of PA.2 is predicted to have an insignificant cumulative effect on energy removal in the future. The cumulative biomass removal from internal and external fisheries under this FMP is not considered sufficient to produce a long-term change in system biomass, respiration, production, or energy cycling outside the range of natural variability (Table 4.5-89).

Energy Redirection

- **Direct/Indirect Effects.** The direct/indirect effects of PA.2 on energy redirection are expected to be insignificant. Predicted effects are minimal relative to the baseline and would not produce long-term changes in system biomass, respiration, production, or energy cycling outside the range of natural variability due to fishery discarding and offal production practices (Table 4.9-7).

- **Persistent Past Effects.** Ecosystem energetics is a dynamic process, and it is difficult to know whether past changes in energy cycling and pathways of energy flow in the BSAI and GOA produced effects that still persist. The most far-reaching changes in quantities and geographic patterns of bycatch discards and offal production from both fish and marine mammal harvests came with international agreements, legislation, and regulatory actions in the 1950s through the 1970s, culminating in passage of the MSA in 1976 (Section 3.10.1.3). These corrective actions greatly curtailed the destabilizing levels of energy redirection that reached their peak in the mid-twentieth century from commercial whaling, fur seal harvests, high-seas driftnet fisheries, and the international commercial groundfish and salmon fisheries. It seems likely, therefore, that under current management practices, quantities and patterns of energy redirection in the BSAI and GOA are much more limited than they were 50 years ago.

- **Reasonably Foreseeable Future External Effects.** Quantities and geographic patterns of bycatch discards and fish processing wastes released into the sea from the IPHC and State of Alaska commercial fisheries and subsistence harvests are not expected to change substantially in the future. External energy will enter the system as graywater and refuse released into the sea from commercial freighters, tankers, and cruise ships. Finally, future climatic trends have the potential to affect energy cycling in the ecosystem; in particular, a warming trend would be expected to accelerate rates of energy conversion, whereas cooler conditions would tend to have a retarding effect.

- **Cumulative Effects.** The implementation of PA.2 is predicted to have an insignificant cumulative effect on energy redirection. Even with the decreases in discards predicted (Table 4.5-81), the cumulative effect of PA.2 in combination with external sources is not expected to depart from the comparative baseline condition enough to produce long-term changes outside the range of natural variability. The discharge of offal from fish processing facilities and of graywater and other refuse from marine vessels into Alaskan waters is regulated through USEPA and ADEC permitting programs, respectively.

Change in Species Diversity

- **Direct/Indirect Effects.** The expected direct/indirect effects of PA.2 on species diversity are rated as unknown for skates, sharks, grenadiers, and other non-managed species, and insignificant for other species groups. This FMP would also provide substantial increases in closed areas such as no-trawling MPAs and no-take reserves across a range of habitat types, review of all existing closures for qualification as MPAs, establishment of an Aleutian Islands management area to protect coral and other living habitat species, and modification of 2002 Steller sea lion protection measures with designation of critical habitat according to scientific data and assessment information. These closures may result in further reductions in HAPC biota bycatch. The adoption and use of key ecosystem indicators for modifying TAC-setting processes may also provide further protection to sensitive groups such as these until more is learned about their life histories. Catch amounts of target species, prohibited species, seabirds, and marine mammals would be insufficient to bring species within these groups below minimum population thresholds. Although forage species population levels are not known, their relatively high turnover rates and the ban on forage fish fisheries under this FMP are considered sufficient to protect them from falling below minimum biologically acceptable limits.

- **Persistent Past Effects.** Although the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, the timing of various increases and decreases in species abundance of fish, seabirds, and marine mammals has not shown a consistent correlation with groundfish fishing intensity (Sections 3.10.1). With the notable exception of the Steller's sea cow extinction in the 1760s (Section 3.10.1.1), changes in species diversity have not characterized the BSAI and GOA ecosystems. Although no fishing-related species removals have been documented under fisheries management policies in effect during the past 30 years, elasmobranchs (sharks, skates, and rays) are particularly susceptible to removal, and benthic invertebrate species (including HAPC species) are susceptible to impacts from bottom trawling (Section 3.10.3). Seabirds have been particularly vulnerable to bycatch mortality, leading to reduced populations of some bird species below minimum biologically acceptable limits. Lack of data on seabird population trends prevents analysis of past effects of fisheries management or environmental change on most seabird species (Section 3.7), but commercial fisheries have been implicated for some declines through bycatch potential. Livingston *et al.* (1999) found that long-term increases and decreases in the abundance of selected BSAI invertebrate, fish, bird, and marine mammal species did not show beneficial correlations with prey abundance, and cyclic fluctuations in species abundance occurred in both fished and unfished species. As emphasized in Section 3.10.1.5, evidence is accumulating that physical oceanographic factors, particularly climate, have a controlling influence on biological community composition in the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** Although past levels of seabird bycatch by the IPHC, western Bering Sea, and State of Alaska fisheries have not been thoroughly or consistently quantified, the rates are considered substantial and can be expected to continue in the future (Section 3.7). In addition, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may deplete numbers to levels near or below biologically acceptable limits in the future. The potential for introduced exotic species to establish viable populations in the BSAI and GOA will also continue. Such exotics may include Atlantic salmon escapees from net-pen farms, invertebrates and plants introduced through ballast water and from ship hulls, and pathogens introduced by Pacific salmon species that have escaped from fish farms (Fay 2002, ADF&G 2002a, Brodeur and Busby 1998). Future climate changes could alter the productivity and distribution of individual species and enable introduced exotic species to establish viable populations.

- **Cumulative Effects.** Under PA.2, a conditionally significant adverse effect on species diversity could result from continued seabird bycatch in the IPHC longline fishery, western Bering Sea fisheries, and State of Alaska commercial fisheries, in combination with the BSAI and GOA groundfish fisheries. In addition, introduced exotic species may establish viable populations that could alter species diversity by competing with native species for food and habitat (Fay 2002). The consistent, sustained concentration of subsistence harvest effort on particularly accessible subpopulations of marine mammals from year to year could intensify this potential effect. Finally, climate change has the potential to alter species productivity and distribution, and a long-term warming trend might facilitate successful establishment of viable populations of exotic species.

Change in Functional (Trophic) Diversity

- **Direct/Indirect Effects.** Potential effects on trophic diversity relate to changes in the variety of species within trophic guilds. Under PA.2, the predicted direct/indirect effects of the groundfish fisheries on trophic diversity are rated as insignificant. Expected results are similar to the comparative baseline condition, for which fishing effects on trophic diversity are also rated as insignificant.

- **Persistent Past Effects.** It is considered unlikely that past removals of fish by the pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries significantly altered the variety of species within trophic guilds. Livingston *et al.* (1999) found no evidence that groundfish fisheries had caused declines in trophic guild diversity for the groups studied. They also found that past changes in species diversity within guilds related to increases in a dominant guild member (e.g., pollock, rock sole) rather than to decreases in abundance caused by fishing pressure (Section 3.10.3). Past variations in climate, such as ENSO events, interdecadal oscillations, and regime shifts, may have affected trophic diversity by influencing the productivity and distribution of different species in different ways, thereby altering the relative proportions of species within guilds. However, minimal research on this type of effect has been conducted for the BSAI and GOA.

- **Reasonably Foreseeable Future External Effects.** NOAA Fisheries and ADF&G biologists have recently brought attention to the potential for escaped farmed Atlantic salmon to establish viable Alaskan populations in competition with one or more of the five Pacific salmon species and steelhead trout (Brodeur and Busby 1998, ADF&G 2002a, Fay 2002). In addition, the concentrated take of marine mammals from the same local subpopulations over a period of years could affect species diversity within piscivore guilds, that is, guilds consisting of fish-eating species. Exotic species introduced to BSAI and GOA waters from fishing vessels and commercial shipping could lead to the establishment of viable populations in competition with native species at similar trophic levels (Fay 2002). A climatic regime shift in the future could affect trophic diversity by expanding some trophic levels and contracting others. In addition, a long-term warming trend could facilitate the establishment of relatively cold-intolerant exotic species populations.

- **Cumulative Effects.** The implementation of PA.2 could result in a conditionally significant adverse effect on trophic diversity. The primary condition for this potential effect is largely speculative—a climatic regime shift could make a trophic guild containing one or more groundfish fishery target species more vulnerable to fishing pressure. A regime shift in the future, similar to well-documented examples that have occurred in the past (Sections 3.3 and 3.10.1.5), could also decrease species diversity within a trophic guild by reducing the productivity or shifting the distributional range of one or more member species. If this climatic effect went undetected and without compensatory adjustments to fishing effort, the continued removal of particular target species, especially slow-growing species such as the rockfish, could decrease their representation within trophic guilds (Heifitz *et al.* 2001).

Change in Functional (Structural Habitat) Diversity

- **Direct/Indirect Effects.** The issue of concern with respect to structural habitat diversity is the removal of HAPC biota such as corals, sea anemones, and other sessile invertebrates that provide physical structures used as habitat by other species, including economically important groundfish species and their prey. Some of the area closures proposed under PA.2 have been developed with corals and other living habitat species in mind. If implemented, these measures could improve protection of HAPC biota throughout their broad spatial distribution, particularly in the Aleutian Islands. With respect to structural habitat diversity, PA.2 is thought to provide significantly beneficial effects relative to the baseline.

- **Persistent Past Effects.** Bottom-trawling by the pre-MSA international groundfish fisheries, groundfish fisheries after passage of the MSA in 1976, and State of Alaska scallop fisheries have all contributed to the damage or depletion of the structural habitat functional guild in past years. Because little is known about the taxonomic structure of benthic communities of the BSAI and GOA, any past effects of trawling and other fishing-related activities on the species diversity of these communities cannot be quantified. Long-term climatic trends may also have influenced HAPC species through effects on their productivity and distribution, but in the absence of data no conclusions can be made.

- **Reasonably Foreseeable Future External Effects.** The State of Alaska scallop fishery will employ bottom dredges that will continue to damage or remove structural habitat provided by sessile invertebrates such as corals, sea anemones, and sponges. This effect is not likely to be reduced in the future. In addition, a large oil or fuel spill could affect areas where these sensitive bottom-dwelling organisms live and damage or kill them. A climatic regime shift could change the mean annual seawater temperature sufficiently to increase or retard the growth of benthic organisms, thereby altering structural habitat diversity.

- **Cumulative Effects.** Direct/indirect effects of PA.2, rated significantly beneficial, could contribute to a conditionally significant beneficial cumulative effect on structural habitat diversity. This rating is conditional because the direct/indirect effect of PA.2 could be offset under any of the following three conditions. First, the additive effect of the scallop fishery, which employs bottom dredges, could counteract, to an unknown extent, the potential benefits of PA.2 on HAPC biota. Second, a large petroleum spill could also damage or destroy these sensitive organisms. Third, a change in seawater temperature resulting from a future climatic regime shift could reduce the productivity, population size, and distribution of bottom-dwelling invertebrates that provide structural habitat.

Change in Genetic Diversity

- **Direct/Indirect Effects.** Under PA.2, target species are not expected to fall below MSST, and spatial/temporal management of TAC, other catch, and selectivity patterns in the fisheries would be similar to the comparative baseline conditions. Consequently, the direct/indirect effects of the groundfish fisheries on genetic diversity are expected to be insignificant under PA.2. However, baseline genetic diversity remains unknown for many species, and the actual effects that fishing may exert on genetic diversity are also largely unknown.

- **Persistent Past Effects.** The pre-MSA international groundfish fisheries, the domestic groundfish fisheries after passage of the MSA in 1976, and the IPHC, State of Alaska, and subsistence fisheries have cumulatively removed large quantities of fish from the BSAI and GOA ecosystems in the past, but data are not available to indicate whether genetic diversity was significantly altered. As discussed in Section 3.10.3, if a fishery concentrates on certain spawning aggregations or on older (larger) age classes of a target species that tend to have greater genetic diversity (dating from an earlier period when fishing was less intensive), then genetic diversity tends to decline in fished versus unfished systems. It is possible that genetic diversity has already declined in the BSAI and GOA ecosystems, but this cannot be determined in the absence of reliable data. Genetic assessments of North Pacific pollock populations and subpopulations conducted by Bailey *et al.* (1999) have found genetic variations among different stocks, but these studies have not found genetic variability across time within the same stocks that might indicate effects from commercial fishing. Heavy exploitation of certain spawning aggregations existed historically (e.g., Bogoslof pollock), but recent and current spatial/temporal management of groundfish has been designed to reduce fishing pressure on spawning aggregations.

- **Reasonably Foreseeable Future External Effects.** Several external factors have the potential to affect the genetic diversity of the BSAI and GOA ecosystems. Atlantic salmon escapes from coastal net-pen farms in Washington State and British Columbia could establish Alaskan runs and viable populations (ADF&G 2002a, Fay 2002). Subsistence harvests of fish could concentrate effort on the same specific subpopulations from year to year, inadvertently but selectively depleting genetically distinct stocks. Similarly, subsistence harvests of some marine mammal species (Section 3.8), particularly those with relatively small and geographically distinct subpopulations (e.g, belugas, harbor seals), may also deplete genetic diversity. The potential for introduced exotic invertebrates to establish viable populations in the BSAI and GOA will unavoidably continue with fishing vessel and commercial shipping traffic in the future. Future climate changes could alter the productivity and distribution of individual species and enable exotic species to establish viable populations.

- **Cumulative Effects.** The potential cumulative effect of PA.2 on genetic diversity is predicted to be insignificant. Several external factors, such as Atlantic salmon escapes, subsistence harvests of marine mammals that concentrate on the same subpopulations year after year, introduction of exotic species through commercial shipping traffic, and climatic facilitation of viable exotic populations have the potential to produce changes in the genetic diversity of the BSAI and GOA ecosystems. None of these, however, would affect the genetic diversity of species targeted or taken incidentally by the groundfish fisheries. For this reason, external sources of potential change in genetic diversity would not be additive or interactive with the groundfish fisheries in the reasonably foreseeable future.

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4.10 Analysis of Alternatives at the Policy Level

As presented in Chapter 2 of this document, there are four policy-level alternatives and a preferred alternative (PA) analyzed in this Programmatic SEIS. Alternative 1 represents the status quo and consists of the explicit policy statements included in the current BSAI and GOA FMPs and the refined management policy embodied in the NPFMC actions and FMP amendments taken since the FMP policy statements were developed. Three alternatives to the status quo are also considered, and a PA has been identified.

In this section, we analyze the impacts on the human environment of the management policy approaches, goals, and objectives of each alternative.

4.10.1 Summary of Framework Analyses

In order to assist in the analysis of the policy alternatives, a two-dimensional analytical framework has been developed that defines a range of implementing management measures for each alternative. This framework consists of a set of FMP components (i.e., TAC-setting Process, Bycatch and Incidental Catch Restrictions, etc.) and a set of example FMPs that include management measures addressing each FMP component. Each alternative, except for Alternative 1, contains a pair of example FMP "bookends" that illustrate and frame the range of that alternative's management measures (see Section 4.2 for further details). Alternative 1, representing status quo, contains just one FMP: the existing management regime in place for the BSAI and GOA, including NPFMC-approved (but not necessarily implemented in regulation yet) measures through June 2002. The intention is that the FMP framework structure will represent a range of management measures that address each FMP component and that are representative of the management measures likely to be implemented under a chosen alternative.

Each of the two dimensions of the framework (the FMP components and the example FMPs) has been analyzed, either qualitatively or quantitatively. Section 4.3 provides a summary of the qualitative analysis papers written for each FMP component. Each paper provides background on the choice of management measures used to address that FMP component and describes the range of management measures that are implemented under each alternative. Additionally, the papers provide a preliminary assessment of the potential impacts of implementing the management measures in a static environment; cumulative impacts between FMP components are not analyzed in these papers. (For the full text of the papers, see Appendix F.)

Sections 4.5 through 4.9 examine the example FMPs in their entirety. The cumulative impacts of implementing all the management measures in an example FMP are analyzed and discussed for each alternative. These analyses incorporate results from the multi-species model developed for this Programmatic SEIS (see Section 4.1.5) as well as other relevant data.

Included in the sections that follow is a summary of relevant conclusions from the framework analyses as they relate to the overall management policy approaches, goals, and objectives of each alternative.

4.10.1.1 FMP Components – Qualitative Analysis

As stated above, Section 4.3 presents a summary of the FMP component qualitative analysis assessment papers, the full text of which can be found in Appendix F. For the purposes of the detailed framework-level analysis of the alternatives, the implications of certain aspects of the framework, particularly those that initiate or define a process rather than implement an action (e.g., development of criteria to set TAC in space and time as opposed to actually setting the TAC), are exclusively dealt with in the qualitative analysis papers. Table 4.10-1 lists those elements of the analytical framework that are dealt with in the qualitative analysis papers but not included in the example FMP analyses.

4.10.1.2 Example FMPs

The example FMPs were each analyzed against a baseline condition, referred to as the comparative baseline, which is described in Chapter 3 and summarized in Section 4.4. A detailed summary of the example FMP analysis for each alternative can be found in the various summary sections, Section 4.5.11 for Alternative 1, Section 4.6.11 for Alternative 2, Section 4.7.11 for Alternative 3, Section 4.8.11 for Alternative 4, and Tables 4.9-1 through 4.9-7 for the PA. A more global summary of the example FMP analysis is found in Tables 4.10-2a and 4.10-2b. For each of the major resource categories that are analyzed in Sections 4.5 to 4.9, the table contains a series of summary statements comparing impacts across the alternatives.

4.10.2 Analysis of Alternative 1

Alternative 1 consists of two policy statements. The first contains the policy statements explicitly stated within the BSAI FMP, dating from 1981, and the GOA FMP, dating from 1979 and as amended in 1985 (identified as Alternative 1(a) in Chapter 2). Although the specific policy language differs between the GOA and BSAI FMPs, the intent in terms of a management policy is very similar. The second is an updated policy (identified as Alternative 1(b) in Chapter 2) that represents the current management policy of the NPFMC and NOAA Fisheries whether as explicitly stated within the FMPs or as evidenced by the management measures that have been adopted by the NPFMC and NOAA Fisheries since the policy statements were included in the FMPs.

Alternative 1(a)

The 1979 BSAI policy statement consists of a set of broad goals that are supported by a number of secondary objectives. The essential management policy for the BSAI is to promote conservation while providing for the optimum yield of the region's groundfish resource. The following additional guidelines are given:

- Conservation and management measures have taken into account the unpredictable characteristics of future resource availability and socioeconomic factors influencing the viability of the industry.

- These goals are intended to meet the requirements of the NPFMC constituency, the resources, and Fishery Conservation Management Act (the original Magnuson-Stevens Fishery Conservation and Management Act).

The 1985 GOA policy statement consists of a set of goals including a principal management goal and a number of objectives. The fundamental management policy for the GOA is to manage the groundfish resources of the GOA to maximize positive economic benefits to the United States, consistent with resource stewardship responsibilities. Fishery management is also required to conform to the National Standards and to the NPFMC Comprehensive Fishery Management Goals.

The existing FMP policy statements date from a period of North Pacific groundfish management history when the principal goal was to develop domestic groundfish fisheries in order to fully utilize the groundfish resources. The FMPs were trying to encourage domestic groundfish exploitation, and therefore the focus of the management policy was to facilitate economic benefit in order to provide incentives to expand the domestic fleet. The environmental issues of bycatch, seabird and marine mammal interaction, habitat degradation, and ecosystem interactions were generally captured under the objective to avoid irreversible or long-term adverse impact to the environment. These problems were not as pressing at the time the existing policy statements were written, due to the smaller size of the domestic fleet, as well as the comparative lack of information on the impact of the fisheries, which twenty years of fishery monitoring data has altered.

Alternative 1(b)

Since the FMP policy statements were adopted, the NPFMC and NOAA Fisheries have implemented management measures that indicate changes in the management policy. The policy statements themselves have not been updated to reflect these changes. In order to incorporate these modifications into this programmatic analysis, an updated policy statement for Alternative 1 (Alternative 1(b)) has been developed. This updated policy statement represents the current policies of the NPFMC and NOAA Fisheries whether as explicitly stated within the FMPs or as evidenced by the management measures that have been adopted.

The updated management approach statement underscores the policy objective that fishery impacts to the environment are mitigated as scientific evidence indicates that the fishery is adversely impacting the ecosystem. The management approach statement is summarized in Table 4.10-3. This policy is based on the assumption that fishing does produce some adverse impact on the environment and, that as these impacts become known, mitigation measures are developed and FMP amendments are implemented.

The updated management approach statement recognizes that the NPFMC management process:

- Is adaptive to new information and reactive to new environmental issues.
- Works towards goals through existing institutions and processes.
- Uses National Standards and other applicable law as its guide in practicing adaptive management, responsible decision-making to consistently amend FMPs accordingly.
- Addresses issues as they are identified through NPFMC staff tasking and research priorities.

The updated management approach statement is fully consistent with the FMP policy statements and the NPFMC and NOAA Fisheries implementation of those policies since they were adopted. The updated policy statement also facilitates a comparison of Alternative 1 to the other alternatives.

Because the current wording of the policy statements in the FMPs differs from the actual implementation of those policies by the NPFMC and NOAA Fisheries, a distinction between Alternative 1(a) and Alternative 1(b) is necessary in order to accurately describe the status quo. If the NPFMC identifies Alternative 1 as its preferred alternative, it will also have to choose whether or not to continue using the current FMP policy statements (Alternative 1(a)) or to amend the FMPs to incorporate the updated policy statements (Alternative 1(b)). However, for analytical purposes, no distinction is necessary because the updated policy statements contained in Alternative 1(b) represent the NPFMC and NOAA Fisheries' interpretation of the policy statements contained in the FMPs. Therefore, the policy-level analysis of Alternative 1 will be representative of both Alternatives 1(a) and 1(b).

A summary of the impacts of Alternative 1 follows below in Section 4.10.2.1. In the remainder of Section 4.10.2, the impacts of the alternative are analyzed in relation to eight policy subheadings: prevent overfishing; preserve food web; reduce and avoid bycatch; avoid impacts to seabirds and marine mammals; reduce and avoid impacts to habitat; allocation issues; increase Alaska Native consultation; and data quality, monitoring, and enforcement. For each subheading, the impacts of the relevant goals and objectives from the management approach are analyzed using the range of implementing management measures for Alternative 1 as a guideline. These guidelines are identified in Section 4.2 and analyzed in Section 4.5.

4.10.2.1 Summary of Alternative 1

The key policy elements that predominantly influence the impacts under Alternative 1 are: the current harvest strategy that incorporates automatic stock rebuilding (ensuring the sustainability of target stocks); incidental catch and bycatch controls; the existing system of closure areas (to protect a variety of species from groundfish fishery interactions); the objective to reduce the adverse effects of the race-for-fish (resulting in gradual implementation of rationalization); and reporting and monitoring requirements (increasing the accuracy of catch accounting).

Alternative 1 is successful at preventing overfishing of target stocks and thus meeting the goal of ensuring the sustainability of the fisheries. Alternative 1 also includes automatic stock rebuilding provisions which have proven to be effective. A weakness of this alternative is that there is no incentive to research fishery impacts on Tier 4-6 stocks in order to change their management status. It is also possible under this alternative to overharvest a vulnerable member of a stock complex.

This alternative is partially successful in achieving the goal of preserving the food web through its protection measures for dominant target species, forage species, and ESA-listed species. However, it will likely make slow, incremental progress in protecting other food web components. This policy is likely effective in protecting food web components that are more well-studied than others and those that are at critical population thresholds, but it is uncertain whether sufficient protection is provided to other food web components for which less complete information is available.

The bycatch management program under Alternative 1 is effective at limiting incidental catch of non-target species and reducing bycatch through incentive programs and monitoring. The weaknesses of the alternative are that bycatch is often reported as a complex rather than as individual species, and that observers are not present to monitor catch on vessels less than 60 ft LOA, which may result in inaccurate estimates of bycatch. This alternative may therefore not provide adequate protection for non-target species.

Alternative 1 is effective at providing protection to listed seabirds and marine mammals as a result of its explicit objectives for ESA-listed species. Although not an explicit policy goal, some protection may also be provided to non-listed seabirds through reduced incidental take as a result of implementing additional seabird protection measures.

This alternative emphasizes incremental implementation of habitat protection measures as scientific information becomes available. As a result, impacts to habitat may be alleviated, albeit slowly. This strategy is likely to be effective in protecting habitat components that are more well-studied than others, but it is uncertain whether sufficient protection will be provided to habitat components for which there is less complete information. Cumulatively, continued adverse impacts result from historical impacts that have potentially caused long-term and possibly irreversible loss of living habitat, especially to long-lived, slow-growing species that are slow to recover.

Alternative 1 is expected to continue to provide economic and community stability within the current management system while adapting management programs when the need arises. The alternative could eliminate the race-for-fish and, by doing so, would increase net-revenues to producers and provide benefits to consumers. However, fewer, although possibly higher paying, fishery related jobs would be created. Non-market, recreation, and tourism values could decrease in the short-run before the transition to rights-based systems is completed.

The goals and policies for Alaska Native consultation and participation in fishery management would continue at the current levels and comply with relevant EOs and other federal law. Traditional knowledge in fishery management would continue to be incorporated in environmental documents as available and appropriate. Subsistence uses would continue consistent with federal law.

This policy will result in a data collection program that will continue to meet minimum acceptable standards for scientific management of the fisheries. Although aspects of the catch collection program could be improved, such as non-random coverage in the 30 percent component of the fleet, current practices do provide useful data for fishery management while remaining mindful of the cost burden on industry of the monitoring program.

4.10.2.2 Prevent Overfishing

Alternative 1 for the BSAI and GOA represents the policy statement currently implemented in the BSAI and GOA. The alternative seeks to prevent overfishing by adopting conservative harvest levels for single species fisheries and specification of OY range. Alternative 1 promotes conservation by avoiding irreversible or long-term adverse effects on fishery resources, and ensures the availability of a multiplicity of options with respect to the future use of groundfish resources. Alternative 1 also sets objectives to meet these goals by promoting rebuilding when stocks have declined below a level capable of producing MSY. The alternative maintains a margin of safety between ABC and OFL to prevent overfishing when the quality of information concerning the resource and ecosystem is questionable.

The Alternative 1 policy is illustrated through FMP 1, which contains a number of management measures that pertain to the sustainability of fisheries and fishery resources. FMP 1 defines four management categories for which catch is constrained by various regulatory mechanisms: target species, prohibited species, other species, and forage fish species. Stocks can be moved from one management category into another only by FMP amendment. There is a fifth category of non-specified species that encompasses all species that may be caught in commercial fisheries but the catch of which is not constrained. Within the target species category, stocks are managed either individually or as part of a stock complex. Stocks within the target species category can be added to or removed from a stock complex within the same category as part of the TAC-setting process (i.e., without an FMP amendment).

Goals, Objectives	**Corresponding Management Measures**	
<u>Goals</u> • Maintain sustainable fisheries • Manage the groundfish fisheries through the current risk-averse conservation and management program that is based on a conservative harvest strategy • Incorporate and apply ecosystem-based management principles <u>Objectives</u> • Adopt conservative harvest levels for single species fisheries and specify OY • Continue to use existing OY cap for BSAI and GOA fisheries • Provide for adaptive management by continuing to specify OY as a range	TAC≤ABC≤OFL Automatic Rebuilding	Quota management based on a tier system. F_{ABC} set below F_{OFL} except at very low stock sizes protecting the stock from unintentional overfishing. The ABC can be set anywhere between zero and the maximum permissible ABC under the Tier system. In practice ABCs are often set below the maximum permissible ABC to address uncertainty in the stock assessment (e.g. BSAI pollock, GOA pollock, BSAI and GOA cod). For Tier 3 stocks, F_{ABC} is decreased linearly with biomass whenever biomass falls below a tier-specific reference level.
	Time/Area	For several species, fishing quotas are distributed across time and area in proportion to the expected underlying biomass of fish in the region at that time. These policies reduce the possibility of spatial temporal concentration of the catch.
	Gear restrictions	For walleye pollock, Pacific cod, and sablefish, gear allocations partition catch to specific gear groups. Differences in gear selectivity are addressed in the stock assessment models and quotas reflect the expected age distribution of the catch by gear.
	OY caps	Optimum Yield restrictions cap the aggregated groundfish catch in the GOA and BSAI. These caps limit the expansion of fisheries (particularly in the BSAI).
	Inseason Multi-species TAC and ABC monitoring	The catch of a given target species is limited by prohibited species bycatch caps and the TACs for other groundfish. The halibut bycatch caps serve as a constraint to BSAI and GOA flatfish expansion.

Impacts of Policy

An illustration of the harvest constraints imposed by Alternative 1 is provided by FMP 1, the current 2002 management regime for the BSAI and GOA. This FMP addresses the impact of fishing mortality by constraining catch. FMP 1 adopts precautionary measures that build sustainable fisheries and promote rebuilding of overfished stocks. The recommended fishing mortality under FMP 1 would not exceed the OFL for any target stock; however, should any stock decline below a level capable of producing MSY, NOAA Fisheries would develop a rebuilding plan to be put in place that would rebuild the stock within ten years or the specified time period for rebuilding plus one generation time. The objective to include a margin of safety when the quality of information is questionable is accommodated by the buffer between F_{ABC} and F_{OFL}, which would reduce the chance of unintentionally overfishing a stock. Irreversible or long-term adverse effects on fishery resources are avoided through harvest rates that prevent overfishing. This policy implements in-season multi-species catch monitoring to ensure that catch does not exceed the OFLs. In the EBS, the upper limit of the OY range (2 million mt) curtails the expansion of some groundfish fisheries. Relative to the baseline, the expected fishing mortality under FMP 1 would have no significant impact on any of the target groundfish stocks.

Under FMP 1, none of the 19 stocks managed in Tiers 1-3 would be expected to become overfished (Table 4.10-2a). The policy promotes healthy spawning stocks by reducing fishing mortality whenever the stock falls below $B_{40\%}$. Relative to the baseline, no significant impacts due to changes in spawning biomass are expected for stocks managed in Tiers 1-3. For stocks or stock complexes managed in Tiers 4-6, the impacts on spawning biomass are unknown because the status of the stock relative to its MSST is unknown for these stocks (Table 4.10-2a). The impacts of Alternative 1 on fishing mortality of GOA Atka mackerel are unknown. Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on fishing mortality.

FMP 1 includes numerous spatial/temporal restrictions on catch that should reduce impacts resulting from concentration of the catch. Under this policy, commercial fishing is not expected to have significant impacts on the genetic makeup or the reproductive success of the stocks managed in Tiers 1-3 (Table 4.10-2a). The impact of commercial fishing on the genetic make-up or reproductive success of stocks managed in Tiers 4-6 is unknown because the status of such stocks relative to their respective MSST is unknown (Table 4.10-2a). Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on fishing mortality.

Harvest restrictions and spatial temporal partitions diffuse the impacts of commercial fishing on prey availability and predation mortality. Impacts of commercial fishing on prey availability for the 19 stocks managed in Tiers 1-3 are expected to be insignificant relative to the baseline (Table 4.10-2a). Impacts of commercial fishing on prey availability of stocks or stock complexes that are managed in Tiers 4-6 are unknown because the status of such stocks relative to their respective MSST is unknown (Table 4.10-2a). Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on fishing mortality.

Harvest restrictions, spatial temporal constraints and gear allocations all serve to mitigate the impact of commercial fishing on fish habitat. The existing closure system in the BSAI and GOA sets aside approximately 11 percent of the EEZ to some form of MPA and designates 0.1 percent of the EEZ as a no-take reserve (Figure 4.2-1). For the fishable area (depth to 1,000 m) of the EEZ, FMP 1 would designate approximately 28 percent of the fishable area as some form of MPA, of which 0.3 percent is designated as a no-take reserve. Relative to the baseline, the impacts on target species resulting from habitat disturbance are considered insignificant for all stocks managed in Tiers 1-3 (Table 4.10-2a). The impacts are unknown for stocks or stock complexes managed in Tiers 4-6.

When taken in aggregate, Alternative 1 is expected to achieve the goals of promoting conservation by avoiding irreversible or long-term adverse effects on fishery resources, and to ensure the availability of multiple options with respect to the future use of groundfish resources. The Alternative 1 policy is consistent with NOAA Fisheries' goal of building and maintaining sustainable fisheries. This policy is also consistent with ecosystem principles that call for in-season multi-species catch monitoring to ensure that catch does not exceed the OFLs. This catch monitoring is facilitated by at-sea observers, port samplers, weekly production reports, and fish ticket information (Appendix F-10). A strength of Alternative 1 is that it encourages automatic rebuilding by linearly reducing F_{ABC} when the stock falls below $B_{40\%}$. This feature may mitigate the lack of a formal declaration of a method for annually assessing the status of stocks relative to the MSST in the FMP. The National Standard Guidelines require FMPs to specify MSST whenever possible (Appendix F-1). Alternative 1 is the only alternative that has an observed track record. This track record shows that none of the stocks managed in Tiers 1-3 is overfished. The track record also shows that the harvest policy is effective at rebuilding depleted stocks (e.g., Aleutian Islands and GOA rockfish stocks). A weakness of Alternative 1 is that there is no incentive to reduce the number of stocks where the status relative to an overfished condition is unknown. While harvest policies may build and maintain the species complex, it is still possible to overharvest a vulnerable member of the complex. Alternative 1 does not require formal examination of the status of groundfish stocks relative to MSST. In practice, this is a technical omission because NOAA Fisheries conducts annual status reviews for the stocks managed in Tiers 1-3. These status reviews are included in the SAFE chapters that are presented to the NPFMC for their use in setting annual TACs.

4.10.2.3 Preserve Food Web

The Alternative 1 policy sets goals and objectives to preserve the food web, as well as specifying management measures that would allow implementation of this policy.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
<u>Goals</u> • Incorporate and apply ecosystem-based management principles • Consider the impact of fishing on predator-prey and other important ecological relationships <u>Objectives</u> • Incorporate ecosystem considerations into fishery management decisions • Continue to protect the integrity of the food web through limits on the harvest of forage species • Develop a conceptual model of the food web	TAC-setting Process	prohibit directed fishery for forage fish
		precautionary adjustments to ABCs, incorporate uncertainty only in Tier 1
		develop ecosystem indicators for future use in TAC-setting

Impacts of Policy

Impacts to foods webs of the BSAI and GOA are mitigated through many of the goals and objectives and the related management measures of this FMP. Alternative 1 objectives specifically incorporate ecosystem considerations into fisheries management decisions, prohibit directed fisheries for forage fish (which often form a central position in channeling energy through the food web), and require precautionary adjustments to ABCs made to Tier 1 stocks. Alternative 1 policies and goals also seek to prevent overfishing, reduce and avoid bycatch, avoid impacts to seabirds and marine mammals, reduce and avoid impacts to habitat, and improve data quality, monitoring, and enforcement, all of which are critical to protection of food web components. These components include target and non-specified species, PSC species, HAPC biota, and marine mammals and seabirds. Various management measures provide protection to important food web components: conservative harvest levels for target species and OY cap (Section 4.10.3.2); accounting for bycatch mortality and PSC limits for prohibited species (Section 4.10.3.4); SSL prey species low biomass rules; spatial/temporal distribution of TAC; closure areas to protect walrus and Steller sea lions, gear modifications to protect seabirds, and short-tailed albatross take restrictions (Section 4.10.3.5), existing closed areas and efforts to identify and designate EFH and HAPC (Section 4.10.3.6); the Observer Program, VMS for Steller sea lion prey species, and scales (Section 4.10.3.9). See the policy analysis in those sections for details on the level of protection provided by Alternative 1 to these individual components.

This alternative specifically attempts to incorporate ecosystem considerations into fishery management decisions through development of ecosystem indicators, conceptual models of the food webs, and prohibition of directed fisheries for forage fish, which often form a central position in channeling energy through the food web. Analysis of the ecosystem effects of FMP 1 involved selection of indicators that would show changes in key members or ecosystem characteristics that are important to the structure and function of marine food webs. Changes in pelagic forage species, top predators, spatial/temporal availability of prey, exotic species introductions, energy removal and redirection through fishery catch removals, discarding, and offal production, and various measures of diversity were evaluated with respect to the potential of fishing to cause changes sufficient to bring these attributes below population, community, or ecosystem thresholds, if such thresholds could be defined. Most of these indicators show an insignificant impact on these ecosystem attributes. However, there were unknown effects on some top predator species and on species diversity due to our lack of knowledge of abundance levels and life history characteristics of species such as skates, sharks, and grenadiers. The continued possibility of adverse impacts was described due to introductions of non-native species from fishing vessel ballast water, such non-native species have the potential to drastically change food webs. Other adverse impacts are possible due to the possible loss of functional diversity through the lack of protection of sensitive, structural habitat organisms such as corals that are very slow growing and remained unchanged relative to the baseline. Qualitative analysis of the alternative with respect to ecosystem effects of the TAC-setting process (Appendix F-1) showed that this alternative has the potential to be considerate of ecosystem needs but would need a more formalized decision-making system to explicitly implement.

Through its protection measures for dominant target species, forage species, and ESA-listed species, when considered as a whole this alternative is partially successful in achieving the goal of preserving the food web. However, it will likely make slow, incremental progress in protecting other food web components. The emphasis in this alternative is on incremental improvements to the fishery management regime as more information becomes available and on protection measures devised in response to requirements for protecting ESA-listed species. This strategy is likely effective in protecting food web components that are more well-studied than others and those that are at critical population thresholds, but it is uncertain whether sufficient protection is provided to others for which we have less complete information.

4.10.2.4 Reduce and Avoid Bycatch

Alternative 1 represents the current management policy in the BSAI and GOA. The alternative seeks to reduce bycatch by implementing gear restrictions, time area restrictions, and in-season bycatch monitoring by deploying domestic observers, port samplers, and requirements for weekly production reports. Bycatch is defined as species that are caught and discarded at sea. A detailed description of the regulations impacting bycatch can be found in the Bycatch qualitative analysis paper (Appendix F-5).

Gear restrictions and time/area restrictions to reduce bycatch in groundfish fisheries are implemented under FMP 1. The FMP prohibits directed fishing for pollock with non-pelagic trawl gear in the BSAI. Directed fishing for sablefish is restricted to longline gear in the GOA. This restriction may reduce the bycatch of species captured in trawl fisheries but may increase the bycatch of sharks and selected rockfish commonly caught in longline fisheries. Non-pelagic trawling is prohibited in the Bristol Bay Red King Crab Savings Area in the BSAI, and in the Cook Inlet in the GOA. Additionally, various areas around Kodiak Island are closed to non-pelagic trawling either year-round or seasonally to protect crab stocks (see Figure 4.2-1).

Groundfish fisheries in the BSAI and GOA are required to discard any incidental catch of halibut, salmon, crab, herring, or Steelhead trout, known collectively as prohibited species. The FMPs currently set catch limits on many of the prohibited species, with penalties ranging from closure of a particular zone or whole management area to closure of a directed fishery or fisheries for a specified season or for the rest of the year. In the BSAI FMP, stair step limits for trawl bycatch within specified zones are set for red king crab and *C. bairdi* crab. The catch limit varies based on stock abundance. The BSAI FMP also specifies an absolute trawl catch limit for chinook salmon and other salmon within specified zones. Once the apportioned PSC limit for a trawl fishery is reached within a zone, the fishery is prohibited from fishing within that zone. The BSAI FMP specifies a trawl catch limit for herring in the BSAI at one percent of annual biomass. Catch limits on *C. opilio* crab and halibut bycatch in the BSAI are established in regulation. The *C. opilio* catch limit applies to a specified zone, and is based on an adjusted percentage of biomass that must fall within a certain range. The halibut catch limit is a BSAI-wide metric ton limit and is based on halibut mortality. Catch limits on halibut bycatch in the GOA are authorized in the FMP, and are set by the NPFMC as part of the annual procedure for setting groundfish harvest levels. There are no other prohibited species catch limits set in the GOA.

Other bycatch reduction measures are required under FMP 1 as well. Full retention by vessels fishing for groundfish of all pollock and Pacific cod fit for human consumption is required under IR/IU regulations. A minimum utilization standard of 15 percent for other groundfish species is also set for all processors. Additional measures that would reduce bycatch of other groundfish are also under consideration. For example, the NPFMC is considering an amendment to require full retention of DSR by hook-and-line and jig vessels in southeast Outside. A Vessel Incentive Program encourages bycatch reduction by setting bycatch reduction standards biannually. If a vessel fails to meet these standards, it can be penalized. In-season bycatch management measures establish fishing seasons for bycatch management and give the NOAA Fisheries Regional Administrator the authority to close areas with high bycatch.

Impacts of Policy

Alternative 1 is expected to encourage the development of practical measures that reduce bycatch and incidental catch of prohibited species, target groundfish, other species, forage fish, and non-specified species. Relative to the baseline, the direct and indirect impacts of Alternative 1 on prohibited species, other species, forage fish, and non-specified species are insignificant (Tables 4.10-2a and 4.10-2b). These rankings do not imply that current harvest practices are safe for all species within the categories noted above. The rankings do imply that adopting Alternative 1 would not represent a significant change relative to the baseline. Two issues are of particular concern. Some prohibited species are currently in a depressed (BSAI chinook) or overfished condition (*C. bairdi* crab, *C. opilio* crab, BSAI red king crab, and BSAI blue king crab). Although the fishing mortality of depressed or overfished non-target species is minor, the additional mortality resulting from groundfish fisheries is not beneficial to these stocks. When cumulative effects are considered, conditionally significant adverse impacts due to fishing mortality are expected for depressed and overfished species. Conditionally significant adverse impacts are also expected for crab species due to change in biomass.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Encourage the development of practical measures that minimize bycatch • Protect threatened and endangered species Objectives • Continue current incidental catch and bycatch management program • Continue to manage incidental catch and bycatch through seasonal distribution of TAC and geographical gear restrictions • Continue to account for bycatch mortality in monitoring annual TACs • Control the bycatch of prohibited species through PSC limits • Continue program to require full utilization of target species • Continue to respond to evidence of population declines by closing areas and implementing gear and seasonal restrictions in affected areas	Bycatch and Incidental Catch Restrictions	Quota management is based on a tier system. F_{ABC} set below F_{OFL} except at very low stock sizes protecting the stock from unintentional overfishing. The ABC can be set anywhere between zero and the maximum permissible ABC under the Tier system. In practice ABCs are often set below the maximum permissible ABC to address uncertainty in the stock assessment (e.g. BSAI pollock, GOA pollock, BSAI and GOA cod). For Tier 3 stocks, F_{ABC} is decreased linearly with biomass whenever biomass falls below a tier-specific reference level.
	Gear Restrictions and Allocations	Directed harvest of walleye pollock in the BSAI is restricted to pelagic gear.
	Spatial/ Temporal Management of TAC	For several species, fishing quotas are distributed across time and area in proportion to the expected underlying biomass of fish in the region at that time. These policies reduce the possibility of spatial/temporal concentration of the catch.

Alternative 1 is effective at limiting the incidental catch of target and non-target species and reducing bycatch. Bycatch monitoring programs are consistent with ecosystem principles that call for in-season multi-species catch monitoring to ensure that catch does not exceed the OFLs. Implementation of at-sea catch monitoring has proved to be beneficial to reducing bycatch of prohibited species. The track record shows that some bycatch reduction incentives coupled with catch monitoring have been effective in reducing the bycatch of prohibited species in groundfish fisheries. A weakness of Alternative 1 is that bycatch is often reported as a complex rather than by species. The absence of at-sea catch monitoring for vessels less than 60 ft LOA may result in less than adequate protection of non-target species. Implementation of IR/IU coupled with AFA has been effective at reducing the bycatch in pollock and Pacific cod fisheries. However, AFA had the negative impact of mandating head and gut vessels to discard pollock when catches exceed 20 percent of the retained catch in the flatfish fisheries.

4.10.2.5 Avoid Impacts to Seabirds and Marine Mammals

The Alternative 1 policy sets goals and objectives to avoid impacts to seabirds and marine mammals, as well as specifying management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Protect threatened and endangered species Objectives • Continue to cooperate with USFWS to protect ESA-listed and other seabird species • Maintain current protection measures to avoid jeopardy to ESA-listed Steller sea lions	TAC-setting Process, Steller sea lion Measures	Steller sea lion prey species low biomass rules
	TAC-setting Process	prohibit directed fishery for forage fish
	Spatial/ Temporal Management of TAC	spatial/temporal distribution of TAC
	MPAs and EFH/ Steller sea lion Measures/ Gear Restrictions and Allocations	seasonal, gear/fishery specific, and total closure areas identified to protect walrus and Steller sea lions
	Seabird Measures	short-tailed albatross take restrictions
		gear modifications to protect seabirds

Impacts of Policy

Impacts to seabirds and marine mammals are mitigated in Alternative 1 through the stated goal of protecting threatened and endangered species. The objectives of this alternative are to continue to cooperate with USFWS to protect ESA-listed and other seabird species and to maintain current protection measures to avoid jeopardy to ESA-listed Steller sea lions. Management measures that provide protection to seabirds and marine mammals in this alternative include: Steller sea lion prey species low biomass rules, prohibition of directed fishery for forage fish, spatial/temporal distribution of TAC, a variety of time/area/gear/fishery closures, fishery closures to protect walrus and Steller sea lions, short-tailed albatross take restrictions, and gear modifications to protect seabirds. Impacts of the alternative with respect to seabirds were evaluated with respect to the potential for fisheries to cause direct mortality through fishing gear and vessel strikes, changes in prey availability (including offal), and changes in benthic habitat that might affect certain prey species of seabirds. Impacts for marine mammals were evaluated with respect to the potential for fishery incidental take or entanglement in marine debris, harvest of prey species, spatial/temporal concentration of fishing on prey, and fishing vessel disturbance.

This alternative is successful at meeting its objective of protection of threatened and endangered species. Impact indicators showed that Alternative 1 impacts to seabirds were minimal. Incidental take of surface-feeding seabirds was substantially reduced from the baseline due to the new mitigation measures in the longline fleet. The risk of exceeding ESA-thresholds for mortality of short-tailed albatross was reduced from the baseline level. The qualitative analysis of seabird protection measures (Appendix F-6) noted the importance of the Observer Program in both monitoring the levels of incidental take and in researching the effectiveness of different seabird avoidance techniques. The groundfish fishery in this alternative is not expected to have population level effects on any seabird species through mortality, changes in food availability, or impacts on benthic habitat. Although some piscivorous bird species such as glaucous-winged gulls might be gaining food subsidies in the baseline, other piscivorous birds would be negatively impacted by competitive interactions with gulls, thus offsetting any changes for the piscivorous bird group as a whole.

Qualitative analysis of the impacts of this alternative on Steller sea lions (Appendix F-4) and the quantitative analysis of impacts on marine mammals showed that impacts were insignificant with respect to all the indicators relative to the baseline. However, the spatial shift in fisheries from closed areas increases the possibility of fishery competitive interaction with other species such as northern fur seals.

This alternative, through its explicit retention of measures for protecting ESA-listed species, is effective at providing protection to listed seabirds and marine mammals. Although some protection is afforded to non-listed seabirds through the implementation of the 2001 seabird protection measures, this is not an explicit part of its policy goal.

4.10.2.6 Reduce and Avoid Impacts to Habitat

The Alternative 1 policy sets goals and objectives to reduce and avoid impacts to habitat, as well as specifying management measures that would implement these objectives.

<table>
<tr><th rowspan="2">Goals, Objectives</th><th colspan="2">Corresponding Management Measures</th></tr>
<tr><th>FMP Component</th><th>Management Measure</th></tr>
<tr><td rowspan="3"><u>Goals</u>
• Protect, conserve and restore living marine resource habitat
• Consider the impact of fishing on habitat
• Encourage the development of practical measures that minimize adverse effects on essential fishing habitat

<u>Objectives</u>
• Respond to new scientific information regarding areas of critical habitat by closing those regions to all fishing (i.e., no-take marine reserves such as Sitka Pinnacles)
• Evaluate the impacts of trawl gear on habitat through the stepwise implementation of a comprehensive research plan, to determine appropriate habitat protection measures
• Continue to evaluate candidate areas for MPAs</td><td>MPAs and EFH, Bycatch and Incidental Catch Restrictions, Gear Restrictions and Allocations</td><td>Existing system of closed areas including Sitka Pinnacles</td></tr>
<tr><td rowspan="2">MPAs and EFH</td><td>EO 13158 description and evaluation of potential MPA areas</td></tr>
<tr><td>Identify and designate EFH and HAPC</td></tr>
</table>

Impacts of Policy

Alternative 1 addresses impacts to habitat by having specific goals and objectives that focus on living marine habitat. Implementation of this policy is expected to result in a gradual reduction and avoidance of impacts to habitat. This reduction in impacts will occur over the long-term in response to new scientific information. Such scientific information will be obtained through a stepwise implementation of a research plan that focuses on the impacts of trawl gear on habitat. Evaluation of areas as potential MPAs and identification and designation of EFH and HAPC are specific management measures. Given that this policy relies on responsiveness to new scientific information and implementation of a research program, it is expected that adverse impacts to habitat will continue in the short-term. This policy will likely be effective for habitat components that are well studied, but it is uncertain whether sufficient protection is provided to components with less complete information.

In addition to the objectives specifically designed for habitat, Alternative 1 policies to prevent overfishing, reduce and avoid bycatch, incorporate ecosystem considerations, and data quality and enforcement goals are important ancillary objectives that could provide reduced impacts to habitat. Management measures such as conservative harvest levels for target species and PSC limits can reduce impacts to habitat because fishing effort may be reduced. Closures for marine mammal protection, especially if they are year-round for all target species, can also provide protection to specific habitat types.

Analysis of FMP 1 involved assessing effects to mortality, damage, and diversity of living marine habitat. In addition, an assessment of effects on the diversity of impacts was performed with the assertion that within fished areas spatially diverse or patchy fishing impacts are preferable to uniformly distributed impacts. These effects are expected to cause insignificant change relative to the baseline. However, adverse impacts could occur because continued mortality and damage to living habitat coupled with historical impacts may cause long-term and possible irreversible loss of living habitat, especially long-lived, slow-growing species which are slow to recover. There are expanses of fished areas where adverse impacts could result from Alternative 1. In these fished areas, continued fishing at Alternative 1 levels may result in habitat levels substantially below unfished levels. In addition, the geographic and habitat type distribution of closures is not expected to provide a diversity of impacts within fished areas. Most areas that are closed to bottom trawling year-round to all species are nearshore areas, or of one habitat type, with the exception of the southeast Alaska trawl exclusion zone. This configuration of closures may change as the goals and objectives of this policy are implemented.

From a cumulative impacts perspective, the baseline condition is adversely impacted due to historical impacts that have potentially caused long-term and possibly irreversible loss of living habitat, especially to long-lived, slow-growing species that are slow to recover. The cumulative impact for this alternative is conditionally significant adverse due to the adverse state of the baseline condition coupled with continued damage and mortality to living habitat.

Overall this alternative emphasizes incremental implementation of habitat protection measures as scientific information becomes available. As a result, impacts to habitat may be alleviated, albeit slowly. This strategy is likely to be effective in protecting habitat components that are more well studied than others but it is uncertain whether sufficient protection will be provided to habitat components for which we have less complete information.

4.10.2.7 Address Allocation Issues

Management measures under Alternative 1 implement a conservative and risk-averse policy that balances sustainability of the resource and the environment with socioeconomic benefits. This policy emphasizes allocation issues and equitable access to the resources among fishery participants and fishing communities. It also includes an explicit recognition of broader ecosystem concerns.

<table>
<tr><th rowspan="2">Goals, Objectives</th><th colspan="2">Corresponding Management Measures</th></tr>
<tr><th>FMP Component</th><th>Management Measure</th></tr>
<tr><td rowspan="3">Goals
• Maintain statutorily mandated programs to reduce excess capacity and the race-for-fish

Objectives
• Continue to reduce excess fishing capacity, overcapitalization and the adverse effects of the race-for-fish
• Provide economic and community stability by maintaining current allocation percentages to harvesting and processing sectors</td><td>Gear Restrictions and Allocations</td><td>Allocate by gear for certain directed fisheries</td></tr>
<tr><td rowspan="2">Overcapacity</td><td>LLP program for groundfish fisheries</td></tr>
<tr><td>Rights-based management programs for certain directed fisheries, and community quota programs</td></tr>
</table>

Impacts of Policy

Alternative 1 explicitly recognizes the adverse effects of the race-for-fish and promotes actions that alleviate those problems while providing for economic and community stability. This policy is evolutionary and adaptive in nature as it responds to management issues. The alternative also recognizes the importance of ecosystem health and the broad range of benefits that the BSAI and GOA marine ecosystems and associated species provide to the American public.

As the race-for-fish is eliminated, in what could be an extended process, the alternative could result in beneficial effects in terms of producer net revenue, consumer benefits, and participant health and safety (see Appendix F-8). The policy provides economic stability to fishery participants and communities by maintaining current allocation percentages to sectors. However, the elimination of the race-for-fish will likely result in a decrease in overall participation levels. In the long-run, communities are likely to see fewer persons employed in jobs related to the fishing industry (fishing, processing, or support sectors), but the jobs that remain could result in longer periods of work and higher pay.

Because elimination of the race-for-fish is expected to be gradual in nature and unlikely to completed in the near-term, it is likely that the adverse effects of the race-for-fish will continue in the short-term. For this reason, the alternative could result in decreased non-market, recreational, and tourism values attributed to the ecosystem. In the long-run, however, with completion of the transition away from the race-for-fish, non-market ecosystem values may increase due to reductions in bycatch and greater harvesting efficiency that are anticipated with rights-based management.

4.10.2.8 Increase Alaska Native Consultation

The Alternative 1 policy sets goals and objectives to increase Alaska Native consultation, as well as specifying management measures that would implement these objectives.

<table>
<tr><th rowspan="2">Goals, Objectives</th><th colspan="2">Corresponding Management Measures</th></tr>
<tr><th>FMP Component</th><th>Management Measure</th></tr>
<tr><td rowspan="3">Objectives
• Continue to incorporate Traditional Knowledge in fishery management
• Continue current levels of Alaska Native participation and consultation in fishery management</td><td rowspan="3">Alaska Native Issues</td><td>Incorporate Traditional Knowledge in fisheries management through existing literature, on-staff anthropologist</td></tr>
<tr><td>Advisory Panel and NPFMC representation</td></tr>
<tr><td>Allow for subsistence uses consistent with Federal law</td></tr>
</table>

Impacts of Policy

Alaska Native consultation in the management of Alaska groundfish fisheries is currently accomplished through a number of measures. These mechanisms include 1) executing Government-to-Government Consultation with federally recognized tribes in accordance with EO 13175; 2) identifying sources of pertinent Traditional Knowledge and incorporating it into NEPA compliance and fishery management activities; 3) representation of Alaska Native groups on the NPFMC and its Advisory Panel; 4) addressing issues related to Alaska Natives during NEPA compliance (effects on Alaska Natives participating in commercial fisheries, effects on Alaska Native communities, effects on subsistence, and Environmental Justice impacts); and 5) allowing for subsistence harvest of fish and wildlife in accordance with federal law.

Under Alternative 1, current management policies and measures used by NOAA Fisheries and the NPFMC regarding Alaska Native consultation would be continued. Through the resources of NOAA Fisheries staff anthropologists, the collection of existing Traditional Knowledge, expansion of an in-house Traditional Knowledge database, and informal consultation with individuals in Alaska Native communities would continue. Formal consultation with federally recognized tribal governments during NEPA compliance under EO 13175 would also continue at current levels during NEPA scoping activities and public comment periods on draft NEPA documents. Similarly, opportunities for Alaska Native participation in NEPA compliance and NPFMC deliberations would continue to be available during NEPA scoping, comment on draft NEPA documents, review of NPFMC documents, and at NPFMC meetings.

Alaska Native representation on the NPFMC and its Advisory Panel would remain the same. Currently one NPFMC seat and two Advisory Panel seats are held by Alaska Native representatives.

Alaska Native participation in groundfish fisheries through individual catcher vessels and CDQ groups would continue at current levels, resulting in benefits to those participants. Similarly, benefits to affected Alaska Native communities would also continue. Primary benefits include: generation of local employment, generation of secondary economic activities that support of the fishing industry, and of community revenue through fish taxes and service fees. Steller sea lion protection measures would remain in effect and subsistence harvest of sea lions are expected to stay at current levels. Direct and indirect effects of groundfish fishing on subsistence resulting from salmon bycatch would be insignificant, although BSAI salmon stocks in Western Alaska are depressed and remain a concern to Alaska Natives. Alternative 1 would not result in adverse Environmental Justice effects on Alaska Natives (see Alaska Native issues qualitative analysis paper in Appendix F-9).

Under Alternative 1, subsistence uses would continue consistent with federal law. Joint-production of subsistence resources, where Alaska Natives who participate in groundfish fishing take advantage of their commercial fishing efforts to harvest subsistence resources, would continue at current levels.

4.10.2.9 Improve Data Quality, Monitoring, and Enforcement

The Alternative 1 policy sets goals and objectives to address data quality, monitoring and enforcement, as well as specifying management measures that would implement these objectives.

Impacts of Policy

Alternative 1 emphasizes the importance of accurate data to guide management decisions pertaining to the groundfish fisheries. In pursuit of this goal, the alternative identifies a number of objectives: to continue monitoring of catch through industry reporting and the Observer Program; to improve community and regional economic impact assessments; and to utilize advances in technology, such as at-sea scales and VMS, to improve monitoring data. These objectives are discussed in further detail below. A related topic is addressed in Chapter 5, which contains a description of ongoing and proposed North Pacific research efforts and identified data gaps.

The Alternative 1 objectives for catch monitoring and economic impacts assessments are implemented primarily through the FMP 1 requirements for industry participants to submit logbook data at regulated intervals, and through the North Pacific Groundfish Observer Program. These programs are described in detail in Appendix F-10 Observer Program and Appendix F-11 Data and Reporting Requirements.

The Data and Reporting Requirements paper describes the requirements under FMP 1 in detail. Fishing and production logbooks submitted on a daily or weekly basis, and State of Alaska fish tickets, supply data such as the groundfish and prohibited species catch weight (or number of animals), species composition, haul location, discard weight and disposition information, and price paid/received. While the biological information on target species catch composition is thorough under the existing system, the economic data collected is very limited (only revenue and prices are collected systematically under mandatory programs). Other efforts, as described in the Data and Reporting Requirements paper, are underway to improve the ability of fishery managers to assess the economic impacts of management decisions, but have so far had mixed success. The paper also identifies the lack of observer coverage on smaller fishing vessels as a weakness of the current system, as well as the low precision level in estimates of discarded fish. The costs to industry and the federal government of collecting and processing the data are rated as insignificant.

<table>
<tr><th rowspan="2">Goals, Objectives</th><th colspan="2">Corresponding Management Measures</th></tr>
<tr><th>FMP Component</th><th>Management Measure</th></tr>
<tr><td rowspan="5"><u>Goals</u>
• Management decisions will use the best available scientific information
• Management process will be adaptive to new information and reactive to new environmental issues
• Draw upon federal, state and academic capabilities in carrying out research, administration, management and enforcement
• Consider the effects of fishing

<u>Objectives</u>
• Continue the existing reporting requirements and Observer Program to provide catch estimates and biological information
• Continue ongoing effort to improve community and regional economic impact assessments
• Increase the quality of monitoring data through improved technological means</td><td rowspan="2">Observer Program</td><td>Fixed 0/30/100% Observer Program coverage; 100/200% for A.A. and CDQ</td></tr>
<tr><td>Third party, pay-as-you-go service delivery model</td></tr>
<tr><td rowspan="3">Data and Reporting Requirements</td><td>Require economic data from industry participants</td></tr>
<tr><td>Require appropriate scales</td></tr>
<tr><td>Require VMS for Steller sea lion prey species</td></tr>
</table>

The elements of and issues related to the Observer Program are discussed in the Observer Program qualitative analysis paper in Appendix F-10. Developed in 1990, the third party pay-as-you-go system is a service delivery model where industry contracts for observer coverage with a third party provider, whose observers are trained by NOAA Fisheries. The agency is responsible for managing the data, which includes biological data on incidental catch of marine mammals and endangered seabirds, fishing effort information, and species composition data. The level of species identification recorded by observers is minimally to the level of the management categories. At the request of NOAA Fisheries stock assessment scientists or others, the Observer Program continues to break out more species for identification; however, many non-target species and some species that are managed within a stock complex are not individually identified at the current time. This program was meant as an interim program, and has been and continues to be improved and changed. A continuing area of controversy is the appearance of conflict of interest that arises from the direct financial relationship between the observer's employer and industry. Additionally, for the component of the fleet with only 30 percent coverage (vessels between 60 ft and 125 ft LOA), observer deployment is non-random and may not be a representative sample of the catch.

Data collected under FMP 1 through industry reporting, the Observer Program, and NOAA Fisheries independent resource surveys (described in Appendix B), are combined into a system that is widely regarded as one of the most comprehensive fishery data collection systems in the world (Appendix F-11). The existing system provides sufficient information to assess the current stock condition of target species and accurately estimate the biomass levels used to set appropriate catch quotas.

The Alternative 1 objective to improve the quality of monitoring data through improved technological means is implemented under FMP 1 through the requirement of certified scales for observer sampling in certain fisheries, and the use of VMS on vessels targeting Steller sea lion prey species. A description of the requirements for certified scales, including motion-compensated scales, in the rationalized AFA and CDQ fisheries, is included in the Data and Reporting Requirements paper in Appendix F-11. The requirements for certified scales in these fisheries has improved the accuracy of observer data.

The introduction of mandatory VMS as a management measure is an example of fishery management reacting to new environmental issues. The rapid decline in the abundance of the western stock of Steller sea lions caused the NPFMC/NOAA Fisheries to implement a series of circular closure areas around rookeries and haulouts. Concentric circles around a point are more difficult to monitor and enforce than linear closures based on latitude and longitude, particularly when they overlap one another (NMFS 2001– Steller sea lion SEIS, Section 3.11). The use of VMS has allowed effective monitoring and enforcement of the Steller sea lion protection measures. For further description of the management implications of VMS, see Section 5.2. FMP 1 demonstrates that the use of new technology has successfully improved data quality in monitoring and enforcement activities.

The emphasis of Alternative 1 is to continue current efforts to improve the scientific understanding of the North Pacific environment and of the effects of fishing, and to use this understanding to manage the groundfish fisheries in a sustainable and conservative manner. The objectives to implement and improve data quality, monitoring, and enforcement will result in a data collection system that allows accurate assessment of managed species or species complexes so as to result in a low threat of overfishing in target fisheries. As the focus of data collection in these objectives is primarily centered on industry vessels (reporting requirements, observers), however, the policy will be most effective for target species and will return less data on those species or ages that are not targeted. This policy will result in a data collection program that will continue to meet minimum acceptable standards for scientific management of the fisheries. Although aspects of the catch collection program could be improved, current practices do provide useful data for fishery management while remaining mindful of the cost burden on industry of the monitoring program.

4.10.3 Analysis of Alternative 2

Alternative 2 consists of a management approach statement and a set of policy objectives. The management approach statement provides the key to the underlying rationale and assumptions for the policy, along with goals and additional guidelines.

The management approach statement for Alternative 2 identifies the goal of maximizing biological and economic yield from the resource by establishing a more aggressive harvest strategy. The management approach statement is summarized in Table 4.10-3. This policy is based on the assumption that fishing does not have an adverse impact on the environment except in specific cases as noted.

A summary of the impacts of Alternative 2 follows below in Section 4.10.3.1. In the remainder of Section 4.10.3, the impacts of the alternative are analyzed in detail, in relation to eight policy subheadings: prevent overfishing; preserve food web; reduce and avoid bycatch; avoid impacts to seabirds and marine mammals; reduce and avoid impacts to habitat; allocation issues; increase Alaska Native consultation; and data quality, monitoring and enforcement. For each subheading, the impacts of the relevant goals and objectives from the management approach are analyzed, using as a guideline the range of implementing management measures for Alternative 2, identified in Section 4.2, and analyzed in Section 4.6.

4.10.3.1 Summary of Alternative 2

The key policy elements that predominantly influence the impacts under Alternative 2 are: resetting of the OY cap to the sum of OFL or the sum of ABCs (resulting in increased yield); absence of an objective to eliminate the race-for-fish (resulting in increased effort); absence of objectives to maintain existing closure areas (resulting in potentially adverse impacts to areas that have been closed to fishing); and the consideration to repeal the Observer Program (resulting in less monitoring and research data.)

The impacts analysis of Alternative 2 is hampered to a certain extent by the fact that controls and restrictions on the fishery are removed under this alternative. It is more difficult to predict the impact of removing rather than imposing restrictions; consequently, the uncertainty about predicted reactions of the fishery and the environment could result in an increased risk to the human environment under this alternative.

Alternative 2 would maximize economic yield while preventing overfishing of target stocks, but it is not effective at preventing stocks from becoming overfished. The weaknesses of this alternative are that it increases the chance of unintentionally overfishing a stock, and catch estimates may be uncertain under this alternative if the Observer Program is repealed. Also, as in Alternative 1, there is no incentive to change the management status of stocks where the impact of fishing is unknown, and it is still possible to overharvest vulnerable members of a managed stock complex.

There is a high potential to create adverse food web impacts under Alternative 2 through its lack of precaution, which leaves no room for uncertainty. The possible lack of catch monitoring results in the potential for adverse food web impacts to go undetected until dramatic food web changes are seen. This alternative provides less precautionary management to many components of the food web.

Alternative 2, as illustrated in FMP 2.1, would not be consistent with the objective of monitoring prohibited species catch, as repeal of the Observer Program would negatively impact catch monitoring. Alternative 2 policies, as illustrated by FMP 2.2, would be less severe. As in Alternative 1, additional weaknesses of the alternative are that bycatch is often reported as a complex rather than as individual species, and the absence of observer monitoring of catch on vessels less than 60 ft LOA may result in inaccurate estimates of bycatch. Therefore Alternative 2 may not provide adequate protection for non-target species.

Alternative 2 retains seabird and marine mammal protection measures for ESA-listed species, but does not go beyond ESA-required protection measures. Additionally, other goals and objectives under this alternative remove management measures currently in place in the comparative baseline. The more aggressive harvesting policy, the relaxation of area closures, and the possible repeal of the Observer Program create a high potential to increase fishery interactions with seabirds and marine mammals that may result in adverse impacts to those species.

The alternative could result in increased impacts to habitat because of less precautionary management measures. Possible elimination of current closed areas and increases in TAC have the potential to result in adverse impacts to habitat that could be hard to reverse, especially for long-lived, slow-recovering living habitats. The policy goal of developing practical measures to minimize adverse effects to EFH could be difficult to achieve if such irreversible impacts occur.

Alternative 2 has the potential to increase allowable catches to maximum biological levels and could eliminate the cushion between ABC levels and levels that result in OFLs. This alternative is expected to significantly increase revenues but would also increase operating costs with the elimination of the LLP and IFQ programs. While fishery production is maximized, product quality and the health and safety of participants suffer. Of particular importance may be the amount of variability in harvests, which could increase significantly and therefore make it much more difficult to make long-term business and infrastructure decisions. Finally, non-market, recreation, and tourism values that accrue to the ecosystem could be reduced substantially.

As in Alternative 1, the goals and policies for Alaska Native consultation and participation in fishery management under Alternative 2 would continue at the current levels and comply with relevant EOs and other federal law. Traditional Knowledge in fishery management would continue to be incorporated in environmental documents as available and appropriate. Subsistence uses would continue consistent with federal law. Other goals and objectives in Alternative 2 would affect Alaska Natives by the increase in economic benefits accruing to participants in the fishery, particularly the CDQ pollock fishery. The increased fishing effort under this alternative may however result in increased salmon bycatch, which could have adverse effects on salmon fisheries particularly in the western Alaska Yukon-Kuskokwim river system.

Alternative 2 objectives maintain a minimum level of data collection to meet conservation requirements. The consideration to repeal the Observer Program may compromise management on the best science available as a result of reduced accuracy and breadth of fishery data. The presumed risk of adversely impacting the environment is assumed in this alternative to be low, however, the costs to industry of funding the Observer Program to gather fishery data may not be considered necessary.

4.10.3.2 Prevent Overfishing

The goals of Alternative 2 are to maximize biological and economic yield from the resource by establishing a more aggressive harvest strategy, while still preventing overfishing of the groundfish stocks. This management approach uses the best scientific information available while taking into account individual stock and ecosystem variability. Alternative 2 would encourage the NPFMC to continue to work with other agencies in protecting threatened and endangered species. A more aggressive harvest strategy would be implemented under Alternative 2. The alternative is based upon the concept that the present FMP is overly conservative and that higher harvests could be taken without threat of overfishing of the target groundfish stocks. This policy assumes that fishing at the recommended maximum harvest level would have no adverse impact on the environment, except in specific cases that are known and mitigated.

The Alternative 2 policy is illustrated through FMP 2.1 and FMP 2.2. Each FMP contains a number of management measures that pertain to the sustainability of fisheries and fishery resources. A full description of the actions imposed under FMP 2.1 and FMP 2.2 can be found in Section 4.2. The bookends represent a range of actions that relax constraints to fishery removals.

Goals, Objectives	Corresponding Management Measures	
Goals • Maximize biological and economic yield from the resource while still preventing overfishing of the groundfish stocks. • Prevent overfishing of target groundfish stocks. • Take into account individual stock and ecosystem variability Objectives • Set OY cap at sum of OFL (FMP 2.1) or the sum of ABCs (FMP 2.2) for each species. • Provide for adaptive management by continuing to specify OY range.	Example Range: F_{OFL}= F_{ABC} to no change from FMP 1	Quota management based on a tier system. Buffers between the target (F_{ABC}) and limit (F_{OFL}) fishing mortality levels may (FMP 2.1) or may not (FMP 2.2) be eliminated. The uncertainty corrections for GOA pollock, BSAI and GOA cod implemented under FMP 1 would be eliminated. For stocks managed in Tier 3, F_{ABC} may (FMP 2.2) or may not (FMP 2.1) be decreased linearly with biomass whenever biomass falls below a tier-specific reference level.
	Time/Area	With the exception of sea lion protection measures, time and area closures would be rescinded allowing open access to fishing grounds within the EEZ. These policies would increase the possibility of spatial temporal concentration of the catch and a race-for-fish. In the case of pollock fisheries the race-for-fish may be mitigated by the development of cooperatives and rationalized fisheries under AFA.
	Gear restrictions	Gear restrictions for walleye pollock, Pacific cod, and sablefish, gear allocations would be rescinded. However, the impact of these changes on the sustainability of the stock may be minor for stocks managed in Tiers 1-3 because stock assessment models account for gear selectivity.
	OY caps	Optimum Yield restrictions would be capped at the sum, by region, of the groundfish ABCs for the BSAI and GOA. In the BSAI this would allow an expansion of some fisheries.
	Inseason Multi-species TAC and ABC monitoring	Under FMP 2.1, the catch of target species would no longer be limited by prohibited species bycatch caps. This would allow the expansion of some groundfish fisheries. Monitoring bycatch would be difficult as a result of an 80% reduction in the number of observer days.

FMP 2.1 adopts a more aggressive harvest strategy by removing the buffer between ABC and the OFL, allowing the maximum OY to float as the sum of the OFLs of the BSAI or GOA groundfish stocks respectively. Prohibited species bycatch limits and bycatch reduction incentive provisions currently imposed by IR/IU would be eliminated. Additionally, the precautionary decrease of F_{ABC} linearly with biomass when the biomass falls below a specific reference level is removed. FMP 2.1 also removes physical constraints from the fisheries by repealing several time/area closures currently in place. The fishery will be returned to an open access scenario, where time/area closures, gear restrictions, and prohibited species catch restrictions are repealed. The potential impact of the groundfish fisheries on Steller sea lions, however, means that the current suite of mitigating protection measures that constrain fishing around rookeries and haulouts and protect Steller sea lion prey species (pollock, Pacific cod and Atka mackerel) when at a low biomass, will remain in place (see Figure 4.2-2). This is necessary to avoid jeopardy and adverse modification, as required by the ESA. The same applies to the impact of groundfish fishing on short-tailed albatross, with the

consequent take limits remaining in effect. Additionally, the federally-mandated effort limitation program enacted under the AFA would remain in place, with its adjunct CDQ allocation, but all other effort limitation programs (such as the sablefish IFQ program and the multi-species CDQ program) would be repealed. Reporting requirements would remain in place, in order to keep track of the impact of the fisheries, but the Observer Program, except as federally mandated by the AFA, would be repealed, and VMS would not be required in the fisheries. This action would reduce the number of observer days by an estimated 80 percent (Observer qualitative analysis paper Appendix F-10).

A more moderate illustration of the Alternative 2 aggressive harvest strategy is provided by FMP 2.2. In this case, the mechanisms for setting ABC and TAC remain the same as Alternative 1 with the following notable exceptions. The uncertainty corrections imposed on BSAI and GOA Pacific cod and GOA walleye pollock would not apply under FMP 2.2. The current OY range that caps yield at 2 million mt in the BSAI and 800,000 mt in the GOA would be removed in favor of an annually varying maximum OY equaling the sum of the ABCs for groundfish stocks in the BSAI and GOA. Additionally, bycatch reduction incentives and bycatch restrictions would be repealed, other than those related to PSC limits or IR/IU. Under the assumption that fishing does not have an impact on the environment other than what is generally known and mitigated, the NPFMC's more stringent seabird avoidance measures enacted in 2001 would be repealed, leaving only the mitigation measures recommended by USFWS to avoid jeopardy for short-tailed albatross. Closure areas in FMP 2.2 mirror those in FMP 1 (see Figure 4.2-3).

Impacts of Policy

Alternative 2 for the BSAI and GOA limits the impact of fishing mortality by constraining catch to the OFL (FMP 2.1) or maximum permissible ABC (FMP 2.2). This alternative defines four management categories for which catch is constrained by various regulatory mechanisms: target species, other species, prohibited species, and forage fish species. Alternative 2 harvest policies are consistent with ecosystem principles that call for in-season multi-species catch monitoring to ensure that catch does not exceed the OFL of groundfish. Stocks can be moved from one management category into another only by FMP amendment. Within the target species category, stocks are managed either individually or as part of a stock complex. Stocks within the target species category can be added to or removed from a stock complex within the same category as part of the TAC-setting process (i.e., without an FMP amendment).

The bookends provide a range of potential impacts associated with this alternative. FMP 2.1 is more aggressive than FMP 2.2; thus, the potential impacts of this alternative represent the upper bound of potential impacts imposed by Alternative 2. This upper bound will serve as the reference for discussion of potential impacts of adoption of Alternative 2. Consideration of cumulative impacts did not change the significance ranking for the impacts of this alternative.

Alternative 2 adopts more aggressive harvest measures that continue to prevent overfishing. Several harvest polices allow for an increase in commercial catch. First, the ABC could be set equal to OFL under this alternative. This does not allow a margin of safety to address uncertainty in the recommended harvest level. Elimination of the buffer between F_{ABC} and F_{OFL}, would increase the chance of unintentionally overfishing a stock. Unintentional overfishing occurs when the harvest recommendation is based on a point estimate from the stock assessment that in retrospect proves to be in error. Second, in-season monitoring of catch and enforcement of quotas would be impeded by the repeal of the Observer Program and reductions in the number of observer sea days. Third, the quality of input data for stock assessments would be reduced due to a reduction in the availability of demographic data typically collected by observers. Fourth, FMPs allows expansion of commercial fisheries. Fifth, in the BSAI, FMP 2.1 removes the prohibited species bycatch cap allowing some fisheries to expand. Overfishing did not occur in the stocks or stock complexes modeled under FMPs 2.1 or 2.2. With the exception of GOA DSR, the expected fishing mortality under Alternative 2 would have no significant impact on any of the target groundfish stocks (Table 4.10-2a). Significantly adverse impacts of fishing mortality are expected for GOA DSR (Table 4.10-2a).

Irreversible or long-term adverse effects on fishery resources are avoided by imposing rebuilding regulations when stocks fall below the level capable of producing MSY. However, the likelihood of a stock falling below the level where the stock is capable of producing MSY is higher under Alternative 2 because the linear reduction in fishing mortality when spawning stock falls below $B_{40\%}$ may (FMP 2.2) or may not (FMP 2.1) be imposed. Under FMP 2.1, seven stocks (BSAI and GOA Pacific cod, EBS pollock, BSAI Greenland turbot, AI Atka mackerel, sablefish, and GOA demersal shelf rockfish) would be expected to become overfished. This finding suggests that the impact of Alternative 2 on changes in biomass of target groundfish stocks would be significantly adverse for these stocks when compared to the baseline (Table 4.10-2a). With the exception of GOA Demersal shelf rockfish, the impacts of Alternative 2 on the change in biomass of stocks or stock complexes managed in Tiers 4-6 would be unknown (Table 4.10-2a). Significantly adverse (FMP 2.1) or conditionally significant adverse (FMP 2.2) impacts on the change in biomass of GOA Demersal shelf rockfish are expected under Alternative 2 (Table 4.10-2a).

Relative to the baseline, Alternative 2 relaxes several spatial/temporal restrictions on catch. With the exception of Steller sea lion protection measures, time and area closures would be removed, allowing open access to fishing grounds within the EEZ. These policies would increase the possibility of spatial temporal concentration of the catch and a race-for-fish. In the case of pollock fisheries the race-for-fish may be mitigated by the development of cooperatives and rationalized fisheries under AFA and CDQ. Under this policy, commercial fishing is expected to have unknown impacts on the genetic structure or the reproductive success of the four of 19 stocks managed in Tiers 1-3 (BSAI and GOA Pacific cod, AI Atka mackerel, and BSAI northern rockfish). With the exception of GOA Demersal shelf rockfish, the impact of commercial fishing on the genetic structure or reproductive success of stocks or stock complexes managed in Tiers 4-6 is unknown because the status of such stock relative to their respective MSST, is unknown. Conditionally significant adverse impacts on the genetic structure and reproductive success of GOA Demersal shelf rockfish are anticipated under Alternative 2 (Table 4.10-2a). Additionally, significantly adverse or insignificant impacts on the genetic structure and reproductive success of BSAI Greenland turbot are anticipated.

Relative to the baseline, Alternative 2 would relax restrictions on the spatial temporal partitioning of catch and could increase overall harvest. The impact of these changes on prey availability is expected to be insignificant for all stocks managed in Tiers 1-3. Impacts of commercial fishing on prey availability for all stocks or stock complexes managed in Tiers 4-6 are unknown.

Harvest restrictions, spatial temporal constraints, and gear allocations all serve to mitigate the impact of commercial fishing on fish habitat. With the exception of four stocks (BSAI and GOA Pacific cod, BSAI Atka mackerel, and sablefish), the impacts on target species resulting from habitat disturbance are considered insignificant for all stocks managed in Tier 1-3 (Table 4.10-2a). With the exception of GOA Demersal shelf rockfish, the impacts of Alternative 2 on habitat for stocks or stock complexes managed in Tiers 4-6 are unknown (Table 4.10-2). Conditionally significant adverse impacts on habitat of GOA Demersal shelf rockfish are expected under Alternative 2 (Table 4.10-2a).

When taken in aggregate, Alternative 2 appears to achieve the goal of maximizing economic yield from the resource while still preventing overfishing of the groundfish stocks. Alternative 2 is not effective at preventing the stocks from falling into an overfished condition. Alternative 2 has several weaknesses. First, the buffer between ABC and OFL could be eliminated which would increase the chance of unintentionally overfishing a stock. Second, in-season catch estimates would be more uncertain due to the repeal of the Observer Program. Third, there is no incentive to reduce the number of stocks where stock status is unknown. While harvest policies may build and maintain the species complex, it is still possible to over-harvest a vulnerable member of the complex. Finally, Alternative 2 under FMP 2.1 could eliminate the linear reduction in fishing mortality when spawning biomass falls below $B_{40\%}$. This would allow fishing at the OFL to continue until the stock biomass fell into an overfished condition. As in Alternative 1, Alternative 2 does not require formal definition of MSST for stocks in Tiers 1-3. In practice, this is a technical omission because NOAA Fisheries conducts annual status reviews for the stocks managed in Tiers 1-3. These reviews are included in the SAFE chapters and provided to the NPFMC for use in annual TAC-setting.

The management actions adopted under Alternative 2 would not be consistent with the goal of taking into account individual stock and ecosystem variability. The ability to enforce quotas during the fishing season would be impeded by the repeal of the Observer Program. The repeal of the Observer Program would also lead to increased uncertainty in the stock assessment because of reductions in demographic information typically collected by observers.

4.10.3.3 Preserve Food Web

Impacts to food webs of the BSAI and GOA are not explicitly considered in the goals and objectives and the related management measures of this FMP. Alternative 2 has policies and goals to prevent overfishing, reduce and avoid bycatch, avoid impacts to marine mammals and birds, reduce and avoid impacts to habitat, and address data quality, monitoring and enforcement issues, all of which are important to protection of food web components that include target and non-specified species, PSC species, HAPC biota, and marine mammals and seabirds. However, the management measures proposed to implement these policies, particularly in the FMP 2.1, do not provide as much protection as in the baseline. Specifically, the less stringent OY formula and lack of precautionary adjustments in ABCs (Section 4.10.3.2), elimination of seasonal catch and PSC limits, repeal of IR/IU (Section 4.10.3.4), allowing a directed fishery for forage species (Section 4.10.3.5), repeal of closed areas (Section 4.10.3.6), repeal Observer Program coverage, and repeal of scales and VMS for Steller sea lion prey species (Section 4.10.3.9) provide less protection to a variety of important food web components. The policy analysis in those sections contain details on the level of protection provided by Alternative 2 to these individual components.

One bookend of this alternative (FMP 2.1) does not specifically attempt to incorporate ecosystem considerations into fishery management decisions and could potentially remove some of those that exist in the baseline such as development of ecosystem indicators, building of conceptual models of the food webs and prohibition of directed fisheries for forage fish (which often form a central position in channeling energy through the food web). Analysis of the ecosystem effects of the alternatives involved selection of indicators that would show changes in key members or ecosystem characteristics that are important to the structure and function of marine food webs. Changes in pelagic forage, top predators, spatial/temporal availability of prey, exotic species introductions, energy removal and redirection through fishery catch removals, discarding and offal production, and various measures of diversity were evaluated with respect to the potential of fishing to cause changes sufficient to bring these attributes below population, community, or ecosystem thresholds when such thresholds could be defined.

This alternative showed large negative changes relative to the baseline in some ecosystem indicators such as energy removal and redirection. There were potential impacts to the pelagic forage of northern fur seals and seabirds and significantly adverse impacts to the pelagic forage availability for Steller sea lions and harbor seals, primarily due to the policy of fishing target species up to OFL and opening up the possibility of harvesting forage species. There were conditionally significant adverse impacts to spatial/temporal concentration of prey because this alternative proposes to open up many previously closed areas and may remove seasonal allocations of TAC. Top predators such as seabirds could experience conditionally significant adverse effects because the areas around the Pribilof Islands are opened to fishing. The possibility of introduction of exotic species via fishing vessel ballast water is largely increased relative to the baseline due to the increased levels of fishing vessel effort that might occur in this alternative. Species diversity would be significantly impacted because fishing levels bring some target species such as walleye pollock and Atka mackerel below minimum stock size thresholds. Other species are potentially adversely affected, such as corals and seabirds, while the effects on others, such as sharks, are unknown.

This alternative also has the potential to adversely affect trophic guild diversity by fishing more heavily on target species, such as walleye pollock and Atka mackerel, that tend to be dominant members of their trophic guilds. Structural habitat diversity is adversely affected because of the lack of closed areas to protect sensitive, slow-growing structural habitat members such as corals. Removing the sablefish IFQ program could increase the number of boats and fishing impacts in coral habitats. Qualitative analysis of Alternative 2 with respect to ecosystem effects of the TAC-setting process (Appendix F-1) showed that this alternative has a greater potential to alter community structure through higher harvest levels that would impact predators dependent on those species and through greater gear-related habitat impacts.

Through its assumption that there is no need to provide explicit protection to the food web, this alternative performs poorly at protecting most food web components, even those that are of the most importance economically. This alternative could provide less precautionary management to a whole spectrum of food web components including top predators, pelagic forage, and structural habitat species through its FMP 2.1 management measures. This more aggressive harvesting policy assumes that fishing does not affect the food web and assumes that fishery data collection efforts necessary to monitor fishery effects are mostly unnecessary. This policy has a high potential to create adverse food web impacts through its lack of precaution, which leaves no room for uncertainty, and its possible lack of fishery catch monitoring, which has the potential for adverse impacts to go undetected until dramatic food web changes are seen.

4.10.3.4 Reduce and Avoid Bycatch

Several policy changes adopted in Alternative 2 would impact the incidental catch of target and non-target species and bycatch. A more aggressive harvest strategy would be implemented as illustrated by an open access fishery with very few constraints under FMP 2.1 to a moderately constrained fishery as illustrated by FMP 2.2. Several time, area, or gear constraints to fishing are repealed under Alternative 2 (see Figures 4.2-2 and 4.2-3). With the exception of the AFA and CDQ fisheries, the Observer Program requirements would be repealed in FMP 2.1. Bycatch reduction incentives and bycatch restrictions would be repealed under FMP 2.1, as would PSC limits and IR/IU.

<table>
<tr><th rowspan="2">Goals, Objectives</th><th colspan="2">Corresponding Management Measures</th></tr>
<tr><th>FMP Component</th><th>Management Measure</th></tr>
<tr><td rowspan="7">Goals
• Encourage development of practical measures that minimize bycatch
• Work with state and federal agencies to protect threatened and endangered species

Objectives
• Monitor prohibited species bycatch and adjust or eliminate PSC limits
• Manage incidental catch and bycatch through closure areas for selected gear types</td><td>Spatial/ Temporal Management of TAC</td><td>Spatial/temporal distribution of TAC</td></tr>
<tr><td>MPAs and EFH, Bycatch and Incidental Catch Restrictions, Gear Restrictions and Allocations</td><td>Eliminate/maintain seasonal, gear/fishery specific, and total closure areas identified to reduce bycatch</td></tr>
<tr><td rowspan="4">Bycatch and Incidental Catch Restrictions</td><td>Eliminate/maintain bycatch limits for prohibited species</td></tr>
<tr><td>Procedure to develop adjustable PSC limits based on a percentage of the annual stock status</td></tr>
<tr><td>Repeal/maintain retention standards for pollock and Pacific cod (IR/IU) and DSR</td></tr>
<tr><td>Repeal/maintain incentive programs (VIP) and bycatch restrictions (including in-season)</td></tr>
</table>

Impacts of Policy

Alternative 2 as illustrated by FMP 2.1 and FMP 2.2 is expected to discourage the development of practical measures that reduce bycatch and incidental catch of prohibited species, target species, other species, forage fish and non-specified species. Relative to the comparative baseline, the direct, indirect, and cumulative impacts of mortality and change in biomass of crab stocks would be significantly adverse (FMP 2.1) or conditionally significant adverse (FMP 2.2) for prohibited species that are currently in a depressed or overfished condition (BSAI *C. bairdi* crab, *C. opilio* crab, BSAI and GOA red king crab, and BSAI blue king crab) (Table 4.10-2a). Impacts on GOA *C. bairdi* crab would be conditionally significant adverse (FMP 2.1) or unknown (FMP 2.2). For BSAI chinook and other salmon and GOA chinook salmon, conditionally significant adverse impacts of fishing mortality would be expected under this alternative, and impacts on GOA other salmon would be conditionally significant adverse under FMP 2.1. The expansion of groundfish fisheries, the repeal of the Observer Program, the elimination of prohibited species bycatch limits, and the removal of bycatch reduction incentives would all lead to increased bycatch and incidental catch of non-target species and target species. The development of target fisheries on forage species would be possible under Alternative 2. However, the impacts of new fisheries on forage species are considered insignificant as these fisheries would be restricted by harvest policies as mandated under Alternative 2.

Alternative 2 policies as illustrated by FMP 2.1 are also inconsistent with the objectives of monitoring prohibited species bycatch. Alternative 2 policies as illustrated by FMP 2.2 would be less severe. Repeal of the Observer Program would negatively impact the quality of catch monitoring. Bycatch is often reported as a complex rather than as a species in Alternative 2. The absence of at-sea catch monitoring for vessels less than 60 ft LOA and reduced at-sea catch monitoring due to the repeal of the Observer Program may result in less than adequate protection of non-target species.

4.10.3.5 Avoid Impacts to Seabirds and Marine Mammals

The Alternative 2 policy sets goals and objectives to avoid impacts to seabirds and marine mammals, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	**Management Measure**
Goals • Work with state and federal agencies to protect threatened and endangered species Objectives • Maintain current protection measures to protect ESA-listed seabird species • Maintain current protection measures to avoid jeopardy to ESA-listed Steller sea lions	TAC-setting Process, Steller sea lion Measures	Steller sea lion prey species low biomass rules
	TAC-setting Process	Allow/prohibit directed fishery for forage fish
	Spatial/ Temporal Management of TAC	Spatial/temporal distribution of TAC
	MPAs and EFH, Steller sea lion Measures, Gear Restrictions and Allocations	Seasonal, gear/fishery specific, and total closure areas identified to protect Steller sea lions; repeal/maintain walrus closures
	Seabird Measures	Short-tailed albatross take restrictions
		RPA-recommended gear modifications to protect seabirds

Impacts of Policy

Alternative 2 has a goal of working with state and federal agencies to protect threatened and endangered species by maintaining current protection measures for ESA-listed seabirds and those designed to avoid jeopardy to ESA-listed Steller sea lions. The management measures employed in this alternative include: Steller sea lion prey species low biomass rules, spatial/temporal distribution of TAC, a variety of time/area/gear/fishery closures, total closure areas for Steller sea lion protections, short-tailed albatross take restrictions, and RPA-recommended gear modifications to protect seabirds. This alternative has the potential to allow directed fisheries on forage species and repeal walrus closure areas. Impacts of the alternative with respect to seabirds were evaluated with respect to the potential for fisheries to cause direct mortality through fishing gear and vessel strikes, changes in prey availability (including offal), and changes in benthic habitat that might affect certain prey species of seabirds. Impacts for marine mammals were evaluated with respect to the potential for fishery incidental take or entanglement in marine debris, harvest of prey species, spatial/temporal concentration of fishing on prey, and fishing vessel disturbance.

These indicators showed that impacts of Alternative 2 on seabirds and marine mammals were increased relative to the baseline condition. The incidental take of short-tailed albatross on longline and trawl third-wire collisions may increase above baseline levels because of increased fishing effort. Removal of area closures around the Pribilof Islands may lead to disproportionate take of fulmars from that colony. Elimination of the sablefish IFQ program could also increase seabird incidental take by the increasing longline effort that would occur in that fishery. Potential development of directed forage fish fisheries could substantially alter prey availability and have population level effects on piscivorous seabirds. Although some piscivorous bird species such as glaucous-winged gulls might be gaining food subsidies from discards and offal in the baseline, other piscivorous birds would be negatively impacted by competitive interactions with gulls, thus offsetting any changes for the piscivorous bird group as a whole that might occur in this alternative. Qualitative analysis of the seabird protection measures (Appendix F-6) noted that the reduced emphasis or elimination of the Observer Program under this alternative would compromise the collection of data on seabird/fishery interactions.

Qualitative analysis of the impacts of this alternative with respect to Steller seal lions (Appendix F-4) showed that management measures repealed under this alternative result in large increases in impacts to some marine mammals even though the Steller sea lion-specific measures are retained. The increased catch of key groundfish prey species that would occur in this alternative results in a significantly adverse impact on Steller sea lions. Although the policy objective is to maintain minimum ESA-required protection measures for ESA-listed species, the analysis of FMP 2.1 indicated that the combination of management measures under this FMP may negate the 'no jeopardy' finding in the 2001 Biological Opinion. As a result, FMP 2.1 in its current form may not meet this objective or comply with Federal law. Also, increased catch of prey species may result in potentially adverse effects on other pinnipeds such as northern fur seal and harbor seals that use these prey. The potential repeal of some area closures may result in adverse impacts to groundfish consuming marine mammals through spatial/temporal prey availability and through increased disturbance.

This alternative does poorly at its goal of avoiding impacts to seabirds and marine mammals. It assumes that measures found in the baseline that are not explicitly for protecting marine mammals and seabirds are unnecessary. The potentially more aggressive harvesting policy, relaxation of area closures, possible repeal of the Observer Program and less stringent seabird protection measures do not provide as much certainty about protection to seabirds and marine mammals as in the baseline.

4.10.3.6 Reduce and Avoid Impacts to Habitat

The Alternative 2 policy sets a goal and objectives to reduce and avoid impacts to habitat, as well as recommending a range of management measures that would implement these objectives.

<table>
<tr><th rowspan="2">Goals, Objectives</th><th colspan="2">Corresponding Management Measures</th></tr>
<tr><th>FMP Component</th><th>Management Measure</th></tr>
<tr><td rowspan="3"><u>Goals</u>
• Encourage development of practical measures that minimize the adverse effects of EFH

<u>Objectives</u>
• Evaluate impacts of trawl gear on habitat through implementation of the existing research plan, identify EFH, and determine appropriate habitat protection measures
• Evaluate candidate areas for MPAs</td><td>MPAs and EFH, Bycatch and Incidental Catch Restrictions, Gear Restrictions and Allocations</td><td>Repeal/maintain existing system of closed areas including Sitka Pinnacles</td></tr>
<tr><td rowspan="2">MPAs and EFH</td><td>EO 13158 description and evaluation of potential MPA areas</td></tr>
<tr><td>Identify and designate EFH and HAPC</td></tr>
</table>

Impacts of Policy

Alternative 2 addresses impacts to habitat by specifying goals and objectives that focus on practical measures that minimize adverse effects to EFH. Evaluation of areas as potential MPAs and implementation of the existing research plan to evaluate trawl gear impacts and determine appropriate protection measures are objectives specifically designed for habitat. These goals and objectives could potentially reduce and avoid impacts to habitat in the long-term; however, the overriding objective of Alternative 2 is the maximization of biological and economic yield from the resource by adopting a more aggressive harvest policy for groundfish stocks. This policy is less precautionary than Alternative 1, and the maximization of fishery yield can potentially come at the expense of increased habitat impacts. In addition, the fishery could be returned to an open access regime, where closures, gear restrictions, and prohibited species catch limits are repealed.

Analysis of Alternative 2 involved assessing effects to mortality, damage and diversity of living marine habitat. An assessment of effects on diversity of impacts was performed with the assertion that within fished areas spatially diverse or patchy fishing impacts are preferable to uniformly distributed impacts. Increased TAC levels and repeal of existing closures are expected to cause increased mortality and damage to living habitat, decreased levels of diversity of living marine habitat, and decreased diversity of fishing impacts. Hence, for almost all effects these impacts are rated as significantly adverse or conditionally significant adverse relative to the comparative baseline. The only insignificant effect is diversity of impacts in the Aleutian Islands because under the baseline there are no notable reserves except for shallow areas near Steller sea lion rookeries which will remain closed in this alternative. Though not specifically analyzed, the relaxing of gear restrictions and returning to open access fishing will also increase impacts. For example, bottom trawl gear may replace pelagic trawl gear in some fisheries which will result in more impacts to benthic habitat.

Overall this policy could result in increased impacts to habitat because of less precautionary management measures. Potential elimination of current closed areas and increases in TAC have the potential to result in adverse impacts to habitat that could be hard to reverse, especially for long-lived, slow-recovering living habitats. The policy goal of developing practical measures to minimize adverse effects to EFH could be difficult to achieve if such irreversible impacts occur.

4.10.3.7 Address Allocation Issues

The Alternative 2 policy maximizes biological and economic yield from the resource while still preventing overfishing of the groundfish stocks. A more aggressive harvest strategy would be implemented based upon the concept that the present policy is overly conservative and that higher harvests could be taken without threat of overfishing. In general, Alternative 2 is based on the premise that fishing has minimal negative impacts on marine resources or the ecosystem and therefore places an increased emphasis on the extraction of commercial benefits. The alternative could remove many of the controls on the industry and considers reducing the burden placed on the industry to report its activities.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	**Management Measure**
Goals • Maintain statutorily-mandated programs to reduce excess capacity and the race-for-fish • Involve and be responsive to the needs and interests of affected states and citizens Objectives • Maintain AFA. and CDQ program as authorized by MSA	Gear Restrictions and Allocations	Allocate by gear for certain directed fisheries
	Overcapacity	Statutorily-mandated rights-based management programs (AFA.)
		Could eliminate or maintain LLP, IFQ sablefish, multi-species CDQ, and community quota share

Impacts of Policy

Alternative 2 has the potential to increase catches to the maximum levels allowable while remaining within OFLs. The alternative could eliminate the cushion between ABC levels and levels that result in OFLs. Because of the emphasis on higher harvests, the alternative is expected to significantly increase revenues that can be extracted from the marine resources. However, because harvests are expected to increase with no real change in biomass levels, it is likely that costs to harvest the additional fish will be higher.

The alternative implicitly presumes that additional restrictions on access to the groundfish fisheries are unnecessary, and in the extreme could result in the elimination of programs that are not mandated by Federal statute. Currently, the groundfish LLP, the sablefish IFQ program, AFA, and CDQ programs restrict access to the marine resources to a limited number of persons. If the alternative removes the LLP and IFQ programs (AFA and pollock CDQs are mandated by Federal statute), it is likely that a significant increase in the number of participants in the fisheries will occur (see Appendix F-8). If restricted access programs are eliminated the commercial benefits of the marine resource could be distributed to a broader base. However, even if access programs are not eliminated, the continuation of the race-for-fish will tend to increase overall costs to capture commercial benefits of the resource. Higher costs could be offset to some extent if the requirements of the Observer Program are relaxed. Currently the Observer Program is estimated to cost the industry approximately $12 million per year (see Appendix F-10).

If access restrictions are relaxed, the greater number of participants and vessels in the fishery would also create additional demands for support industries, particularly in communities adjacent to fishing grounds (Hiatt et al. 2001). The emphasis on maximum production and the potential to revert to the race-for-fish is likely, however, to reduce product quality and the health and safety of participants. The alternative could also lead to increased bycatch and shorter seasons if the race-for-fish significantly increases. In addition, because the BSAI pollock fishery remains rationalized with AFA and CDQs, those participants may be able to increase their industry dominance in the long-run.

Because of the more aggressive harvest strategy, the removal of many of the controls on the industry, and the potential reduction in fishery data from the Observer Program, there could be much more uncertainty in the industry (Appendix F). The lack of certainty reduces the ability of commercial interests to plan their business activities, and therefore is likely to reduce profit potential. Furthermore, the emphasis on commercial activity and the lack of controls is likely to result in significantly lower non-market, recreational and tourism values attributed to the ecosystem by the American public. For further information, see the non-market discussion in Section 3.9.8 and discussion on ecosystem values in Section 4.10.3.3.

4.10.3.8 Increase Alaska Native Consultation

The Alternative 2 policy sets objectives to increase Alaska Native consultation, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Objectives • Continue to incorporate Traditional Knowledge in fisheries management • Continue current levels of Alaska Native participation and consultation in fishery management	Alaska Native Issues	Incorporate Traditional Knowledge in fisheries management through existing literature, on-staff anthropologist
		Advisory Panel and NPFMC representation
		Allow for subsistence uses consistent with Federal law

Impacts of Policy

Under Alternative 2, current management policies and measures used by NOAA Fisheries and the NPFMC regarding Alaska Native consultation would be continued. Through the resources of NOAA Fisheries staff anthropologists, the collection of existing Traditional Knowledge, expansion of an in-house Traditional Knowledge database, and informal consultation with individuals in Alaska Native communities would continue. Formal consultation with federally recognized tribal governments during NEPA compliance under EO 13175 would also continue at current levels during NEPA scoping activities and public comment periods on draft NEPA documents. Similarly, opportunities for Alaska Native participation in NEPA compliance and NPFMC deliberations would continue to be available during NEPA scoping, comment on draft NEPA documents, review of NPFMC documents, and at NPFMC meetings.

Alaska Native representation on the NPFMC and its Advisory Panel would remain the same. Currently one NPFMC seat and two Advisory Panel seats are held by Alaska Native representatives. Under Alternative 2, the increased emphasis on harvest levels and removal of some existing controls on the fishery could overshadow consideration of Alaska Native issues related to subsistence.

Alaska Native participation in groundfish fisheries through individual catcher vessels and CDQ groups would generally increase, resulting in benefits to those participants. While the allocation of multi-species harvest to CDQ groups would be eliminated, an increase in the CDQ pollock allocation would increase benefits overall. Similarly, benefits to affected Alaska Native communities would also continue and likely increase, particularly to CDQ communities, generating local employment, secondary economic activities that support of the fishing industry, and community revenue through fish taxes and service fees. Steller sea lion protection measures would remain in effect and subsistence harvest of sea lions is expected to stay at current levels. However, the increase in harvest would result in some adverse effects on Steller sea lion, and cumulative effects on sea lions would remain adverse. Therefore, effects on subsistence harvest of Steller sea lions would be potentially adverse. Direct and indirect adverse effects of groundfish fishing on subsistence resulting from salmon bycatch would increase for BSAI salmon stocks in western Alaska, which are depressed and remain a concern to Alaska Natives. As a result, this alternative would result in potential adverse Environmental Justice effects on Alaska Natives related to adverse subsistence impacts (see the Alaska Native Issues qualitative analysis paper in Appendix F-9).

Under Alternative 2, subsistence uses would continue consistent with federal law. Joint production of subsistence resources, where Alaska Natives who participate in groundfish fishing take advantage of their commercial fishing efforts to harvest subsistence resources, would continue at current levels.

4.10.3.9 Improve Data Quality, Monitoring and Enforcement

Alternative 2 maximizes economic yield under the assumption that fishing has few adverse effects on the environment, and those that are adverse are known and mitigated. The policy sets goals and objectives to address data quality, monitoring and enforcement, as well as recommending a range of management measures that would implement these objectives.

Impacts of Policy

The goal of the alternative is to use the best scientific information available to manage the fisheries and consider the effects of fishing, and to use all available resources (federal, state, and academic) to assist in research, administration, management, and enforcement.

The objectives under Alternative 2 continue the existing industry reporting requirements to provide catch estimates and biological information, and the ongoing efforts to improve economic impact assessments. Additionally, the repeal of the Observer Program is considered.

The existing reporting regulations require vessel captains to provide estimates of total catch and discards, limited species composition data, and haul times and locations. For further information, see the Data and Reporting Requirements paper in Appendix F-11. Industry is not currently required to report cost or revenue data necessary to accurately assess the economic impact of fishing on regional or community economies. Ongoing efforts to elicit voluntary cooperation of industry in researching these data has met with mixed success.

<table>
<tr><th rowspan="2">Goals, Objectives</th><th colspan="2">Corresponding Management Measures</th></tr>
<tr><th>FMP Component</th><th>Management Measure</th></tr>
<tr><td rowspan="5"><u>Goals</u>
• Management approach based on the best scientific information available
• Draw upon federal, state and academic capabilities in carrying out research, administration, management and enforcement
• Consider the effects of fishing

<u>Objectives</u>
• Continue existing reporting requirements to provide catch estimates and biological information
• Continue ongoing effort to improve community and regional economic impact assessments
• Consider repealing the Observer Program</td><td rowspan="2">Observer Program</td><td>Repeal/fixed 0/30/100% Observer Program coverage; 100/200% for AFA. and CDQ</td></tr>
<tr><td>Repeal/third party, pay-as-you-go service delivery model</td></tr>
<tr><td rowspan="3">Data and Reporting Requirements</td><td>Require economic data from industry participants</td></tr>
<tr><td>Repeal except for AFA./require appropriate scales</td></tr>
<tr><td>Repeal/require VMS for Steller sea lion prey species</td></tr>
</table>

Alternative 2 also has an objective to consider repealing the Observer Program. The repeal of the program would apply to all groundfish fisheries with the exception of AFA and CDQ pollock, thus representing an 80 percent cut in observer days (see the Observer Program paper in Appendix F-10). The implications of this repeal are also discussed in other policy sections under this alternative, relating to target species (Section 4.10.3.2), the food web (Section 4.10.3.3), bycatch (Section 4.10.3.4), and allocation issues (Section 4.10.3.7). Because the presumed risk of adversely impacting the environment is assumed in this alternative to be low, the costs to industry of funding the Observer Program to gather fishery data may not be considered necessary. However, observers provide additional information on commercial fishing harvests that may not be otherwise captured by survey vessels or vessel logbook information. Stock assessment data is collected by observers, such as age structures and stomach samples, and fishery scientists use the Observer Program as a platform from which to complete special projects. Also, interactions with marine mammals and endangered seabirds are recorded by observers. The repeal of the Observer Program would increase the reliance of fishery managers on industry data, which is less accurate in terms of total catch and discard estimates, and is not as precise in terms of species reporting. Although there would be less need for inseason management data under Alternative 2 through the repeal of groundfish and potentially PSC bycatch restrictions, accurate catch estimates are still required as part of the annual stock assessment process. As a result, stock assessment scientists may adapt to the lack of precision by generating more conservative catch limit estimates.

As a whole, the Alternative 2 policy emphasizes the maximization of economic yield. The specific goals and objectives require the collection of data to maintain a minimum level to meet conservation requirements. The goal to manage fisheries based on the best available science could potentially be compromised under this policy, as only the pollock fisheries would still be monitored for age-structuring of catch. However, because the presumed risk of adversely impacting the environment is low, the costs imposed on industry of additional monitoring efforts may not be worth the tradeoff in economic yield.

4.10.4 Analysis of Alternative 3

Alternative 3 consists of a management approach statement and a set of policy objectives. The management approach statement provides the key to the underlying rationale and assumptions for the policy, along with policy goals and additional guidelines for the policy.

The management approach statement for Alternative 3 represents the need to balance many competing uses of marine resources and different social and economic goals for fishery management. The management approach statement is summarized in Table 4.10-3. Under this approach, additional conservation and management measures will be taken as necessary to respond to social, economic or conservation needs, or if scientific evidence indicates that the fishery is negatively impacting the environment.

The Alternative 3 management approach statement also indicates that the NPFMC management process will:

- Utilize and improve upon existing processes to involve a broad range of the public in decision-making.

- Maintain the balanced goals of the National Standards Guidelines and other provisions of the MSA as well as the requirements of other applicable law.

A summary of the impacts of Alternative 3 follows below in Section 4.10.4.1. In the remainder of Section 4.10.4, the impacts of the alternative are analyzed in detail, in relation to eight policy subheadings: prevent overfishing, preserve food web, reduce and avoid bycatch, avoid impacts to seabirds and marine mammals, reduce and avoid impacts to habitat, allocation issues, increase Alaska Native consultation, and data quality, monitoring and enforcement. For each subheading, the impacts of the relevant goals and objectives from the management approach are analyzed, using as a guideline the range of implementing management measures for Alternative 3, identified in Section 4.2 and analyzed in Section 4.7.

4.10.4.1 Summary of Alternative 3

The key policy elements that predominantly influence the impacts under Alternative 3 are: the emphasis on rationalizing the fisheries (resulting in increased efficiency and flexibility); the incorporation of ecosystem considerations (increasing the uncertainty buffers in management accounting); and the likelihood of additional closure areas (which may result in a variety of impacts, depending how the closures are situated).

Predictions about the impacts under this alternative are difficult due to the uncertainty involved in defining ecosystem management and predicting the impacts of protecting areas. Increased emphasis on relatively less abundant species, through protection measures and increased monitoring, indicates a tendency towards ecosystem management but as the implications of such management are uncertain. The tendency is to manage cautiously while accelerating research and data-gathering. The large potential gain in flexibility from rationalization has the potential to create ecosystem benefits.

Alternative 3 prevents overfishing of target stocks and reduces the likelihood that stocks will become overfished, through precautionary harvest policies, and imposition of rebuilding regulations when stocks fall below the level capable of producing MSY. This alternative would formally define criteria for determining the status of stocks relative to an overfished condition in order to better satisfy the requirements of the National Standard 1 Guidelines. Efforts would be accelerated to identify methods for reducing the number of stocks where the status relative to an overfished condition is unknown.

This alternative is successful in making many improvements relative to the baseline in achieving the goal of preserving the food web. The emphasis of this alternative is not only on using the best scientific information available to determine catch levels but also on providing additional protection against uncertainty by designation of MPAs and reserves. If these improvements are implemented, this strategy is likely to provide protection to a broad range of food web components.

The bycatch and incidental catch reduction policies in Alternative 3 are consistent with accelerating precautionary management measures through additional bycatch constraints and monitoring. Bycatch reduction objectives and reductions in incidental catch are likely to be achieved without a major cost to industry due to the incentives for more efficient use of fishery resources under cooperatives, comprehensive rationalization of fisheries or other bycatch incentive programs implemented under this alternative.

The goal of minimizing human-caused threats to protected species is largely met in this alternative by actively adjusting protection measures, actively reviewing the status of marine mammal fishery interactions, and through research. This approach, which may provide additional conservation measures in response to scientific evidence, is likely to provide increased protection to marine mammals and seabirds.

This alternative has a potential to reduce and avoid impacts to habitat by careful placement of closures. Placement of closures in lightly fished or not fished areas could result in avoidance of future habitat impacts if fisheries were to move effort into surrounding areas. Placement of closures in heavily fished areas can mitigate impacts, reduce unintended consequences, and achieve overall benefits to habitat if closures do not encompass entire habitat types or areas of fishing intensity. In the short-term, information from the Observer Program could be used to locate such closures. In the long-term, scientific information gained from this policy can potentially lead to modification of the placement of MPAs and help meet the policy objective to assess the necessary and appropriate habitat protection measures. Cumulatively, the alternative results in a split impact rating, as the adverse condition of the baseline is coupled with continued damage and mortality to living habitat, however the alternative has strong potential to mitigate these adverse impacts.

Alternative 3 promotes increased social and economic benefits through the elimination of the race-for-fish while also emphasizing the long-term economic value of the fishery through the promotion of rights-based allocations to individuals, sectors, and communities. In addition, this alternative promotes ecosystem-based management and is likely to increase non-market, recreational, and tourism values assigned to the ecosystem. It is not possible to determine the long-term effect on overall ecosystem value (commercial and non-market values combined) because it is not known whether the fishing sectors, even with rights-based allocations, will be able to adapt to the changes resulting from the increased emphasis on ecosystem tools and, in particular, the additional number and significance of closed areas.

The goals and policies for Alaska Native consultation and participation in fishery management under Alternative 3 would increase current levels by expanding informal and formal consultation between the NPFMC/NOAA Fisheries and Alaska Native participants and tribal governments. Traditional knowledge would be more formally incorporated in fishery management and additional data would be collected. Other goals and objectives in Alternative 3, such as reductions in PSC limits, may benefit subsistence salmon use by reducing bycatch levels in the groundfish fisheries.

Through data collection measures that will result in reducing uncertainty, Alternative 3 is likely to be effective in achieving the goal of accelerating the use of precautionary management measures. The objectives to improve the Observer Program and observer data will increase the quality of fishery data by implementing increased flexibility of, and potentially expanding, observer coverage. Additionally, the expanded economic data and potential for independent verification would allow for more accurate and credible economic impact assessments. A funding source would, however, need to be identified to implement improvements to these programs.

4.10.4.2 Prevent Overfishing

Alternative 3 would seek to accelerate the existing precautionary management measures through community or rights-based management, ecosystem-based management principles, and, where appropriate and practicable, increased habitat protection and additional bycatch constraints. Under this approach, additional conservation and management measures would be taken as necessary to respond to social, economic, or conservation needs, or if scientific evidence indicated that the fishery was negatively impacting the environment. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management. The Alternative 3 policy is illustrated by FMP 3.1 and FMP 3.2. Each FMP contains a number of management measures that pertain to the sustainability of fisheries and fishery resources. The bookends represent a range of actions that alter constraints to fishery removals.

A detailed description of FMP 3.1 appears in Section 4.2. Briefly, FMP 3.1 continues precautionary practices seen in Alternative 1 where TAC is less than or equal to the ABC, and the ABCs are less than the OFL. Uncertainty corrections applied under Alternative 1 to BSAI and GOA Pacific cod and GOA pollock would not apply. OY restrictions would be identical to Alternative 1, where the OY range for the BSAI and GOA is capped at 2 million mt and 800,000 mt for the BSAI and GOA, respectively. The 2 million mt cap in the BSAI would limit the expansion of fisheries. The FMP would formally specify MSSTs for Tiers 1-3 in accordance with National Standard Guidelines. Sharks and skates would be removed from the other species complex and given their own TACs, and criteria to do the same for other target stocks would be developed. Efforts to develop ecosystem indicators to be used in TAC-setting, as per ecosystem management principles, would be accelerated.

In order to balance the needs of social and economic stability with habitat protection and resource conservation, the NPFMC would conduct a review of the existing system of closure areas in the BSAI and the GOA (for closure areas under FMP 3.1, see Figure 4.2-4), and evaluate them against a developed MPA methodology.

FMP 3.1 recognizes that the anticipated community or rights-based management programs may address bycatch reduction objectives (a review of bycatch in existing programs is initiated), but in the meantime accelerated precaution counsels a moderate reduction of PSC limits as an intermediary step. Additionally, in the GOA the FMP would add PSC limits for crab, herring and salmon to its specifications for halibut. Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through improvements in the Observer Program and third party verification of economic data.

Goals, Objectives	**Corresponding Management Measures**	
<u>Goals</u> • Accelerate the existing precautionary management measures through community or rights-based management, ecosystem-based management principles • Where appropriate and practicable, increase habitat protection and impose additional bycatch constraints • Sound conservation of living marine resources <u>Objectives</u> • Adopt conservative harvest levels for multi-species and single species fisheries • Provide for adaptive management. • Continue to specify OY as a range or a formula • Initiate a scientific review of the adequacy of $F_{40\%}$ • Continue to collect scientific information and improve upon MSSTs including obtaining biological information necessary to move Tier 4 species into Tiers 1-3 in order to obtain MSSTs	Example Range: TAC $\leq$ABC$\leq$OFL, formal adjustments for uncertainty, automatic rebuilding, specific harvest policies for rockfish	Quota management based on a tier system. F_{ABC} set below F_{OFL} except at very low stock sizes protecting the stock from unintentional overfishing. Additional adjustments for uncertainty are incorporated into F_{ABC} under FMP 3.2. For tier 3 stocks, F_{ABC} is decreased linearly with biomass whenever biomass falls below a tier-specific reference level. For example purposes only, F_{ABC} for Tier 3 rockfish stocks would be set at $F_{60\%}$.
	Time/Area	For several species, fishing quotas are distributed across time and area in proportion to the expected underlying biomass of fish in the region at that time. These policies reduce the possibility of spatial temporal concentration of the catch. Relative to FMP 1 and FMP 3.1, FMP 3.2 imposes additional marine reserves and marine protected areas.
	Gear restrictions	For walleye pollock, Pacific cod, and sablefish, gear allocations partition catch to specific gear groups. Differences in gear selectivity are addressed in the stock assessment models and quotas reflect the expected age distribution of the catch by gear.
	OY caps	Under FMP 3.1, OY restrictions cap the aggregated groundfish catch in the GOA and BSAI at 800,000 mt and 2 million mt, respectively. These caps limit the expansion of fisheries (particularly in the BSAI). These OY caps would be replaced with species specific OYs under FMP 3.2
	Inseason Multi-species TAC and ABC monitoring	The catch of a given target species is limited by prohibited species bycatch caps and the TACs for other groundfish. The halibut bycatch caps serve as a constraint to BSAI and GOA flatfish expansion. Reduced bycatch allowances would further constrain target fisheries. Sharks and skates would be moved from the other species management category.

FMP 3.2 incorporates an uncertainty correction into the estimation of ABC for all species. This represents a significant acceleration of precautionary management. Additionally, OY would be specified separately for each stock or stock complex rather than for the groundfish complex as a whole (i.e., the 2 million mt OY cap would be eliminated), and would be set equal to the species-respective TAC. FMP 3.2 would also incorporate taxon-specific biological reference points in the tier system where scientifically justifiable. For example purposes, FMP 3.2 capped F_{ABC} at $F_{60\%}$ rather than $F_{40\%}$ for stocks managed in Tiers 1-3. In implementing this bookend, criteria would be developed for specifying MSSTs for Tiers 4-6, along with a list of priority candidate stocks; and a development of criteria for moving stocks from the other species and non-specified species categories would minimally result in sharks and skates being given their own TACs.

FMP 3.2 also reexamines the existing closure system in the BSAI and the GOA. The closures aim to provide protection for a wide range of species, from Steller sea lions to slope rockfish to prohibited species, as well as to respect traditional fishing grounds and maintain open area access for coastal communities. Additionally, the bookend would extend the existing bottom-trawl ban on pollock to the GOA.

To increase precaution regarding bycatch, PSC limits would be significantly reduced by the NPFMC (and set for all prohibited species in the GOA), but would not be expected to act as a proportionate restraint on the fisheries due to the incentives for bycatch reduction under cooperatives, or other bycatch incentive programs implemented as necessary under this bookend.

Impacts of Policy

Alternative 3 limits the impact of fishing mortality by setting an ABC less than the OFL. This alternative defines four management categories for which catch is constrained by various regulatory mechanisms: target species, other species, prohibited species and forage fish species. Alternative 3 harvest policies are consistent with ecosystem principles that call for in-season multi-species catch monitoring to ensure that catch does not exceed the OFL of groundfish. This catch monitoring is facilitated by at-sea observers, port samplers, weekly production reports and fish ticket information (Appendix F-10). Stocks can be moved from one management category into another only by FMP amendment. Within the target species category, stocks are managed either individually or as part of a stock complex. Stocks within the target species category can be added to or removed from a stock complex within the same category as part of the TAC-setting process (i.e., without an FMP amendment).

The bookends provide a range of potential impacts associated with this alternative. FMP 3.1 is similar to FMP 1 except that uncertainty corrections applied under Alternative 1 to BSAI and GOA Pacific cod and GOA pollock would not apply. FMP 3.2 imposes more constraints to fisheries removals and allows the OY caps for the GOA and BSAI to equal the sum of the ABCs of groundfish for the GOA and BSAI regions respectively.

Several measures associated with Alternative 3 could result in reductions in catch relative to baseline conditions. First, an uncertainty correction could be applied that would account for measurement and process error in the assessment (FMP 3.2). Second, the ABC for Tier 3 rockfish species could be set at $F_{60\%}$ (FMP 3.2). Third, a 0-10 percent (FMP 3.1) or 10-30 percent reduction (FMP 3.2) in bycatch would be imposed under this alternative. Finally, sharks and skates would be broken out of the other species complex. While the FMPs used to illustrate Alternative 3 demonstrate conservative harvest polices, it is important to note that the combinations of tools available under Alternative 3 could lead to a more aggressive harvest. For example, if the quota system described in FMP 3.1 and the OY system described in FMP 3.2 were adopted, the BSAI pollock fisheries could be expanded during periods of high abundance. Direct and indirect impacts analyses revealed that overfishing did not occur in the stocks or stock complexes modeled under FMPs 3.1 or 3.2 (Table 4.7-1). Relative to the comparative baseline, the expected fishing mortality under Alternative 3 would have no significant impact on any of the target groundfish stocks. Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on fishing mortality.

Relative to the comparative baseline, the likelihood of a stock falling below the level where the stock is capable of producing MSY is reduced under Alternative 3. Under FMP 3.1 and FMP 3.2 none of the stocks managed in Tiers 1-3 would be expected to become overfished. The direct and indirect impact of Alternative 3 on changes in biomass of all of the Tier 1-3 target groundfish stocks would be insignificant relative to the baseline (Table 4.7-1). The direct and indirect impact of commercial fishing on the biomass of target groundfish stocks managed in Tiers 4-6 is unknown because the status of such stocks relative to their respective MSSTs is unknown (Table 4.7-1). Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on changes in biomass.

Relative to the comparative baseline, FMP 3.2 adds several spatial/temporal restrictions on catch. These restrictions would decrease the spatial/temporal concentration of the catch. Under this policy, commercial fishing is expected to have insignificant impacts on the genetic makeup or the reproductive success of the 19 stocks managed in Tiers 1-3. The direct and indirect impact of commercial fishing on the genetic makeup or reproductive success of stocks managed in Tiers 4-6 is unknown because the status of such stocks relative to their respective MSSTs is unknown. Alternative 3 would initiate research to define MSSTs for stocks managed in Tiers 4-6. Once the MSST definition is established, the significance of commercial harvest on Tiers 4-6 stocks could be evaluated. Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on fishing mortality.

Relative to the comparative baseline, Alternative 3 would increase restrictions on the spatial temporal partitioning of catch and could reduce overall harvest of target groundfish. The direct and indirect impact of these changes on prey availability is expected to be insignificant or unknown for all stocks managed in Tiers 1-3 (Table 4.7-1). Direct and indirect impacts of commercial fishing on prey availability of all stocks or stock complexes managed in Tiers 4-6 are unknown because the status of such stocks relative to MSST is unknown (Table 4.7-1). Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on fishing mortality.

Harvest restrictions, spatial temporal constraints, and gear allocations all serve to mitigate the impact of commercial fishing on fish habitat. The closure system described in the FMP 3.2 would close approximately 18 percent of the EEZ to some form of MPA and designates approximately 3.1 percent of the EEZ as a no-take reserve (Figure 4.2-5). For the fishable area (depth to 1,000 m) of the EEZ, FMP 3.2 would designate approximately 8 percent of the fishable area as a no-take reserve and about 40 percent of the fishable area as some form of MPA. Relative to the comparative baseline, the impacts on target species resulting from habitat disturbance are considered insignificant or unknown for all stocks managed in Tiers 1-3 (Table 4.10-2a). The impacts are unknown for stocks or stock complexes managed in Tiers 4-6.

When taken in aggregate, Alternative 3 appears to accelerate the existing precautionary management measures through community or rights-based management, ecosystem-based management principles and, where appropriate and practicable, increased habitat protection and additional bycatch constraints.

Irreversible or long-term adverse effects on fishery resources are avoided by precautionary harvest policies and imposition of rebuilding regulations when stocks fall below the level capable of producing MSY. Strengths of Alternative 3 are that the FMPs will adopt formal criteria for status determination, and research will be accelerated to develop ecosystem-based harvest policies. The community or rights-based management would reduce the race-for-fish under Alternative 3. Efforts would be accelerated to identify methods for reducing the number of stocks where the status relative to an overfished condition is unknown. Alternative 3 would establish formal specifications for MSST whenever possible. Another strength of this policy is that FMP 3.2 would develop a list of priority candidate stocks for moving stocks from the other species and non-specified species categories. The catch of these species would be monitored. Until this system is developed, harvest policies may build and maintain the species complex, but it is still possible to over harvest a vulnerable member of the complex.

4.10.4.3 Preserve Food Web

The Alternative 3 policy sets goals and objectives to preserve the food web, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	**Management Measure**
Goals • Accelerate precautionary management measures through ecosystem-based principles • Promote sound conservation of living marine resources • Incorporate ecosystem-based considerations into management decisions • Take into account NAS Sustainable Fisheries policy recommendations Objectives • Incorporate ecosystem-based considerations into fishery management decisions • Develop indices of ecosystem health as targets for management • Improve the procedure to adjust ABCs as necessary to account for uncertainty and ecosystem factors such as predator-prey relationships and regime shifts • Initiate a research program to identify the habitat needs of different species that represent the significant food web	TAC-setting Process	Prohibit directed fishery for forage fish
		Procedures to incorporate precaution and uncertainty into ABCs
		Procedure to develop and use key ecosystem indicators in TAC-setting

Impacts of Policy

Impacts to food webs of the BSAI and GOA are mitigated through many of the goals and objectives and related management measures of this alternative, some of which are improvements beyond those provided in the baseline. In addition to objectives specifically for incorporating ecosystem considerations into fisheries management decisions and prohibition of directed fisheries for forage fish (which often form a central position in channeling energy through the food web) and precautionary adjustments to ABCs made to Tier 1 stocks that were part of Alternative 1, this alternative provides for the possibility of developing explicit procedures for incorporating predator/prey relationships and regime shifts in ABC adjustments and initiates a research program to identify the different habitat needs of species that are significant food web components. Other policies of this alternative such as preventing overfishing, reducing bycatch, avoiding impacts to seabirds and marine mammals, reducing impacts to habitat, and improving data quality, monitoring, and enforcement are critical to protection of food web components, which include target and non-specified species, PSC species, HAPC biota, and marine mammals and seabirds. Management measures such as revised procedures for ABC, MSST setting, incorporating precaution, and space/time allocation for TAC (Section 4.10.4.2); additional bycatch reduction measures (Section 4.10.4.4); further gear modifications for seabird protection and possible extension of fishery closure areas and seasonal take for marine mammal protection (Section 4.10.4.5); procedures to identify MPAs and no-take marine reserves (Section 4.10.4.6) and improvements to the Observer Program coverage (Section 4.10.4.9) that are proposed as improvements beyond the baseline in Alternative 3 provide increased protection to a variety of food web components. See the policy analysis in those sections for details on the level of protection provided by Alternative 3 to these individual components.

This alternative specifically attempts to incorporate ecosystem considerations into fishery management decisions through advancements in how uncertainty and ecosystem factors such as predator/prey relationships and regime shifts are used in ABC adjustment. It will continue to prohibit directed fisheries for forage fish, develop ecosystem indicators, and develop conceptual models of the food web. Analysis of the ecosystem effects of Alternative 3 involved selection of indicators that would show changes in key members or ecosystem characteristics that are important to the structure and function of marine food webs. Changes in pelagic forage, top predators, spatial/temporal availability of prey, exotic species introductions, energy removal and redirection through fishery catch removals and discards/offal production, and various measures of diversity were evaluated with respect to the potential of fishing to cause changes sufficient to bring these attributes below population, community, or ecosystem thresholds, if such thresholds could be defined. Most of these indicators showed there were insignificant impacts of this alternative on these ecosystem attributes. There were unknown effects of this alternative on top predator species and species diversity due to our lack of knowledge of abundance levels and life history characteristics of species such as skates, sharks, and grenadiers, although breaking these species out of the other species group and giving each its own TAC would provide additional protection. The additional area closures proposed in the FMP 3.2 of this alternative would result in improvements relative to the comparative baseline in spatial/temporal availability of forage to marine mammals and birds and protection of corals. Qualitative analysis of this alternative with respect to the ecosystem effects of the TAC-setting process (Appendix F-1) showed that increased protection is provided in this alternative to stocks that need it most, such as slower-growing, long-lived species such as rockfish, skates, and sharks and would thus reduce the possibility of adverse impacts to those groups and to their role in the food webs of these ecosystems. Thus, if these improvements are implemented, this alternative has the potential to decrease ecosystem impacts relative to the comparative baseline.

As a whole, through its goal to accelerate precautionary management measures through ecosystem-based principles and objectives to develop indices of ecosystem health and take ecosystem factors into account in ABC setting, and to initiate a habitat research program, this alternative is successful in making many improvements beyond the status quo in achieving the goal of preserving the food web. The emphasis in this alternative is on using the best scientific information available to determine catch levels but also on providing additional protection against uncertainty by designation of MPAs and reserves. If these improvements are implemented, this strategy is likely to provide protection to a broad range of food web components.

4.10.4.4 Reduce and Avoid Bycatch

Several policy changes adopted in Alternative 3 would change the incidental catch of target and non-target species and bycatch. The expected incidental catch of target and non-target species under Alternative 3 is difficult to project. The expected TAC under Alternative 3 could increase substantially if management adopted Amendment 56 as described in FMP 3.1 but modified the OY range as described under FMP 3.2. On the other hand, expected TAC could decrease if the uncertainty correction and reduced rockfish F_{OFL} described by FMP 3.2 were adopted. Breaking sharks and skates from the other species complex would ensure that these species are not harvested at rates above the Maximum Fishing Mortality Threshold. Criteria for defining the membership within species complexes and the circumstances when species should be broken out of complexes would be developed.

Many precautionary conservation benefits would be realized in FMPs 3.1 and 3.2 through the comprehensive rationalization of all fisheries (except those already part of a cooperative or IFQ program). Community or rights-based management programs may address bycatch reduction objectives (a review of bycatch in existing programs is initiated), but in the meantime a moderate reduction of PSC limits would be adopted as an intermediary step. The NPFMC would also be addressing habitat and bycatch concerns by reducing concentrated effort in the fisheries.

Effective monitoring and timely reaction to change in the environment and the fisheries would be enhanced through increases in coverage and improvements to the Observer Program, as well as an increase in the use of VMS and the range of economic data collected from industry. Alternative 3 would require 100 percent observer coverage for boats over 60 ft LOA. Additional observer coverage would reduce uncertainty in catch composition and demographic information collected at sea by observers. Improved species identification of other species and forage fish would be achieved under Alternative 3.

Impacts of Policy

Alternative 3 is expected to encourage the development of practical measures that reduce bycatch and incidental catch of target and non-target species. Relative to the comparative baseline, the impacts of mortality and change in biomass associated with the Alternative 3 policy would be insignificant for prohibited species that are currently in a depressed or overfished condition (BSAI and GOA chinook salmon, *C. bairdi* crab, *C. opilio* crab, BSAI and GOA red king crab, and BSAI blue king crab [Table 4.10-2a]). While cumulative impacts are considered conditionally significant, adverse impacts due to mortality are still expected for the species noted above as well as for BSAI and GOA chinook salmon. Alternative 3 is expected to have an insignificant impact on forage fish. The impact of Alternative 3 on other species and non-specified groups is unknown.

Alternative 3 policies as illustrated by FMPs 3.1 and 3.2 are consistent with the goal of accelerating precautionary management measures through additional bycatch constraints where appropriate and practicable. Alternative 3 policies are also consistent with the objective of monitoring prohibited species bycatch. Increased precaution regarding bycatch would be achieved through reductions in PSC limits. Bycatch reduction objectives (0-10 percent for FMP 3.1 or 10-30 percent for FMP 3.2) and reductions in incidental catch are likely to be achieved due to the incentives for more efficient use of fisheries resources under cooperatives, comprehensive rationalization of fisheries, or other bycatch incentive programs implemented under this alternative.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Accelerate precautionary management measures through additional bycatch constraints where appropriate and practicable • Promote sound conservation of living marine resources • Minimize human-cause threats to protected species Objectives • Continue and improve current incidental catch and bycatch management program • Develop incentive programs for incidental catch and bycatch reduction including the development of mechanisms to facilitate the formation of bycatch pools, vessel bycatch allowance, or other bycatch incentive systems • Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits as information becomes available • Continue program to reduce discards by developing management measures that encourage the use of gear and fishing techniques that reduce discards	Spatial/ Temporal Management of TAC	Spatial/temporal distribution of TAC
	MPAs and EFH, Bycatch and Incidental Catch Restrictions, Gear Restrictions and Allocations	Seasonal, gear/fishery specific, and total closure areas identified to reduce bycatch; reviews to develop appropriate closure bycatch closure areas in the GOA
	Bycatch and Incidental Catch Restrictions	Reduce existing PSC limits for prohibited species, establish PSC limits for prohibited species other than halibut in the GOA
		Procedure to develop mortality rate-based approach to setting limits
		Retention standards for pollock and Pacific cod (IR/IU) and DSR
		Review bycatch reduction incentive programs (repeal/maintain VIP)
		Bycatch restrictions (including in-season)/ repeal or modify MRBs and establish system of caps and quotas

4.10.4.5 Avoid Impacts to Seabirds and Marine Mammals

The Alternative 3 policy sets goals and objectives to avoid impacts to seabirds and marine mammals, as well as recommending a range of management measures that would implement these objectives.

Impacts of Policy

This alternative seeks to provide conservation of living marine resources and minimize, to the extent practicable, human-caused threats to protected species. It will accomplish those goals through continued cooperation with USFWS to protect seabird species, initiation of a joint research program with USFWS to evaluate populations of seabirds that interact with groundfish fisheries, maintenance or possible adjustment of current protection measures for Steller sea lions to avoid jeopardy, and review of marine mammal/fishery interactions and development of appropriate fishery management measures for mitigation, if needed. Management measures that are improvements beyond those provided in the status quo include harvest control rules for Steller sea lion prey species, possible extension of seasonal/gear/fishery specific closures and total closure areas for walrus and Steller sea lion protection, and possible gear improvements to protect seabirds. Elimination of the race-for-fish in this alternative may also tend to decrease direct takes of marine mammals and seabirds. Impacts of the alternative with respect to seabirds were evaluated with respect to the potential for fisheries to cause direct mortality through fishing gear and vessel strikes, changes in prey availability (including offal), and changes in benthic habitat that might affect certain prey species of seabirds. Impacts for marine mammals were evaluated with respect to the potential for fishery incidental take or entanglement in marine debris, harvest of prey species, spatial/temporal concentration of fishing on prey, and fishing vessel disturbance.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	**Management Measure**
<u>Goals</u> • Promote sound conservation of living marine resources • Minimize human-cause threats to protected species <u>Objectives</u> • Continue to cooperate with USFWS to protect ESA-listed and other seabird species • Initiate joint research program with USFWS to evaluate current population estimates for all seabirds species that interact with the groundfish fisheries • Maintain or adjust current protection measures as appropriate to avoid jeopardy to ESA-listed Steller sea lions • Encourage programs to review status of other marine mammals stocks and fishing interactions (right whales, sea otters, etc.) and develop fishery management measures as appropriate	TAC-setting Process, Steller sea lion Measures	Steller sea lion prey species low biomass rules/ Steller sea lion prey species harvest control rule
	TAC-setting Process	Prohibit directed fishery for forage fish
	Spatial/ Temporal Management of TAC	Spatial/temporal distribution of TAC
	MPAs and EFH, Steller sea lion Measures, Gear Restrictions and Allocations	Maintain/extend as necessary seasonal, gear/fishery specific, and total closure areas identified to protect walrus and Steller sea lions
	Seabird Measures	Short-tailed albatross take restrictions
		Develop further gear modifications to protect seabirds

These indicators showed that Alternative 3 provides increased protection to seabirds and marine mammals relative to the comparative baseline. As in Alternative 1, incidental take of albatross, fulmars, shearwaters, and gulls is substantially reduced due to new mitigation measures in the longline fleet. In addition, mitigation measures for the trawl fleet are likely to reduce collisions with trawl third wires. The Seabird Protection Measures paper (Appendix F-6) noted that the Observer Program would be expanded under this alternative to improve the collection of seabird/fishery interaction data and to measure the effectiveness of mitigation measures. The groundfish fishery is not expected to have population level effects on any seabird species through mortality, changes in food availability, or benthic habitat. Although some piscivorous bird species such as glaucous-winged gulls might be gaining food subsidies from discards and offal in the baseline, other piscivorous birds would be negatively impacted by competitive interactions with gulls, thus offsetting any changes for the piscivorous bird group as a whole that might occur in this alternative.

Qualitative analysis of this alternative with respect to Steller sea lions (Appendix F-4) found that the additional proposed protection measures would function to further separate the groundfish fishery in space an time and would result in an additional buffer against uncertainty with respect to protection of Steller sea lions and some other marine mammals. Some improvements to marine mammal impacts are seen relative to the comparative baseline because of additional closures out to 15nm and designation of MPA under this alternative. Even though Alternative 1 showed no serious adverse impacts to marine mammals and seabirds, this alternative provides an additional buffer against uncertainty by providing additional protection.

The goal of minimizing human-caused threats to protected species is largely met in this alternative by actively adjusting protection measures, status review of marine mammal fishery interactions, and research. This approach, which may provide additional conservation measures in response to scientific evidence , is likely to provide increased protection to marine mammals and seabirds.

4.10.4.6 Reduce and Avoid Impacts to Habitat

The Alternative 3 policy sets goals and objectives to reduce and avoid impacts to habitat, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Accelerate precautionary management measures through increased habitat protection where appropriate and practicable • Promote sound conservation of living resources • Maintain a healthy marine resource habitat Objectives • Develop goals, objectives and criteria to evaluate the efficacy of MPAs and no-take marine reserves as tools to maintain abundance, diversity, and productivity of marine organisms • Consider implementation of MPAs if and where appropriate, giving due consideration to areas already closed to various types of fishing operations • Develop a research program to identify regional baseline habitat information and mapping • Evaluate the impacts of all gear on habitat through the implementation of a comprehensive research plan, to determine habitat protection measures as necessary and appropriate • Identify and designate EFH and HAPC	MPAs and EFH, Bycatch and Incidental Catch Restrictions, Gear Restrictions and Allocations	Existing system of closed areas including Sitka Pinnacles, modify based on MPA process
	MPAs and EFH	Develop procedure to identify MPAs and no-take marine reserves
		Identify and designate EFH and HAPC, EFH mitigation measures part of MPA development process

Impacts of Policy

Alternative 3 addresses impacts to habitat by having specific goals and objectives that focus on living marine habitat. This policy accelerates habitat protection where appropriate and practicable and could result in a gradual-to-rapid reduction and avoidance of impacts to habitat depending on how quickly management measures are implemented. Development of a procedure to identify MPAs and no-take marine reserves and identification of EFH mitigative features are identified as specific management measures.

In addition to the objectives specifically designed to address habitat concerns, Alternative 3 policies are designed to prevent overfishing, reduce and avoid bycatch, incorporate ecosystem considerations, and improve data quality and enforcement. These goals are important ancillary objectives that could provide reduced impacts to habitat. Management measures such as revised procedures for ABCs that incorporate greater precaution can potentially reduce impacts to habitat if fishing effort is reduced. Closures for marine mammal protection, especially if they are year round for all target species, can also provide protection to specific habitat types. Measures to avoid and reduce impacts could occur on a rapid time line, especially if precautionary measures are implemented before complete scientific information is available.

A composite of several different concepts for habitat protection and mitigation were qualitatively analyzed. After the concepts were analyzed, specific implementations of the concepts were analyzed and results compared to the comparative baseline. The basis for these conceptual closures is to illustrate how the effects of fishing on EFH can be mitigated by reducing the impacts caused by a particular fishery by closing specific areas. The conceptual strategies are:

- Reduce the impacts caused by a particular fishery by closing specific areas.

- Incorporate a "band-approach" where closures would be oriented perpendicular to depth contours from near shore to deep water assuring protection of a diversity of habitat types across a range of geographic areas.

- Develop a special conservation area in the Aleutian Islands to protect sensitive cold water coral communities.

- Create rotational closures.

All of these approaches are variations of MPAs. Concepts 1-3 have the most potential for benefits to habitat. However, careful placement of the MPAs is required to avoid unintended consequences. Displacement of effort to new areas with more sensitive habitat may be an unintended consequence. If closures are placed primarily in areas with high fish densities and displace effort into areas of low densities then increased effort in a given area could lead to more habitat impacts. For closures to be most effective they should be combined with some effort controls. Ancillary management measures associated with Alternative 3 that result in reduced effort could result in increased effectiveness of MPAs. However, closures alone, if they are strategically placed within historically fished areas, can provide benefits to habitat without necessarily requiring a reduction in TACs. Benefits to habitat could occur with closure areas strategically placed that do not encompass entire habitat types or clusters of fishing intensity. To be most effective, closure areas should include some portion of areas where high fishing intensity has occurred, but need not be so large that they encompass entire habitat types or clusters of fishing intensity. Placement of small closures within areas of high fishing intensity could also promote scientific understanding of the effectiveness of such management measures. The specific location of MPAs could have serious social and economic consequences. Determining where to locate MPAs for habitat goals should include consultation with the fishing industry and nearby communities.

Rotational closures could protect sea floor habitat while not permanently closing an area to fishing. However, rotational closures are not appropriate for highly structured sea floor habitats with long-lived species. For rotational closures to be effective, specific knowledge of indicator species' recovery times is required because if the rotation schedule is less than the recovery time then all areas may be maintained in a disturbed state with little benefits to habitat. If not carefully implemented, a more homogeneous distribution of fishing effort and habitat disturbance than in years prior to the closure could occur.

Analysis of specific management measures indicated mixed ratings relative to the comparative baseline for effects to mortality and damage to living habitat. These mixed ratings result from the specific location of bottom trawl closure MPAs and the uncertainty of how changes in TAC will interact with MPAs. For example, in the GOA many of the specific strategy (1) closed areas on the slope are encompass high effort areas which would be expected to have higher target fish densities. This could result in a much higher effort to catch fish in lower density open areas. This higher effort could result in enough of an increase in habitat impacts to negate impact reduction in the closed areas. Whether decreased TACs for some species will offset this increase in habitat impacts is uncertain. This uncertainty in predicted impacts led to a insignificant or possibly significantly adverse change to mortality and damage to living habitat relative to the baseline in the GOA.

This policy could lead to improved benthic community diversity and geographic diversity of impacts. Analysis of specific management measures in the Bering Sea indicated some improvement in the geographic diversity of impacts. Large expanses of high fishing intensity could still remain open in the Bering Sea, but there is at least one closure area that covers a portion of a high fishing intensity area, providing some improvement in the geographic diversity of impacts. In the Aleutian Islands, some closure areas bisect apparent historic clusters of fishing patterns, thus providing a diversity of impacts for the habitat being fished. In the GOA, closures also often encompass clusters of historically high fishing intensity, leaving little diversity or contrast of fishing intensity and thus leading to no improvement over the baseline.

From a cumulative impacts perspective, the baseline condition is adversely impacted due to historical impacts that have potentially caused long-term and possibly irreversible loss of living habitat, especially to long-lived, slow-growing species which are slow to recover. Although some benefits accrue to habitat within the proposed MPAs in FMP 3.2, impacts from fishing are not totally eliminated, and TAC/effort is likely to remain high. While there is an incremental expansion of no-take MPAs, the closures analyzed under this FMP 3.2 are not refined and may not be effective at preventing mortality or protecting benthic community structure. However, if properly designed and located, future closures could provide successful mitigation of the effects of fishing and, over time, adversely impacted habitat could recover. The cumulative impact predicted for this alternative is a split rating of conditionally significant adverse/conditionally significant beneficial. The adverse state of the baseline condition particularly with regard to slow-growing species would continue the cumulative adverse impact, however the alternative has the potential to provide mitigative benefits to affected habitat.

Overall, this policy has the potential to reduce and avoid impacts to habitat by careful placement of closures. Placement of closures in lightly fished or not fished areas could result in avoidance of future habitat impacts, if effort expands to new or lightly fished areas. Placement of small closures within heavily fished areas can potentially mitigate impacts, reduce unintended consequences, and achieve overall benefits to habitat and meet policy goals and objectives. Strategic placement of small closures will also help meet the policy objective of evaluating the efficacy of MPAs and implementation of a research program to evaluate impacts of gear. In the long-term, scientific information gained from this policy can potentially lead to modification of the placement of MPAs and help meet the policy objective to assess the necessary and appropriate habitat protection measures.

4.10.4.7 Address Allocation Issues

This policy would seek to accelerate the existing precautionary management measures through community or rights-based management and ecosystem-based management principles. Under this approach, additional conservation and management measures would be taken as necessary to respond to social, economic or conservation needs, or if scientific evidence indicated that the fishery was negatively impacting the environment. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	**Management Measure**
Goals • Accelerate precautionary management measures through community rights-based management • Take into account NAS Sustainable Fisheries policy recommendations • Provide socially and economically viable fisheries and fishing communities	Gear Restrictions and Allocations	Allocate by gear for certain directed fisheries
Objectives • Provide economic and community stability to harvesting and processing sectors through fair allocation of fishery resources • Maintain LLP program and further decrease excess fishing capacity and other adverse effects of the race-for-fish by eliminating latent licences and extending programs such as community or rights-based management to some or all groundfish fisheries • Provide for adaptive management by periodically evaluating the effectiveness of rationalization programs and the allocation of property rights based on performance • Extend the cost recovery program to all rationalized groundfish fisheries to support fishery management	Overcapacity	LLP program for groundfish fisheries Procedures and development of rights-based management programs for the groundfish fisheries, to include community quota programs or other community protections

Impacts of Policy

Alternative 3 promotes increased social and economic benefits through the promotion of rights-based allocations to individuals, sectors and communities. In addition, this alternative promotes ecosystem-based management which could increase the specificity of the species reporting, could increase the areas in which fishing is restricted, and places additional emphasis on the reduction on bycatch. For that reason this policy alternative has the potential to increase non-market value and the benefits derived from recreational, subsistence and tourism activities related to the BSAI and GOA marine ecosystems. See Section 3.9.8 and Section 4.10.4.3 for additional information on ecosystem values.

As the race-for-fish is eliminated, the alternative could result in positive effects in terms of producer net revenue, consumer benefits, and participant health and safety. For additional information on the effects of the race-for-fish and rights-based management see the Overcapacity qualitative analysis paper in Appendix F-8. The policy provides economic stability to fishery participants and communities by maintaining current allocation percentages to sectors. However, the elimination of the race-for-fish will likely result in a decrease in overall participation levels. In the long-run, communities are likely to see fewer persons employed in jobs related to the fishing industry (fishing, processing, or support sectors), but the jobs that remain could be more stable and provide higher pay.

With an end to the race-for-fish and implementation of rights-based allocations, participants are expected to be better able to adapt to the additional restrictions placed on the fishery because of increased emphasis on ecosystem management. To the extent participants are able to adapt, the rights-based allocations within the alternative are expected to decrease the number of direct participants and activities of support industries, Remaining participants however, are likely to have increased stability and incomes. The alternative's promotion of rights-based allocations is also expected to increase consumer benefits and health and safety of participants. Additionally, because the disincentives for bycatch reduction inherent in the race-for-fish are reduced, the alternative could reduce bycatch, even if additional bycatch regulations are not imposed.

It is not possible to determine the long-term effect on overall ecosystem value because it is not known whether the fishing sectors, even with rights-based allocations, will be able to able to fully adapt to the changes resulting from the increased emphasis on ecosystem tools, in particular the additional number and significance of closed areas. If the fishing sectors are unable to fully adapt to the additional restrictions, it is likely that commercial benefits from the fishery could decrease and could offset expected gains in non-market values, and subsistence, recreational, and tourism benefits.

The alternative also promotes more adaptive management and would very likely provide additional economic data as well as additional management funding through a cost recovery program. The additional funding could help to offset increases in management costs that could occur with additional closed areas and data collection requirements and the monitoring and enforcement of rights-based management. The collection of additional economic data could be critical in the development and eventual acceptance of additional ecosystem regulations. Regulations such as bycatch restrictions and the creation of MPAs have the potential to have negative effects at least in the short-term on industry participants; if additional data can reduce the uncertainty of social and economics effects associated with these types of restrictions, then it may increase the probability that these regulations could be approved and implemented. See the Data and Reporting Requirements qualitative analysis paper in Appendix F-11 for additional information the benefits of additional socioeconomic data.

4.10.4.8 Increase Alaska Native Consultation

The Alternative 3 policy sets objectives to increase Alaska Native consultation, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Objectives • Continue to incorporate Traditional Knowledge in fishery management • Consider ways to enhance collection of Traditional Knowledge from communities, and incorporate such knowledge in fishery management where appropriate • Increase Alaska Native participation and consultation in fishery management	Alaska Native Issues	Develop and implement procedures to incorporate Traditional Knowledge into fisheries management/ do Traditional Knowledge research
		Increase consultation with Alaska Natives
		Encourage increased participation/ representation of Alaska Natives in fishery management
		Allow for subsistence uses consistent with Federal law

Impacts of Policy

Under Alternative 3, there would be some changes to current management policies and measures used by NOAA Fisheries and the NPFMC regarding Alaska Native consultation. These changes increase efforts to collect Traditional Knowledge, and develop and implement measures to incorporate it into fishery management. NOAA Fisheries staff anthropologists would increase the collection of existing Traditional Knowledge, expand of an in-house Traditional Knowledge database, and continue informal consultation with individuals in Alaska Native communities. NOAA Fisheries and the NPFMC would work with Alaska Natives to evaluate and develop measures to incorporate Traditional Knowledge. Formal consultation with federally recognized tribal governments during NEPA compliance under EO 13175 would also continue at current levels during NEPA scoping activities and public comment periods on draft NEPA documents, but other forms of consultation would also be considered. Similarly, opportunities for Alaska Native participation in NEPA compliance and NPFMC deliberations would continue to be available during NEPA scoping, public comment periods on draft NEPA documents, review of NPFMC documents, and at NPFMC meetings. However, other forms of outreach and information exchange would be considered to increase participation.

Increased participation and representation of Alaska Natives in fishery management would be encouraged under Alternative 3. NOAA Fisheries and the NPFMC would work with Alaskan Natives to identify and develop measures that would increase participation and representation in fishery management.

Under Alternative 3, Alaskan Native participation in the fisheries will be affected by rationalization of fisheries and closure of areas to fishing. CDQ groups fishing in the BSAI would continue to benefit from rationalization. Non-CDQ Alaskan Native participants in the GOA would also benefit from rationalization of fisheries, although these benefits could be offset by closures of areas currently fished by smaller vessels. Benefits to Alaskan Native communities would be mixed, with CDQ communities receiving increased revenues, while on-CDQ Native communities could experience a reduction in employment and support services due to rationalization of fisheries.

Reduced levels of salmon bycatch and additional area closures could benefit subsistence harvest of Steller sea lion and salmon in western Alaska, although cumulative effects have a greater influence on the availability of both subsistence resources. The potential for Environmental Justice impacts as a result of this alternative would be limited to any adverse effects of rationalization on non-CDQ Alaskan Native communities.

Under Alternative 3, subsistence uses would continue consistent with federal law. Joint production of subsistence resources, where Alaska Natives who participate in groundfish fishing take advantage of their commercial fishing efforts to harvest subsistence resources, would continue at current levels, except where closure of fishing areas in the GOA could adversely affect joint production.

4.10.4.9 Improve Data Quality, Monitoring and Enforcement

Alternative 3 accelerates precautionary management of the groundfish fisheries. The policy sets goals and objectives to address data quality, monitoring, and enforcement, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Base management on the best scientific information available Objectives • Increase the utility of groundfish fishery observer data for the conservation and management of living marine resources • Improve Groundfish Observer Program, and consider ways to address the disproportionate costs associated with the current funding mechanism • Improve community and regional economic impact assessments through increased data reporting requirements • Increase the quality of monitoring data through improved technological means • Establish a coordinated, long-term ecosystem monitoring program to collect baseline information and compile existing information from a variety of ongoing research initiatives • Adopt the recommended research plan included in this document • Cooperate with research institutions such as the NPRB in identifying research priorities to address pressing fishery issues	Observer Program	Fixed 0/30/100% / 0/100/100% Observer Program coverage, scientifically based; 100/200% for AFA. and CDQ
		Address conflict of interest in funding
		Improve observer data, develop uncertainty estimates
	Data and Reporting Requirements	Require broader range of economic data from industry participants, verified through third party
		Require appropriate scales
		Require VMS for Steller sea lion prey species / Steller sea lion prey species and all vessels > 125 ft; modify to incorporate new technology and system providers

Impacts of Policy

The goal of Alternative 3, as with all the alternatives, is to base fishery management on the best scientific information available. The objectives specific to Alternative 3 are to increase the utility of observer data, and to improve the Observer Program; to improve economic impact assessments by changing data reporting requirements; to utilize advances in technology to improve the quality of monitoring data; to establish an ecosystem monitoring program; to adopt a plan for research priorities, and to work with research institutions to get these priorities addressed.

The Observer Program objective would be implemented through management measures that would either maintain or expand existing coverage but allow more flexible deployment of observers; improve observer data, including development of uncertainty estimates; and address the conflict of interest in funding. Building more flexibility into observer deployment, so that coverage can be adjusted rapidly to respond to monitoring needs for data or compliance, would be beneficial and was an original intent of the Research Plan that preceded the interim Service Delivery Model program currently in place (for further historical description, see the Observer Program paper in Appendix F-10). Merely expanding coverage from 30 percent to 100 percent on the 60 to 125 ft LOA component of the fleet, would provide more data on those vessels but would leave other issues, such as flexibility of observer placement and the lack of observer coverage on vessels less than 60 ft LOA, unaddressed.

Implementing improvements to observer data under Alternative 3 is accomplished through measures addressing observer sampling stations, the level of species identification in observer samples, and uncertainty estimates. Historically, observers have identified only fish that are managed to the species level; however, the Observer Program has responded to requests to further identify other organisms, most recently skates, sculpins, and some coral species. The program must maintain a balance in consideration of the amount of time to teach identification and to record these species in the field, so as not to sacrifice target species data. A pilot project to determine the recording time required in the field is currently underway, with the goal of understanding the cost-benefit relationships of increasing the specificity of identification. This program would be expanded under Alternative 3. Regarding the setting of uncertainty estimates, currently there are no established confidence intervals for observer data. A 1997 analysis has indicated, however, that while statistical procedures may be appropriate for the most abundant species in the catch, the statistical precision decreased for rarer species, and the adoption of statistical estimators may need to be paralleled with an increase in the current level of observer coverage and the amount of hauls sampled (for further discussion, see the Observer Program paper in Appendix F-10).

The Observer Program funding issue stems from the appearance of a conflict of interest arising from the direct financial relationship between the observer's employer and industry. Alternative 3 changes the funding mechanism in order to alleviate any taint on the credibility of observer data, and proposes a range of solutions that include full federal funding, industry fee-based funding and setting aside a portion of TAC (for further discussion, see the Observer Program paper in Appendix F-10).

The implementation of changes to the data and reporting requirements expands the range of economic data requested from industry participants, and potentially sets up a third party verification system for reported data. New information would include data on employment, variable harvesting and processing costs, and fixed/annual costs (see Appendix F-11, the Data and Reporting Requirements paper, for further discussion). This additional information would enhance the ability of analysts to provide accurate estimates of the costs and benefits of proposed regulatory actions. Additionally, third party data collectors would be able to verify revenue data currently submitted. While authenticated data would allow for more accurate and credible economic impact assessments, a funding source would need to be identified to support the independent verification system.

The use of available technology to improve monitoring data is implemented through the requirements for appropriate scales and for VMS requirements to be potentially extended to all vessels over 125 ft LOA. The requirement for scales would not create any immediate change; however, should VMS be required aboard vessels that are not already so equipped, this would impose a cost on those vessels in terms of installation, maintenance, and transmission costs. Additionally, new VMS technology and system providers will be explored, which may lead to a reduction in costs or improvements in technology and usage.

Establishing an effective ecosystem monitoring plan would accelerate precautionary management by providing an appropriate baseline against which to measure the impacts of fishing. Various ongoing research initiatives would contribute to this program, and new areas of research would be identified. The results would be compiled into a comprehensive monitoring plan. Funding for such a program would need to be identified, but the results would be a beneficial step in understanding the ecosystem impacts of fishery interactions.

Alternative 3 also adopts the recommended research plan included in Chapter 5 of this document, which identifies data gaps and research needs. Alternative 3 expands research efforts by seeking out partners, such as the North Pacific Research Board, to fund research on these data needs.

The Alternative 3 data quality, monitoring, and enforcement objectives conform with the overall policy intent of the alternative, namely to accelerate precautionary management in two ways: where appropriate, to take steps to incorporate uncertainty and ecosystem considerations into fishery management, and at the same time, to increase efforts to improve scientific understanding and diminish uncertainty. The objectives in Alternative 3 result in data collection on direct fishery impacts and interactions as well as on broader ecosystem relationships and indirect effects.

4.10.5 Analysis of Alternative 4

Alternative 4 consists of a management approach statement and a set of policy objectives. The management approach statement provides the key to the underlying rationale and assumptions for the policy, along with policy goals and additional guidelines for the policy.

The management approach statement for Alternative 4 represents an extremely precautionary approach to managing fisheries under scientific uncertainty, in which the burden of proof is shifted from a demonstration of adverse environmental impact to prohibit or proscribe a fishery to a demonstration of no adverse impact to authorize one. The management approach statement is summarized in Table 4.10-3. This policy is based on the assumption that fishing does produce adverse impacts on the environment but due to lack of information and uncertainty, we know little about these impacts.

The Alternative 4 management approach statement also provides further guidance about NPFMC management decisions:

- Management decisions assume that science cannot eliminate uncertainty and that action must be taken in the face of large uncertainties, guided by policy priorities and the strict interpretation of the precautionary principle.

- Management decisions will involve and be responsive to the public but decrease emphasis on industry and community concerns.

As well as the effects of the policy:

- The strategy will result in a number of significant changes to the FMPs that will significantly curtail the groundfish fisheries until more information is known about the frequency and intensity of fishery impacts upon the environment.

- Once more is known about fishery effects on the ecosystem, scientific information will be used to modify and relax the precautionary measures initially adopted.

A summary of the impacts of Alternative 4 follows below in Section 4.10.5.1. In the remainder of Section 4.10.5, the impacts of the alternative are analyzed in detail, in relation to eight policy subheadings: prevent overfishing, preserve food web, reduce and avoid bycatch, avoid impacts to seabirds and marine mammals, reduce and avoid impacts to habitat, allocation issues, increase Alaska Native consultation, and data quality, monitoring, and enforcement. For each subheading, the impacts of the relevant goals and objectives from the management approach are analyzed, using as a guideline the range of implementing management measures for Alternative 4, identified in Section 4.2, and analyzed in Section 4.7.

4.10.5.1 Summary of Alternative 4

The key policy element that influences impacts under Alternative 4 is the shift of the burden of proof to the user of the resource to demonstrate that the intended use will not have a detrimental effect on the environment, which raises the standard of justification required for fishery management actions. Key management objectives that implement this approach are: reduce the ABCs, and in turn the TACs, or consider temporarily suspending the fisheries, to account for uncertainty; institute extensive closure areas (resulting in the closure of traditional fishing areas and an increased emphasis on non-consumptive values); phase out fisheries with greater than 25 percent incidental catch and bycatch rates; develop a Fisheries Ecosystem Plan; and increase data collection and monitoring (in order to fill in data gaps and adjust restrictive measures as appropriate).

Predictions about the impacts under this alternative are difficult due to the uncertainty involved in defining ecosystem management and predicting the impacts of protecting areas. The emphasis is on instituting protective measures, particularly focusing on less abundant or economically valuable species, while at the same time imposing extensive monitoring and data-gathering to increase understanding of fishery impacts.

Alternative 4 establishes a very conservative harvest policy which is likely to prevent overfishing and reduce the chance that stocks would become overfished. Constraints to commercial harvest coupled with systems of closed areas would effectively reduce impacts from the race-for-fish and therefore from spatial/temporal concentration of catch. Catch monitoring would also increase under this alternative, resulting in more complete fisheries data. As with Alternative 3, this alternative would define criteria for determining the status of all managed stocks relative to an overfished condition in order to better satisfy the requirements of the National Standard 1 Guidelines. In the long-term, this alternative would protect the most vulnerable species of the complex, but the resulting management of many stocks with low biomass would be difficult to implement.

This alternative is very successful in meeting the goal of preserving the food web, by providing large buffers against scientific uncertainty about ecosystem impacts resulting from fishing. The assumption that the present level of scientific information is insufficient to manage fisheries without excessive risk to the ecosystem results in the implementation of highly precautionary measures. This strategy provides improvements over the baseline and achieves protection of virtually all food web components and thus ecosystem functions. Although the alternative is successful in producing a food web that is less influenced by fishing activity, predictions about the abundance changes of individual food web components that might result are uncertain due to the difficulty in accurately predicting predator-prey relationships.

The bycatch and incidental catch reduction policies under Alternative 4 are effective. Reduced bycatch and incidental catch would be achieved through extreme reductions in target groundfish catch and strong bycatch and incidental catch limits.

Alternative 4 is very successful at avoiding impacts to seabirds and marine mammals through its specific objectives to protect all seabirds from fishing interactions, and extending protection measures for Steller sea lion critical habitat and prey base. This largely increased level of protection provides a substantial buffer against uncertainty with regards to protection of marine mammals and seabirds.

The emphasis of the Alternative 4 policy on habitat provides large buffers against scientific uncertainty about the impacts of fishing on habitat. The combination of highly precautionary measures associated with increasing marine reserves and other closure areas will likely achieve protection and avoidance of impacts to habitat. Cumulatively, the alternative has a split rating, as the existing adverse condition of the baseline includes damage to slow-growing species unlikely to recover within the time period predicted in this analysis, however this alternative provides strong protection for habitat and potential for mitigation.

The Alternative 4 goals of incorporating and enhancing non-consumptive use values are met but at the expense of commercial value and potentially the continued viability of coastal communities. The precautionary policies in Alternative 4 could result in substantial reductions in allowable catches and could also result in the closure of large portions of traditional fishing areas. The alternative is likely to result in a substantial increase in the non-market values of the ecosystem, but is also likely to result in a substantial decrease in efficiency, net revenues, and the number of participants in the fisheries.

Alternative 4 would directly involve Alaska Natives in fishery management through the development of co-management or cooperative research programs. Consultation and participation objectives would focus on subsistence uses and cultural values of living marine resources. However, other goals and objectives in Alternative 4, that greatly reduce or eliminate commercial fishing, would adversely impact Native communities, including CDQ communities, through the loss of employment, economic activity, and community revenues.

Alternative 4 expands research and monitoring programs to obtain information necessary to fulfill the requirements of this alternative. The policy objectives are successful in increasing fisheries data by expanding the Observer Program to full coverage for vessels over 60 ft LOA, and instituting 30 percent coverage on smaller boats. Additionally, the requirements to improve the accuracy of data through technological means such as at-sea scales and VMS will improve monitoring and enforcement under this alternative.

4.10.5.2 Prevent Overfishing

This policy represents an extremely precautionary approach to managing fisheries under scientific uncertainty. It shifts the burden of proof to the user of the resource and the agency to demonstrate that the intended use would not have a detrimental effect on the environment. It would involve a strict interpretation of the precautionary principle. Management discussions would involve and be responsive to the public, but would decrease emphasis on industry and community concerns in favor of ecosystem processes and principles. This policy assumes that fishing does produce adverse impacts on the environment, but due to a lack of information and uncertainty, we know little about these impacts. The initial restrictive and precautionary conservation and management measures would be modified or relaxed when additional, reliable scientific information becomes available.

A detailed description of FMP 4.1 and FMP 4.2 appears in Section 4.2. FMP 4.1 illustrates a Fishery Management Plan where current levels of fishing are reduced and other precautionary restrictions are implemented until scientific research shows that the fisheries have no adverse effect on the resource and its environment. FMP 4.2 suspends all fishing until fisheries can be shown to have no adverse effect on the resource and its environment

Accordingly, FMP 4.1 would substantially reduce the impacts of the fishery. A modified TAC-setting process would create a more substantial buffer between ABC for selected species. and the OFL by setting the fishing mortality rate at $F_{75\%}$ for all Steller sea lion prey species (pollock, Pacific cod and Atka mackerel) and for rockfish (as long-lived, slow-growing species). Also, the *max* F_{ABC} for each stock or stock complex in Tiers 1-5 would be adjusted downward as a function of uncertainty in the biomass survey estimate for that stock or stock complex.

Under FMP 4.1, OY would be specified separately for each stock or stock complex rather than for the groundfish complex as a whole, and would be set equal to the respective TAC. The current precautionary practice of setting TAC less than or equal to ABC would be formalized in the FMP. For species managed as members of a stock complex, rather than setting TAC as the aggregate of the individual members' ABCs, the max_{ABC} value for each component stock would be determined and the TAC set equal to the lowest value. Where sufficient biological information is available, such as with EBS pollock, TAC would be distributed on a smaller spatial scale. Minimum stock size thresholds would be determined for all tiers.

To further mitigate the possibility of detrimental biological and environmental impact, 20 to 50 percent of the management area would be designated as no-take marine reserves (i.e., no commercial fishing) covering the full range of marine habitats within the 1,000 m bathymetric line (see Figure 4.2-6). As part of this area in the Aleutian Islands, a Special Management Area would be established to protect coral and other live bottom habitats. This area would also include spawning reserve areas for intensively fished species. Comprehensive trawl exclusion zones would be set to protect all Steller sea lion critical habitat, and trawling itself would be restricted to only those fisheries that cannot be prosecuted with other gear types (i.e, the flatfish fisheries.)

In an effort to reduce waste and the risk of adverse impact to the environment, existing PSC limits would be reduced by half under this bookend, as would bycatch and discard rates. IR/IU would be extended to all target species. Stringent PSC limits would be set for salmon, crab and herring in the GOA, and as information becomes available, bycatch limits would be set for non-target species also. Protection measures would be set for all seabird species.

As this policy alternative necessitates greater research and data-gathering efforts, FMP 4.1 would expand observer coverage to 100 percent for all vessels over 60 ft LOA and require 30 percent observer coverage on vessels presently exempted from observer coverage (i.e., vessels under 60 ft LOA). VMS would be made mandatory for all groundfish vessels, as would motion-compensated scales for weighing all catches at sea or at shore-based processors. Cooperative research and data-gathering programs would be initiated as well to expand the use of Traditional Knowledge in fisheries management.

FMP 4.2 extrapolates the precautionary principles of Alternative 4 by suspending all fishing until the fisheries can be shown to have no adverse effect on the resource and its environment. The TAC for all species would be set at zero. All areas of the EEZ (3 to 200 nautical miles) would be closed to all fishing (e.g. commercial, recreational, and subsistence) (see Figure 4.2-7). Bycatch and incidental catch, as well as the take of seabirds and marine mammals, would then necessarily be reduced to zero. Scientific research and data-gathering efforts would continue. When a fishery can be shown to pose no significant threat of adverse biological and environmental impacts, or if adverse effects can be successfully mitigated through use of fishery-specific regulations, the measures illustrated by this FMP would be relaxed to allow fishing to resume.

Under the FMP 4.2 illustration, we have assumed that each groundfish fishery currently conducted within the EEZ in the BSAI and GOA would be individually reviewed by the NPFMC and NOAA Fisheries. Upon completion of this review (up to 2 years), the agency would certify those fisheries that are found to have no significantly adverse impacts on the environment and authorize fishing under a specific set of regulations. If a fishery is found by this review to produce significantly adverse environmental effects, and mitigation measures cannot be designed to mitigate those effects, that fishery would not be certified and would remain closed until more scientific information is known.

Impacts of Policy

The harvest policies in Alternative 4 as illustrated by FMP 4.1 are consistent with ecosystem principles that call for in-season multi-species catch monitoring to ensure that catch does not exceed the OFL of groundfish. This catch monitoring is facilitated by at-sea observers, port samplers, weekly production reports, and fish ticket information (Appendix F-10). For several stocks managed in Tiers 4-6, direct and indirect impacts analyses reflect a shift away from unknown to insignificant. This change is possible because Alternative 4 requires that status criteria be established for stocks managed in these tiers. Cumulative effects considerations do not change the impact rankings for target stocks.

Goals, Objectives	Corresponding Management Measures	
<u>Goals</u> • Establish a fishery conservation and management program to maintain ecological relationships among exploited, dependent and related species as well as ecosystem processes that sustain them • Adopt an extremely precautionary approach to managing fisheries under scientific uncertainty • Shift the burden of proof to the user of the resource and the agency to demonstrate that the intended use would not have a detrimental effect on the environment <u>Objectives</u> • Prevent overfishing by transitioning from single-species to ecosystem-oriented management of fishing activities • Protect the productivity and genetic diversity of groundfish	Example Range: TAC ≤ABC≤OFL, formal adjustments for uncertainty, automatic rebuilding, specific harvest policies for rockfish	Quota management based on a tier system. Revised procedures to set ABC, TAC including precautionary fishing mortality rates for individual species and species complexes. For example purposes only, F_{ABC} for Tier 3 rockfish stocks would be set at $F_{750\%}$, F_{ABC} for Atka mackerel, BSAI and GOA Pacific cod, and BSAI and GOA pollock would be set equal to $F_{75\%}$. Uncertainty corrections based on the lower 90% confidence limits of the survey biomass indices would be applied to F_{ABC}.
	Time/Area	Spatial/temporal distribution of TAC on a smaller scale. These policies reduce the possibility of spatial temporal concentration of the catch. FMPs 4.1, and 4.2 create large marine reserves and marine protected areas. FMP 4.1 closes 20-50% of known spawning areas of target species across the range of the stock.
	Gear restrictions	For walleye pollock, Pacific cod, and sablefish, gear allocations partition catch to specific gear groups. Differences in gear selectivity are addressed in the stock assessment models and quotas reflect the expected age distribution of the catch by gear.
	OY caps	Under FMPs 4.1 and 4.2 Optimum Yield caps for the GOA and BSAI would be set at the sum of the ABCs for the GOA and BSAI.
	Inseason Multi-species TAC and ABC monitoring	The catch of a given target species is limited by prohibited species bycatch caps and the TACs for other groundfish. The halibut bycatch caps serve as a constraint to BSAI and GOA flatfish expansion. Reduced bycatch allowances would further constrain target fisheries. Procedures to break-out species from existing managed categories would be phased in.

The bookends provide a range of potential impacts associated with this alternative. Several management measures associated with FMP 4.2 would close all commercial fisheries in the short-term. Several constraints to commercial fisheries are imposed under FMP 4.1. First, an uncertainty correction would be applied that would account for measurement in the survey biomass estimates. Second, the F_{ABC} for Steller sea lion prey species and rockfish species would be set at $F_{75\%}$. Third, FMP 4.1 would impose a 30-60 percent reduction in bycatch. Fourth, FMP 4.2 would set the ABC for species managed as a complex equal to the lowest single species ABC for members of the complex. Finally, procedures for breaking species out of the other species complex would be established. Direct and indirect impacts analyses revealed that overfishing did not occur in the 38 stocks or stock complexes modeled under FMP 4.1 or FMP 4.2 (Table 4.10-2a). Relative to the comparative baseline, the expected fishing mortality under Alternative 4 would have no significant impact on any of the target groundfish stocks.

Relative to the comparative baseline, the likelihood of a stock falling below the level where the stock is capable of producing MSY is reduced under Alternative 4. Irreversible or long-term adverse effects on fishery resources are avoided by extremely precautionary harvest policies, and imposition of rebuilding regulations when stocks fall below the level capable of producing MSY. Under FMP 4.1 and FMP 4.2, none of the stocks managed in Tiers 1-3 would be expected to become overfished (Table 4.8-1). Adoption of FMP 4.1 would have a significantly beneficial impact on the ability of the stock to maintain itself above an overfished condition for BSAI Pacific cod, BSAI/GOA sablefish, BSAI Atka mackerel and BSAI Pacific ocean perch. Adoption of FMP 4.2 would have a significantly beneficial impact on the ability of the stock to maintain itself above an overfished condition for EBS pollock, BSAI and GOA Pacific cod, BSAI/GOA sablefish, BSAI Atka mackerel, and BSAI Pacific ocean perch. The direct and indirect impacts of Alternative 4 on Tiers 1-3 target groundfish stocks other than those mentioned above would be insignificant relative to the baseline (Table 4.8-1). With the exception of GOA Atka mackerel, the direct and indirect impacts of commercial fishing on the biomass of target groundfish stocks managed in Tiers 4-6 are considered insignificant because fisheries removals are constrained to very low levels (Table 4.8-1).

Relative to the comparative baseline, Alternative 4 adds several spatial/temporal restrictions on catch. These restrictions would decrease the spatial/temporal concentration of the catch. The direct and indirect impacts of spatial temporal concentration of the catch under Alternative 4 are unknown for GOA Atka mackerel. With the exception of GOA Atka mackerel, the direct and indirect impacts of commercial fishing on the genetic structure of the stock are considered insignificant (Table 4.8-1). Direct and indirect impacts of spatial temporal concentration of the catch on reproductive success are insignificant for most stocks or stock complexes. Significantly beneficial impacts of spatial temporal concentration of the catch on the reproductive success of BSAI Atka mackerel and BSAI Pacific ocean perch are expected.

Relative to the comparative baseline, Alternative 4 would increase restrictions on the spatial temporal partitioning of catch and could reduce overall harvest of target groundfish. The direct and indirect impacts of these changes on prey availability and predation mortality are expected to be insignificant for all stocks managed in Tiers 1-3 (Table 4.8-1). Direct and indirect impacts of commercial fishing on prey availability and predation mortality of all stocks or stock complexes managed in Tiers 4-6 are unknown because the status of the stock relative to MSST are unknown (Table 4.8-1).

Harvest restrictions, spatial temporal constraints, and gear allocations all serve to mitigate the impact of commercial fishing on fish habitat. The closure system described in the FMP 4.1 would close approximately 19 percent of the EEZ to some form of MPA and designates approximately 11 percent of the EEZ as a no-take reserve (Figure 4.2-6). For the fishable area (depth to 1,000 m) of the EEZ, FMP 4.1 would designate approximately 29 percent of the fishable area as a no-take reserve and about 51 percent of the fishable area as some form of MPA. FMP 4.2 assumes 100 percent of the EEZ would be designated as a no-take reserve (Figure 4.2-7). Relative to the comparative baseline, the impacts on target species resulting from habitat disturbance are considered insignificant for 37 of 38 stocks (Table 4.10-2a).

When taken in aggregate, Alternative 4 appears to impose an extremely precautionary approach to managing fisheries under scientific uncertainty. The policy establishes a fishery conservation and management program to maintain ecological relationships among exploited, dependent, and related species, as well as ecosystem processes that sustain them. Strengths of Alternative 4 are that the FMPs will adopt formal criteria for status determination. MSSTs would be formally specified in the FMPs whenever possible under Alternative 4 bringing this policy into compliance with NOAA Fisheries guidelines for National Standard 1. Status criteria would be established for stocks managed in Tiers 4-6. The constraints to commercial harvest coupled with systems of closed areas would reduce the race-for-fish under Alternative 4 and would reduce the spatial temporal concentration of the catch. Setting ABCs for species managed in complexes at the lowest single species ABC for members of the complex would curtail the impact of fishing some target groundfish stocks managed in Tiers 4-6. A weakness of this policy is that treatment of species complexes for Alternative 4 could be administratively cumbersome and practically difficult to implement. A second weakness of this policy is that the increased closed areas envisioned under FMP 4.1 could restrict commercial harvests to a very limited region of the Aleutian Islands and GOA. A third weakness of Alternative 4 is that implementing requirements to establish status criteria for stocks managed in Tiers 4-6 would require a substantial increase in funds to support catch monitoring, enforcement, collection of and analysis of demographic information, and additional surveys.

4.10.5.3 Preserve Food Web

The Alternative 4 policy sets goals and objectives to preserve the food web, as well as recommending a range of management measures that would implement these objectives.

<table>
<tr><th rowspan="2">Goals, Objectives</th><th colspan="2">Corresponding Management Measures</th></tr>
<tr><th>FMP Component</th><th>Management Measure</th></tr>
<tr><td rowspan="4"><u>Goals</u>
• Establish a fishery conservation and management program to maintain ecological relationships among exploited, dependent and related species as well as ecosystem processes that sustain them
• Incorporate and apply strict ecosystem principles
• Address the impact of fishing on predator-prey and other important ecological relationships in the marine environment

<u>Objectives</u>
• Develop and implement a Fishery Ecosystem Plan through the modification or amendment of current FMPs
• Conserve native species and biological diversity at all relevant scales of genetic, species, and community interactions
• Reduce the ABC to account for uncertainty and ecological considerations for all exploited stocks, including genetic, life history, food web and habitat considerations
• Set fishing levels in a highly precautionary manner to preserve ecological relationships between exploited, dependent, and related species</td><td rowspan="4">TAC-setting Process</td><td>Prohibit directed fishery for forage fish</td></tr>
<tr><td>Set F_{75} for Steller sea lion prey species and for vulnerable (e.g., long-life, slow-growing) species</td></tr>
<tr><td>Procedures to incorporate precaution, survey variance and uncertainty into ABCs</td></tr>
<tr><td>Evaluate a range of ABCs using the lower bound of a confidence limit to address uncertainties in stock assessment advice</td></tr>
</table>

Impacts of Policy

Impacts to food webs of the BSAI and GOA are reduced through most of the goals and objectives and the related management measures of this FMP. In addition to the objectives of developing a Fisheries Ecosystem Plan, conserving native species and biological diversity at all scales, and implementing highly precautionary fishing levels to preserve ecological relationships are all viewed as positive benefits of this policy.

Alternative 4 goals and objectives, which include the prevention of overfishing, bycatch reduction, avoidance of impacts to seabirds, marine mammals, and habitat, and improvements in data quality and monitoring, are critical to the protection of all food web components, which include target and non-specified species, PSC species, HAPC biota, and marine mammals and seabirds. The following management measures in FMP 4.1 provide increased protection to a variety of important food web components, relative to the baseline: revised procedures to set ABC that include much more precautionary *F* rates than in the baseline, procedures to incorporate precaution into ABCs, and finer scale spatial temporal distribution of the TAC (Section 4.10.5.2); larger reductions in PSC limits and extension of IR/IU to all target species (Section 4.10.5.4); more precautionary *F* limits for Steller sea lion prey species and gear modifications and fishing methods to reduce incidental take of all ESA-listed seabirds or species of concern to levels approaching zero (Section 4.10.5.5); establishment of large amounts of no-take MPAs, special Aleutian Islands coral management area, and additional bottom trawling restrictions (Section 4.10.5.6); and expansion of the data quality and monitoring goals through expanded observer coverage, VMS for all groundfish vessels, and uncertainty estimate development for all stocks (Section 4.10.5.9). At the alternative's most stringent application in FMP 4.2, fisheries would not be prosecuted until scientific research could show there was no significant ecological impact. See the policy analysis in those sections for details on the level of protection provided by Alternative 4 to these individual components.

This alternative specifically incorporates ecosystem considerations into fishery management decisions through development of a Fisheries Ecosystem Plan and application of ecosystem principles by modification of ABC to take uncertainty and ecological factors into account. Analysis of the ecosystem effects of FMP 4.1 involved selection of alternatives that would show changes in key members or ecosystem characteristics that are important to the structure and function of marine food webs. Changes in pelagic forage, top predators, spatial/temporal availability of prey, exotic species introductions, energy removal and redirection through fishery catch removals and discarding and offal production, and various measures of diversity were evaluated with respect to the potential for fishing to cause changes sufficient to bring these attributes below population, community, or ecosystem thresholds, if such thresholds could be defined. Virtually all of these indicators showed a beneficial change relative to the comparative baseline, although the amount and direction of change that would actually occur is uncertain because of difficulties in accurately predicting predator/prey interactions. This alternative shows potential significant improvements in pelagic forage availability through its more precautionary *F* limits on walleye pollock and Atka mackerel and significant improvements in spatial/temporal availability of forage through the designation of areas open to fishing outside foraging areas of mammals. By its TAC rules based on the least abundant group member, this alternative removes the uncertainty about protection of sensitive species such as sharks and skates that are managed in groups. Qualitative analysis of the alternative with respect to the ecosystem effects of the TAC setting process (Appendix F-1) shows that its management measures have the potential to make large reductions in TACs of several species that are key food web members such as walleye pollock and Atka mackerel and protection of sensitive, slow growing species through least abundant member TAC rules. These provide protection to food webs that rely on these pelagic forage species and to species diversity.

This alternative is very successful in meeting the goal of preserving the food web through its objectives of reducing ABCs to take uncertainty and ecological considerations into account and to set fishing levels in a highly precautionary manner to preserve food web relationships. The emphasis in this alternative is on providing large buffers against scientific uncertainty about ecosystem impacts of fishing through much more stringent *F* levels for some species and closures of large amounts of areas to fishing. It assumes scientific information is not sufficient to manage fisheries without excessive risk to the ecosystem, and thus prescribes these more highly precautionary measures. This strategy provides improvements, most significantly beneficial, from the comparative baseline and likely achieves protection of virtually all food web components and thus ecosystem function.

4.10.5.4 Reduce and Avoid Bycatch

Several policy changes adopted in Alternative 4 would impact the bycatch and incidental catch or target and non-target species. At the extreme, bycatch and incidental catch of target and non-target species would be zero under FMP 4.2. FMP 4.1 imposes several constraints to fishing that would reduce bycatch and the incidental catch of target and non-target species in groundfish fisheries. FMP 4.1 would substantially reduce the impacts of the fishery through a modified TAC-setting process. This FMP would also impose constraints to incidental catch of species managed as members of a stock complex by setting conservative TACs for the complex. FMP 4.1 creates no-take marine reserves (i.e., no commercial fishing) that would serve as a refuge for non-target species (see Figure 4.2-6). In an effort to reduce waste and the risk of adverse impact to the environment, existing PSC limits and bycatch rates would be cut in half. IR/IU would be extended to all target species. FMP 4.1 would expand observer coverage to 100 percent for all vessels over 60 ft LOA and require 30 percent observer coverage on vessels presently exempted from observer coverage (i.e., vessels under 60 ft LOA). VMS would be made mandatory for all groundfish vessels, as would motion-compensated scales for weighing all catches at sea or at shore-based processors. Cooperative research and data-gathering programs would be initiated as well to expand the use of Traditional Knowledge in fisheries management.

Impacts of Policy

Alternative 4 is expected to encourage the development of practical measures that reduce bycatch and incidental catch of prohibited species, target species, other species, forage fish and non-specified species. Relative to the comparative baseline, the impacts of mortality and change in biomass associated with the Alternative 4 policy would be conditionally significant beneficial impacts due to changes in fishing mortality for prohibited species that are currently in a depressed or overfished condition (BSAI and GOA chinook salmon and BSAI other salmon, *C. bairdi* crab, *C. opilio* crab, BSAI and GOA red king crab, and BSAI blue king crab [Table 4.10-2a]). In addition, conditionally significant beneficial impacts due to changes in fishing mortality are anticipated for GOA other salmon. Conditionally significant beneficial impacts due to changes in biomass and habitat are anticipated for crab stocks that are currently in a depressed or overfished condition. The impact of Alternative 4 on forage fish mortality is insignificant. The impact of Alternative 4 on all other non-target or unspecified groups is unknown.

Alternative 4 as illustrated by FMP 4.1 indicates that BSAI flatfish fisheries may expand relative to the comparative baseline. This expansion results from reductions in trawl fisheries for Pacific cod and rockfish. This expansion may by constrained by the policy objective of phasing out fisheries with >25 percent incidental catch and bycatch rates. However, in the short - term species typically caught in fisheries that target flatfish may experience higher rates of incidental fishing mortality.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Implement measures that avoid or minimize bycatch Objectives • Include bycatch mortality in TAC accounting and improve the accuracy of mortality assessments for target, non-target and PSC bycatch, including unobserved mortality • Reduce bycatch, incidental catch and PSC limits (e.g., by 10%/ year for five years) • Phase out fisheries with >25% incidental catch and bycatch rates • Establish PSC limits for salmon, crab and herring in the GOA • Set stringent bycatch limits for vulnerable non-target species based on best available information • Protect habitat and reduce bycatch, prohibit trawling in fisheries that can be prosecuted with more selective gear types and establish trawl closures areas	MPAs and EFH, Bycatch and Incidental Catch Restrictions, Gear Restrictions and Allocations	Establish gear closure areas and marine reserves to reduce and avoid bycatch
	Bycatch and Incidental Catch Restrictions	Reduce existing PSC limits for prohibited species, establish PSC limits for prohibited species other than halibut in the GOA
		Procedure to develop mortality rate-based approach to setting limits
		Extend retention standards for pollock and Pacific cod (IR/IU) to all target species
		Vessel incentive programs (VIP) and bycatch restrictions (including in-season)

Alternative 4 policies as illustrated by FMPs 4.1 and 4.2 are consistent with the goal of implementing measures that avoid or reduce bycatch. Alternative 4 policies are also consistent with the objectives of accounting for bycatch mortality in TAC accounting and improving the accuracy of mortality assessments for target, non-target and PSC bycatch, including unobserved mortality. Reduced bycatch and incidental catch would be achieved through extreme reductions in target groundfish catch and strong bycatch and incidental catch limits.

4.10.5.5 Avoid Impacts to Seabirds and Marine Mammals

The Alternative 4 policy sets objectives to avoid impacts to seabirds and marine mammals, as well as recommending a range of management measures that would implement these objectives.

Impacts of Policy

This alternative has objectives to set protection measures immediately for all seabird species; cooperate with USFWS to develop fishing methods that reduce seabird takes to levels approaching zero for all threatened, endangered, or USFWS species of management concern; initiate a joint research program with USFWS to evaluate populations of seabirds that interact with groundfish fisheries; and increase existing protection measures for Steller sea lions by further gear restrictions in critical habitat and more conservative harvest levels for key prey species. Management measures to accomplish these objectives include setting F_{75} for Steller sea lion prey species, continued prohibition of directed fishery for forage fish, comprehensive trawl exclusions zones to protected all designated Steller sea lion critical habitat, short-tailed albatross take restrictions, setting protection measures for all seabird species, and development of gear modifications and fishing methods to reduce incidental take of ESA-listed or seabird species of concern to levels approaching zero. Impacts of the alternative with respect to seabirds were evaluated with respect to the potential for fisheries to cause direct mortality through fishing gear and vessel strikes, changes in prey availability (including offal), and changes in benthic habitat that might affect certain prey species of seabirds. Impacts for marine mammals were evaluated with respect to the potential for fishery incidental take or entanglement in marine debris, harvest of prey species, spatial/temporal concentration of fishing on prey, and fishing vessel disturbance.

<table>
<tr><th rowspan="2">Goals, Objectives</th><th colspan="2">Corresponding Management Measures</th></tr>
<tr><th>FMP Component</th><th>Management Measure</th></tr>
<tr><td rowspan="6"><u>Objectives</u>
• Set protection measures immediately for all seabird species and cooperate with USFWS to develop fishing methods that reduce incidental takes to levels approaching zero for all threatened or endangered species and for USFWS' list of species of management concern
• Initiate joint research program with USFWS to evaluate current population estimates for all seabird species that interact with the groundfish fisheries and modify protection measures based on research findings
• Increase existing protection measures for ESA-listed Steller sea lions by further restricting gear in critical habitat and setting more conservative harvest levels for prey base species</td><td>TAC-setting Process, Steller sea lion Measures</td><td>Set F_{75} for Steller sea lion prey species</td></tr>
<tr><td>TAC-setting Process</td><td>Prohibit directed fishery for forage fish</td></tr>
<tr><td>MPAs and EFH, Steller sea lion Measures, Gear Restrictions and Allocations</td><td>Comprehensive trawl exclusion zones to protect all designated Steller sea lion critical habitat</td></tr>
<tr><td rowspan="3">Seabird Measures</td><td>Short-tailed albatross take restrictions</td></tr>
<tr><td>Set protection measures for all seabird species</td></tr>
<tr><td>Develop gear modifications and fishing methods that reduce incidental take for all ESA-listed seabirds or other species of concern to levels approaching zero</td></tr>
</table>

Qualitative analysis of the Steller sea lion protection measures and other policies of this alternative (Appendix F-4) found that the policies and measures provided large buffers against uncertainty and would provide substantially more certainty of marine mammal protection. Quantitative indicators showed that Alternative 4 provides significantly beneficial population level effects on Steller sea lions and potential improvements for northern fur seal and harbor seals due to increases in prey abundance and availability, although the amount and direction of change that would actually occur is uncertain because of difficulties in accurately predicting predator/prey interactions.

Although some piscivorous bird species such as glaucous-winged gulls might be gaining food subsidies from discards and offal in the baseline, other piscivorous birds would be negatively impacted by competitive interactions with gulls, thus offsetting any changes for the piscivorous bird group as a whole that might occur in this alternative. Incidental take of albatross, fulmars, shearwaters, and gulls would be greatly reduced from the baseline due to new mitigation measures and greatly reduced fishing effort for both the longline and trawl fleets. The risk of exceeding ESA-threshold mortality of short-tailed albatross would be greatly reduced from the baseline levels. The qualitative analysis paper entitled Seabird Protection Measures (Appendix F-6) noted that the Observer Program would be expanded under this alternative to cover all of the groundfish fleet and would play a vital role in seabird/fishery interaction research. As in Alternatives 1 and 3, this alternative is not expected to have any population level effects on seabird species through mortality, changes in food availability, or benthic habitat. Thus, this alternative provides much more protection to seabirds and marine mammals relative to the baseline, even though baseline determinations showed no serious adverse impacts of the groundfish fishery on these populations.

This alternative is very successful at avoiding impacts to seabirds and marine mammals by setting protection measures immediately for all seabirds, implementing further gear restrictions in critical habitat of Steller sea lions and setting more conservative harvest levels for Steller sea lion prey. This largely increased level of protection provides a substantial buffer against uncertainty with respect to protection of marine mammals and seabirds.

4.10.5.6 Reduce and Avoid Impacts to Habitat

The Alternative 4 policy sets a goal and objectives to reduce and avoid impacts to habitat, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Address the impacts of fishing on habitat Objectives • Zone and delimit fishing gear use in the action area and establish no-take marine reserves (both pelagic and nearshore) encompassing 20-50% of management areas to conserve EFH, provide refuges from fishing, serve as experimental controls to test the effects of fisheries, protect genetic and biological diversity, and foster regeneration of depleted stocks in fished areas • Protect habitat and reduce bycatch, prohibit trawling in fisheries that can be prosecuted with more selective gear types and establish trawl closures areas • Manage fisheries in an explicitly adaptive manner to facilitate learning (including large no-take marine reserves that provide experimental controls) • Protect marine habitats, including EFH, HAPC, ESA-designated critical habitats and other identified habitat types • Commit to funding a comprehensive research plan in order to a provide baseline habitat atlas	MPAs and EFH	Establish 20-50% of management area as no take MPAs covering the full range of marine habitats
		Establish Aleutian Islands Special Management Area to protect coral/live bottom habitat
		Identify and designate EFH and HAPC
	Gear Restrictions and Allocations	Restrict bottom trawling for flatfish to specific areas

Impacts of Policy

Alternative 4 represents a fundamental change in the management of fisheries by presuming that the current groundfish fisheries are producing large-scale adverse effects on the marine ecosystem including habitat. Current levels of fishing are reduced and 20 to 50 percent of the management area would be designated as no-take marine reserves (i.e., no commercial fishing) within the 1,000 m bathymetric line. A Special Management Area would be established in the Aleutian Islands to protect coral and living habitat. Bottom trawling would be restricted to only those fisheries that cannot be prosecuted with other gear types (i.e, the flatfish fisheries). Given these management goals and associated measures, impacts to habitat are expected to be significantly reduced and possibly eliminated relative to comparative baseline levels.

Alternative 4 addresses impacts to habitat by the presumption that current groundfish fisheries are producing adverse effects to habitat. The institution of large scale no-take marine reserves, restrictions to trawling, and reduced TACs should accelerate habitat protection and will cause rapid reduction and avoidance of impacts to habitat. For short-lived biota with fast recovery rates, recovery from past effects could occur quickly. For other species of living substrates such as long-lived corals and perhaps some sponges, increases over comparative baseline levels may not occur or may occur only after many years.

Implementation of this policy will result in large scale geographical shifts in fishing efforts or no fishing at all. At its most stringent application fisheries would not be prosecuted until scientific research shows there would be no significant impacts. At its less stringent application, reductions in target species catches should over-ride any negative impacts due to geographic shifts in fishing effort and result in less overall impacts and overall benefits to habitat. The reduction in TAC associated with this policy could even negate the need for closed areas. This policy also calls for a commitment to funding a comprehensive research plan which should enable meeting the policy goal of addressing impacts to habitat, adapting management to facilitate learning, and responding to new information.

From a cumulative impacts perspective, the baseline condition is adversely impacted due to historical impacts that have potentially caused long-term and possibly irreversible loss of living habitat, especially to long-lived, slow-growing species which are slow to recover. While benefits, in terms of decreased mortality and protection of community structure, accrue due to the extensive reductions in TACs and reduction in bottom trawling, it is uncertain whether these benefits will sufficiently mitigate the accumulated adverse impacts in the baseline. The cumulative rating is split between conditionally significant adverse, due to the fact that the baseline is already considered to be impacted and additional impacts both internal and external, cannot be eliminated, and conditionally significant beneficial as the alternative has the potential to provide significant mitigative benefits to affected habitat.

The emphasis of this policy is on providing large buffers against scientific uncertainty about impacts of fishing on habitat. Under this alternative, current scientific information is presumed to be insufficient to manage fisheries without excessive risk to habitat. Overall prescription of the highly precautionary measures associated with this policy will likely achieve protection of and avoidance of impacts to habitat.

4.10.5.7 Address Allocation Issues

This policy represents a highly precautionary approach to managing fisheries under scientific uncertainty. It shifts the burden of proof to the user of the resource and the agency to demonstrate that the intended use would not have a detrimental effect on the environment. Management discussions would involve and be responsive to the public, but would decrease emphasis on industry and community concerns in favor of ecosystem processes and principles. When fishing is allowed the policy could place additional controls on the fisheries through bycatch restrictions, gear restrictions, additional time and area closures or other traditional management measures.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Include the use of explicit allocative or cooperative programs to reduce excess capacity and allocate fish to particular gear types and fisheries • Identify and incorporate non-consumptive use values Objectives • Reduce excess fishing capacity and employ equitable allocative or cooperative programs to end the race-for-fish, reduce waste, increase safety, and promote long-term sustainability and benefits to fishing communities • Consider non-consumptive use values	Gear Restrictions and Allocations	Allocate by gear for certain directed fisheries
	Overcapacity	LLP program for groundfish fisheries, additional procedures to reduce effort such as seasonal exclusive area registration
		Rights-based management programs for certain directed fisheries, and community quota programs
		Effort-limiting regulations, such as limits on trips, gear size, vessel size or horsepower

Impacts of Policy

The principle policy goals of the Alternative, namely the incorporation and the implied enhancement of non-consumptive ecosystem values appears to be largely met by the management measures. The achievement of this goal however, appears to be at the expense of commercial benefits to the fishing and processing industry, coastal communities dependent on fisheries, and seafood consumers.

The precautionary policies in Alternative 4 could result in substantial reductions in allowable catches and could also result in the closure of large portions of traditional fishing areas. In fisheries that are allowed to continue, the policy calls for imposition of additional bycatch and incidental catch restrictions, as well as additional time and area closures, and gear restrictions. Together these additional controls on effort could have a substantial negative consequence on efficiency and the ability of the industry to create profits. Overall, we are unable to determine the net effect of values generated from the ecosystem. The alternative is likely to result in a substantial decreases in the commercial value from the ecosystem, and in the extreme could affect the continued viability of fishing communities as well as fishing and processing sectors. At the same time the alternative would likely result in substantial increases in non-market values attributed to the ecosystem by the American public and could increase recreational and tourism values. Benefits to recreation and tourism, however, could also be negatively affected to extent that Alaskan coastal communities dependent on groundfish are also involved in recreation and tourism. Additional information on ecosystem values can be found in Section 3.9.8 and Section 4.10.5.7.

The alternative would likely increase the controls placed on the participants in terms of allowable gears, trip lengths, and fishing periods and allowable bycatch, and therefore would result in declines in harvesting and processing efficiency, and could substantially alter the current distribution of catches and processing among sectors and communities. This alternative could also substantially decrease the number of participants in the fishery, community revenues, monies to support industries. Health and safety factors of participants could worsen because of increased distance to open fishing area, but because of the reduction in participants overall numbers of injuries would likely decline. Management costs for this alternative could be higher than the comparative baseline for the fisheries that continue because of the increased number of regulations, but to the extent that fisheries are shut down, overall management costs could be reduced.

4.10.5.8 Increase Alaska Native Consultation

The Alternative 4 policy sets goals and objectives to increase Alaska Native consultation, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Objectives • Utilize Traditional Knowledge in fishery management, including monitoring and data-gathering capabilities, through co-management and cooperative research programs • Increase participation of and consultation with Alaska Native subsistence users and explicitly address the direct, indirect and cumulative fishery impacts on traditional subsistence uses and cultural values of living marine resources	Alaska Native Issues	Initiate cooperative research programs to enhance Traditional Knowledge in fishery management
		Increase consultation with and encourage participation of subsistence users (Native and non-Native)
		Provide for traditional Native subsistence uses within protected areas

Impacts of Policy

Under Alternative 4, Alaska Native participation and consultation in fishery management would increase. NOAA Fisheries and the NPFMC would utilize Traditional Knowledge in fishery management, including investigating Native involvement in monitoring and data-gathering capabilities. Opportunities for co-management and cooperative research would also be evaluated and implemented. Consultation with subsistence users would increase, and their participation in fishery management would be encouraged. Direct, indirect, and cumulative fishery impacts on subsistence would be explicitly addressed through consultation and co-management.

Increased participation and representation of Alaska Natives in fishery management would be encouraged under Alternative 4. NOAA Fisheries and the NPFMC would work with Alaska Natives to identify and develop measures that would increase participation and representation in fishery management.

Alaska Native participation in commercial fishing would be greatly reduced or suspended under Alternative 4. This would contribute further to adverse cumulative effects resulting in trends in salmon and crab fisheries. Benefits to Native communities would also be adversely affected through loss of employment, economic activity and community revenues, including CDQ communities. Combined with trends in other fisheries and state funding programs, cumulative effects on Alaska Native communities would be adverse. Potential adverse groundfish fishing effects on Steller sea lion and salmon resources would be reduced or removed, resulting in potential beneficial effects, although adverse cumulative effects on the availability of these resources are a greater factor than effects related to fishing. There would be Environmental Justice impacts on Alaska Natives due to the reduction or elimination of the groundfish fishery and reductions in community benefits.

While subsistence activities would be allowed in protected areas, the ability to harvest subsistence through joint production would be reduced or eliminated, resulting in adverse subsistence effects.

4.10.5.9 Improve Data Quality, Monitoring and Enforcement

Alternative 4 places the burden of proof on NPFMC/NOAA Fisheries to demonstrate that the prosecution of the fisheries does not have an adverse effect on the environment. Therefore, fishery managers are required to justify that their management actions have no adverse impact on resources. This will result in the imposition of restrictive measures on the fisheries, which may be lifted or modified once appropriate evidence can be produced to show that the fishery will have no adverse impact. The policy sets goals and objectives to address data quality, monitoring and enforcement, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	**Management Measure**
<u>Goals</u> • Modify restrictive conservation and management measures as additional reliable scientific information becomes available • Draw upon federal, state, academic and other capabilities in carrying out research, administration, management and enforcement • Expand research and monitoring programs will fill critical data gaps <u>Objectives</u> • Increase the precision of observer data through increased observer coverage and enhanced sampling protocols, and address the shortcomings of the current funding mechanism by implementing either a federally funded or equitable fee-based system for a revamped Observer Program Research Plan • Improve enforcement and in-season management through improved technological means • Establish a coordinated, long-term monitoring program to collect baseline information and better utilize existing research information to improve implementation of the Fishery Ecosystem Plan • Adopt the recommended research plan included in this document	Observer Program	Expand observer coverage (30/100/100%), with 100% of hauls observed
		Address conflict of interest in funding
		Develop uncertainty estimates for all possible stocks
	Data and Reporting Requirements	Require economic data from industry participants
		Require motion-compensated scales
		Require VMS for all groundfish vessels

Impacts of Policy

The data quality, monitoring and enforcement goals for this policy are to expand research and monitoring programs to be able to fill data gaps and modify restrictive management measures as appropriate. Assistance in meeting these goals would be drawn from all areas, federal, state and academic. In order to further the Alternative 4 goals, several objectives are specified. The Observer Program would be reorganized to address current shortcomings of the funding mechanism, and the precision of observer data should be increased. Management would take advantage of the latest technology to assist inseason management and enforcement efforts. A coordinated effort to develop a baseline ecosystem monitoring plan should be developed, and the research priorities identified in Chapter 5 of this document should be pursued.

The Alternative 4 objectives for the Observer Program are implemented through expanded observer coverage; the development of uncertainty estimates for all possible stocks; and measures to address the conflict of interest in funding. The Observer Program paper in Appendix F-10 contains a detailed discussion of the changes under Alternative 4. Observer coverage would be increased to 100 percent on vessels greater than 60 ft LOA, and all hauls retrieved while the observer is aboard would be sampled for species composition. Vessels less than 60 ft LOA would be required to carry an observer for 30 percent of their fishing days. Expanded coverage would reduce the uncertainty from the effects of the fisheries on direct takes of target and non-target species. As with Alternative 3, the funding mechanism would be changed to address conflict of interest. However, the change in emphasis from industry and community concerns to ecosystem-oriented management would likely result in changes to the data collection protocols as well, which would increase the costs of the program. The emphasis on ecological relationships among species may emphasize the need for trophic interaction data, such as stomach collections, in addition to other critical observer data such as otolith collections, bycatch accounting, and total catch estimates. If the Alternative 4 policy is adopted in the form of FMP 4.2, however, there would be no need for the Observer Program until NOAA Fisheries could certify that a directed fishery has no adverse effect on the environment. Alternative 4 also calls for the use of technology to achieve more accurate monitoring and enforcement by requiring the use of motion-compensated scales on all vessels, and expanding VMS to all groundfish vessels. The Data and Reporting Requirements paper in Appendix F-11 contains a more detailed description of the implications of these management measures. The requirement to install motion-compensated scales on all vessels may become an obstacle to some vessels that are not large enough to accommodate the equipment. However, the use of motion-compensated scales on AFA and CDQ vessels has already increased the accuracy of reported catch, and could be expected to do the same in this application. Requiring VMS on all vessels (rather than only being used in certain directed fisheries, as is currently the case) would increase its utility as a management tool. Although such a program would increase costs for industry to install, maintain and transmit VMS data, and for NOAA Fisheries to track incoming data, it would prove an effective tool for monitoring the additional closure areas in place under this alternative. Additionally, as VMS software becomes more advanced, it could be linked with electronic logbook entries to record and verify the location of hauls, further improving the accuracy of fisheries data. A further description of the management implications of scales and VMS is included in Chapter 5.

The baseline ecosystem collection effort that would be initiated under Alternative 4 would be used to improve the implementation of the Fishery Ecosystem Plan developed under this alternative in accordance with the Ecosystem Principles Advisory Panel recommendations (EPAP 1999). This research initiative for baseline ecosystem information would likely be coordinated by NOAA Fisheries, but would require input from a wide variety of sources (e.g., industry, academic, federal and state). At its optimum, the program would provide the necessary evidence to determine the impact of the fisheries on resources, and thus allow for modification of the restrictive measures imposed on the fisheries as appropriate.

Alternative 4 also advocates the adoption of the recommended research plan included in this document. Research priorities and identified data gaps are included in Chapter 5 of this document. Alternative 4 seeks to expand research efforts to be able to collect these data.

The assumption of Alternative 4 is that fisheries do impact all aspects of the ecosystem through the complex relationships that link its elements. Until these relationships are more fully understood and downstream effects as well, there is an urgent need to manage interactions with the ecosystem, in terms of fishery removals, with great precaution. This fundamental assumption of Alternative 4 prioritizes the need for increased accuracy and breadth of monitoring and enforcement efforts on the one hand (e.g., to monitor and control fishing-related disruption to the ecosystem), and of research efforts on the other (e.g., to accelerate the scientific understanding of the ecosystem in order to determine what level of fishing is appropriate.)

4.10.6 Analysis of the Preferred Alternative

The preferred alternative (PA) consists of a management approach statement and a set of policy objectives. The management approach statement provides the key to the underlying rationale and assumptions for the policy goals and objectives, and additional guidelines for the implementation of the policy.

The management approach statement for the PA represents a precautionary approach, of applying judicious and responsible fisheries management practices, based on sound scientific research and analysis, proactively rather than reactively, to ensure the sustainability of fishery resources and associated ecosystems for the benefit of future, as well as current generations. This management approach statement is summarized in Table 4.10-3. Under this approach, the NPFMC and NOAA Fisheries intend to consider and adopt, as appropriate, measures that accelerate the stated precautionary, adaptive management approach through community or rights-based management, ecosystem-based management principles that protect managed species from overfishing, and increased habitat protection and bycatch constraints, where appropriate and practicable.

The PA management approach statement also indicates that the NPFMC and NOAA Fisheries management process will:

- Base management measures on the best scientific information available.
- Consider reasonable, adaptive management measures as described in the MSA in conformance with the National Standards, the ESA, NEPA, and other applicable law.
- Take into account the National Academy of Science's recommendations on Sustainable Fisheries Policy.

A summary of the impacts of the PA follows below in Section 4.10.6.1. In the remainder of Section 4.10.6, the impacts of the alternative are analyzed in detail, in relation to nine policy subheadings: prevent overfishing; promote sustainable fisheries and communities; preserve food web; manage, reduce and avoid bycatch and incidental catch; avoid impacts to seabirds and marine mammals; reduce and avoid impacts to habitat; promote equitable and efficient use of fishery resources; increase Alaska Native consultation; and improve data quality, monitoring and enforcement. For each subheading, the impacts of the relevant goals and objectives from the management approach are analyzed, using as a guideline the range of implementing management measures for the PA identified in Section 4.2 and analyzed in Section 4.9.

4.10.6.1 Summary of the Preferred Alternative

The key policy elements that predominantly influence the impacts under the PA are: the emphasis on rationalizing the fisheries (resulting in increased efficiency and flexibility); the incorporation of ecosystem considerations (increasing the uncertainty buffers in management accounting); and the likelihood of additional closure areas (which may result in a variety of impacts, depending how the closures are situated).

Predictions about the impacts under this alternative are difficult due to the uncertainty involved in defining ecosystem management and predicting the impacts of protecting areas. Increased emphasis on relatively less abundant species, through protection measures and increased monitoring, indicates a tendency towards ecosystem management but as the implications of such management are uncertain, the tendency is to manage cautiously while accelerating research and data-gathering. The large potential gain in flexibility from rationalization has the potential to create ecosystem benefits.

The PA prevents overfishing of target stocks and reduces the likelihood that stocks will become overfished, through precautionary harvest policies, and imposition of rebuilding regulations when stocks fall below the level capable of producing MSY. Efforts would be accelerated to improve the current harvest strategy, including in PA.2, additional procedures to incorporate uncertainty and develop spawning stock biomass estimates, in particular for Tiers 4-5.

The goal of promoting sustainable fisheries and communities under the PA is likely to be successful. The precautionary adjustments made to quota management decrease the risk of inadvertently overfishing managed species. Additionally, the transition to rights-based management under this alternative will promote the objectives of increasing efficiency, stability and safety in the long-term.

As a whole, through its goal to accelerate precautionary management measures through ecosystem-based principles, and its objectives to develop indices of ecosystem health and to take ecosystem factors into account in ABC setting, this alternative is successful in making many improvements beyond the status quo in achieving the goal of preserving the food web. The emphasis in this alternative is on using the best scientific information available to determine catch levels, but also on providing additional protection against uncertainty by designation of MPAs and reserves. If these improvements are implemented, this strategy is likely to provide protection to a broad range of food web components.

The bycatch and incidental catch reduction policies in the PA are consistent with minimizing human-caused threats to protected species and accelerating precaution through additional bycatch constraints, such as reduced PSC limits. Bycatch reduction objectives and reductions in incidental catch are likely to be achieved without a major cost to industry due to the incentives for more efficient use of fishery resources under cooperatives, comprehensive rationalization of fisheries or other bycatch incentive programs implemented under this alternative.

The goal of minimizing human-caused threats to protected species, and if appropriate and practicable, other seabird and marine mammal species, is largely met in the PA by actively adjusting seabird and marine mammal protection measures, and status review of endangered and threatened marine mammal fishery interactions. This approach, which may provide additional conservation measures in response to scientific evidence, is likely to maintain protection to ESA-listed marine mammals and seabirds, and may increase protection for other seabirds and marine mammals.

This alternative has the potential to reduce and avoid impacts to habitat by careful placement of closures. Placement of closures in lightly fished or not fished areas will provide mitigation and result in avoidance of future habitat impacts if fisheries were to move effort into surrounding areas. Closures in heavily fished areas should be small to minimize displaced efforts and reduce chances of unintended consequences. To achieve overall benefits, closures should not encompass entire habitat types or areas of fishing intensity. In the short-term, information from the Observer Program could be used to locate such closures. In the long-term, scientific information gained from this policy can potentially lead to modification of the placement of MPAs and help meet the policy objective to assess the necessary and appropriate habitat protection measures. Cumulatively, the alternative results in a split impact rating, as the adverse condition of the baseline is coupled with continued damage and mortality to living habitat, however the alternative has strong potential to mitigate these adverse impacts.

The PA promotes increased social and economic benefits through the elimination of the race-for-fish while also emphasizing the long-term economic value of the fishery through the promotion of rights-based allocations to individuals, sectors, and communities. In addition, this alternative promotes ecosystem based management and is likely to increase non-market, recreational, and tourism values assigned to the ecosystem. It is not possible to determine the long-term effect on overall ecosystem value (commercial and non-market values combined) because it is not known whether the fishing sectors, even with rights-based allocations, will be able to adapt to the changes resulting from the increased emphasis on ecosystem tools and, in particular, the potential addition to the number and significance of closed areas.

The goals and policies for Alaska Native consultation and participation in fishery management under the PA would increase current levels by expanding informal and formal consultation between the NPFMC/NOAA Fisheries and Alaska Native participants and tribal governments. Local and Traditional Knowledge would be more formally incorporated in fishery management and additional data would be collected. Other goals and objectives in the PA, such as reductions in PSC limits, may benefit subsistence salmon use by reducing bycatch levels in the groundfish fisheries.

Through data collection measures that will result in reducing uncertainty, the PA is likely to be effective in achieving the goal of accelerating the use of precautionary management measures. The objectives to improve the Observer Program and observer data will increase the quality of fishery data by implementing increased flexibility of, and potentially expanding, observer coverage. Additionally, the expanded economic data and potential for independent verification would allow for more accurate and credible assessments of economic impacts. A funding source would, however, need to be identified to implement improvements to these programs. The alternative also emphasizes the importance of enforcement concerns in fishery management.

4.10.6.2 Prevent Overfishing

The PA incorporates forward looking conservation measures that address differing levels of uncertainty. Under this approach, the NPFMC would seek to accelerate precautionary management measures through community or rights-based management, ecosystem-based management principles that protect managed species from overfishing, and, where appropriate and practicable, increased habitat protection and bycatch constraints. The PA policy is illustrated by PA.1 and PA.2. Each FMP contains a number of management measures that pertain to the sustainability of fisheries and fishery resources. The bookends represent a range of actions that alter constraints to fishery removals.

A detailed description of PA.1 appears in Section 4.2. Briefly, PA.1 continues precautionary practices seen in Alternative 1 where TAC is less than or equal to the ABC, and the ABCs are less than the OFL. Uncertainty corrections applied under Alternative 1 to BSAI and GOA Pacific cod and GOA pollock would also apply. OY restrictions would be identical to Alternative 1, where the OY range for the BSAI and GOA is capped at 2 million mt and 800,000 mt for the BSAI and GOA, respectively. The 2 million mt cap in the BSAI limits the expansion of fisheries. The FMP would formally specify MSSTs for Tiers 1-3 in accordance with National Standard Guidelines. Efforts to develop ecosystem indicators to be used in TAC-setting, as per ecosystem management principles, would be continued. Under PA.2, the calculation of OY caps would be revisited to determine their relevancy to the current environmental conditions and the current knowledge of stock levels.

PA.2 incorporates an uncertainty correction into the estimation of ABC for all species. This represents a significant acceleration of precautionary management. PA.2 would also develop and implement criteria for using key ecosystem indicators in TAC-setting, and other precautionary practices. As a proxy for a more conservative harvest strategy for rockfish, PA.2 capped F_{ABC} at $F_{60\%}$ rather than $F_{40\%}$ for rockfish stocks managed in Tier 3. In implementing this bookend, analysis and data collection would be initiated for specifying MSSTs for priority stocks in Tiers 4-6. The development of criteria to manage target and non-target species consistently, and for moving stocks from the other species and non-specified species categories, would begin with breaking BSAI and GOA sharks and BSAI skates out of the other species group for TAC-setting.

Impacts of Policy

As in Alternative 1, the PA limits the impact of fishing mortality by setting an ABC less than the OFL. This alternative defines four management categories for which catch is constrained by various regulatory mechanisms: target species, other species, prohibited species and forage fish species. The PA harvest policies are consistent with ecosystem principles that call for in-season multi-species catch monitoring to ensure that catch does not exceed the OFL of groundfish. This catch monitoring is facilitated by at-sea observers, port samplers, weekly production reports and fish ticket information (Appendix F-10). Stocks can be moved from one management category into another only by FMP amendment. Within the target species category, stocks are managed either individually or as part of a stock complex. Stocks within the target species category can be added to or removed from a stock complex within the same category as part of the TAC-setting process (i.e., without an FMP amendment).

The bookends provide a range of potential impacts associated with this alternative. PA.1 is similar to FMP 1, and harvest control rules would continue to be used and improved to maintain a spawning stock biomass with the potential to produce sustained yields on a continuing basis. PA.2 imposes more constraints to fishery removals and develops criteria for bringing non-specified species into a managed category.

Goals, Objectives	Corresponding Management Measures	
<u>Goals</u> • NPFMC intends to take appropriate measures to insure the continued sustainability of the managed species • Consider and adopt measures that accelerate ecosystem-based management principles that protect managed species from overfishing • Recognizes need to balance many competing uses of marine resources including protection of the long-term health of the resource and the optimization of yield • Seeks to provide sound conservation of living marine resources <u>Objectives</u> • Adopt conservative harvest levels for multi-species and single species fisheries and specify OY • Continue to use existing OY cap for BSAI and GOA groundfish fisheries as stated in current law. • Provide for adaptive management by continuing to specify OY as a range • Initiate a scientific review of the adequacy of $F_{40\%}$ and adopt improvements as appropriate • Continue to improve the management of species through species categories.	Example Range: ABC<OFL, sum of TACs within OY range, formal adjustments for uncertainty, automatic rebuilding, appropriate harvest policies for rockfish	Quota management based on a tier system. F_{ABC} set below F_{OFL} except at very low stock sizes protecting the stock from unintentional overfishing. Additional adjustments for uncertainty are incorporated into F_{ABC} under PA.2. PA.1 continues to use harvest control rules to maintain sustainable stocks. For example purposes only, F_{ABC} for Tier 3 rockfish stocks would be set at $F_{60\%}$ in PA.2.
	Time/Area	For several species, fishing quotas are distributed across time and area in proportion to the expected underlying biomass of fish in the region at that time. These policies reduce the possibility of spatial temporal concentration of the catch. Relative to FMPs 1 and PA.1, PA.2 imposes additional marine reserves and marine protected areas.
	Gear restrictions	For walleye pollock, Pacific cod, and sablefish, gear allocations partition catch to specific gear groups. Differences in gear selectivity are addressed in the stock assessment models and quotas reflect the expected age distribution of the catch by gear.
	OY caps	OY restrictions cap the aggregated groundfish catch in the GOA and BSAI at 800,000 mt and 2 million mt, respectively. These caps limit the expansion of fisheries (particularly in the BSAI). As a progressive measure, the calculation of OY caps would be revisited under PA.2 to determine their relevancy to the current environmental conditions and information on stock levels.
	Inseason Multi-species TAC and ABC monitoring	The catch of a given target species is limited by prohibited species bycatch caps and the TACs for other groundfish. The halibut bycatch caps serve as a constraint to BSAI and GOA flatfish expansion. Reduced bycatch allowances would further constrain target fisheries. Sharks and skates would be moved from the other species management category under PA.2.

Several measures associated with the PA could result in reductions in catch relative to baseline conditions. First, an uncertainty correction could be applied that would account for measurement and process error in the assessment (PA.2). Second, the development of appropriate harvest strategies Tier 3 rockfish species could result in a more conservative strategy (PA.2). Third, a 0-10 percent (PA.1) or 0-20 percent reduction (PA.2) in bycatch would be imposed under this alternative. Finally, sharks and skates could be broken out of the other species complex (PA.2). The FMPs used to illustrate the PA demonstrate conservative harvest polices. Direct and indirect impacts analyses revealed that overfishing did not occur in the stocks or stock complexes modeled under PA.1 or PA.2 (Table 4.9-1). Relative to the comparative baseline, the expected fishing mortality under the PA would have no significant impact on any of the target groundfish stocks. Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on fishing mortality.

Relative to the comparative baseline, the likelihood of a stock falling below the level where the stock is capable of producing MSY is reduced under the PA. Under PA.1 and PA.2 none of the stocks managed in Tiers 1-3 would be expected to become overfished. The direct and indirect impact of the PA on changes in biomass of all of the Tier 1-3 target groundfish stocks would be insignificant relative to the baseline (Table 4.9-1). The direct and indirect impact of commercial fishing on the biomass of target groundfish stocks managed in Tiers 4-6 is unknown because the status of such stocks relative to their respective MSSTs is unknown (Table 4.9-1). Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on changes in biomass.

Relative to the comparative baseline, PA.2 adds several spatial and temporal restrictions on catch. These restrictions would decrease the spatial/temporal concentration of the catch. Under this policy, commercial fishing is expected to have insignificant impacts on the genetic makeup or the reproductive success of the 19 stocks managed in Tiers 1-3. The direct and indirect impact of commercial fishing on the genetic makeup or reproductive success of stocks managed in Tiers 4-6 is unknown because the status of such stocks relative to their respective MSSTs is unknown. The PA would initiate research to collect information necessary to determine MSSTs, particularly for stocks managed in Tiers 4-5. Once the MSST definition is established, the significance of commercial harvest on those stocks could be evaluated. Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on fishing mortality.

Relative to the comparative baseline, the PA would increase restrictions on the spatial temporal partitioning of catch and could reduce overall harvest of target groundfish. The direct and indirect impact of these changes on prey availability is expected to be insignificant for all stocks managed in Tiers 1-3 (Table 4.9-1). Direct and indirect impacts of commercial fishing on prey availability of all stocks or stock complexes managed in Tiers 4-6 are unknown because the status of such stocks relative to MSST is unknown (Table 4.9-1). Consideration of cumulative impacts does not change the expectations for direct or indirect impacts of this alternative on fishing mortality.

Harvest restrictions, spatial temporal constraints, and gear allocations all serve to mitigate the impact of commercial fishing on fish habitat. The closure system described in PA.2 would close approximately 18 percent of the EEZ to some form of MPA and designate approximately 3.1 percent of the EEZ as a no-take reserve (Figure 4.2-9). For the fishable area (depth to 1,000 m) of the EEZ, PA.2 would designate approximately eight percent of the fishable area as a no-take reserve and about 40 percent of the fishable area as some form of MPA. Relative to the comparative baseline, the impacts on target species resulting from habitat disturbance are considered insignificant for all stocks managed in Tiers 1-3 (Table 4.9-1). The impacts are unknown for stocks or stock complexes managed in Tiers 4-6.

When taken in aggregate, the PA appears to increase existing precautionary management measures. Irreversible or long-term adverse effects on fishery resources are avoided by precautionary harvest policies and imposition of rebuilding regulations when stocks fall below the level capable of producing MSY. Strengths of the PA are that the FMPs will adopt formal criteria for status determination, and research will be accelerated to develop ecosystem-based harvest policies. Community or rights-based management adopted under the PA would reduce the race-for-fish. Efforts would be accelerated to identify methods for reducing the number of stocks where the status relative to an overfished condition is unknown. Another strength of this policy is that PA.2 would develop a list of priority stocks for moving stocks from the other species and non-specified species categories, using consistent criteria. The catch of these species would be monitored. Until this system is developed, harvest policies may build and maintain the species complex, but it is still possible to over harvest a vulnerable member of the complex.

4.10.6.3 Promote Sustainable Fisheries and Communities

The PA sets goals and objectives to promote sustainable fisheries and communities, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Ensure the sustainability of fishery resources and associated ecosystems for the benefit of future as well as current generations • Provide socially and economically viable fisheries and fishing communities • Recognize the need to balance different social and economic goals for sustainable fishery management including protection of the long-term health of the resource and the optimization of yield Objectives • Promote conservation while providing for OY in terms fo providing the greatest overall benefit to the nation with particular reference to food production, and sustainable opportunities for recreational, subsistence, and commercial fishing participants and fishing communities • Promote management measures that, while meeting conservation objectives, are also designed to avoid significant disruption of existing social and economic structures • Promote fair and equitable allocation of identified available resources in a manner such that no particular sector, group, or entity acquires an excessive share of the privileges • Promote increased safety at sea	TAC-setting Process	Quota management based on a tier system. F_{ABC} set below F_{OFL} except at very low stock sizes, protecting the stock from unintentional overfishing. Additional adjustments for uncertainty are incorporated in ABC setting.
		Optimum Yield restrictions cap the aggregated groundfish catch in the GOA and BSAI. These caps limit the expansion of fisheries (particularly in the BSAI).
	Overcapacity	Maintain existing restricted access programs while developing rationalization that includes benefits to rural communities

Impacts of Policy

The goal of promoting sustainable fisheries and communities is pursued through the following objectives: provide the greatest overall benefit to the nation, increase efficient use of fishery resources, avoid significant disruption of existing social and economic structures, promote fair and equitable allocation of resources, and promote increased safety at sea.

The impact of these goals and objectives for sustainable fisheries and communities would not be significantly different from the comparative baseline. To the extent that these goals are in the MSA, the objectives are also part of the status quo fishery management policy. Specific management actions that would further implement these goals under the PA are also captured in Section 4.10.6.2, Prevent Overfishing, and Section 4.10.6.8, Promote Equitable and Efficient Use of Fishery Resources. Management measures such as conservative quota management, and adjustments made under the PA to account for uncertainty, ensure the sustainability of the managed species by maintaining a spawning stock biomass for the target species with the potential to produce sustained yields. Improvements to the monitoring and data collection programs, as described in Section 4.10.6.10, Improve Data Quality, Monitoring and Enforcement, would allow fishery managers to achieve a more accurate understanding of the impact of fishing activity on the stocks and the ecosystem, and of the status of the stocks.

The acceleration under the PA of the move towards comprehensive rationalization of the groundfish fisheries is also an effective implementation tool for the objectives considered in this section. As discussed in further detail in Section 4.10.6.8, the implementation of rationalization, which allows for flexible fishing practices, is likely to improve efficient use of fishery resources while reducing unwanted incidental catch and bycatch, to increase overall benefit to the nation in terms of food production, and also to increase safe fishing practices. The transition to rationalization in the short-term could disrupt stability, however in the long-term, the stability of fisheries would be increased in comparison to a derby-style fishery. Likewise, communities would also tend to experience an increase in stability as a result of built-in community protections to the rationalization programs. The objective of equity would likely be met through allocating the resource based on historic participation in the fishery.

The goal of promoting sustainable fisheries and communities under the PA is likely to be successful. The precautionary adjustments made to quota management decrease the risk of inadvertently overfishing managed species. Additionally, the transition to rights-based management under this alternative will promote the objectives of increasing efficiency, stability and safety in the long-term.

4.10.6.4 Preserve Food Web

The PA sets goals and objectives to preserve the food web, as well as recommending a range of management measures that would implement these objectives.

Impacts of Policy

Impacts to food webs of the BSAI and GOA are mitigated through many of the goals and objectives and related management measures of this alternative, some of which are improvements beyond those provided in the comparative baseline. In addition to objectives specifically for incorporating ecosystem considerations into fisheries management decisions and prohibiting directed fisheries for forage fish (which often form a central position in channeling energy through the food web), and the precautionary adjustments to the ABCs of Tier 1 stocks that were part of Alternative 1, this alternative provides for the possibility of developing other precautionary ABC adjustments to account for ecosystem factors, and specifically develops indices of ecosystem health as targets for management. Other policies of this alternative, such as preventing overfishing, reducing bycatch, avoiding impacts to seabirds and marine mammals, reducing impacts to habitat, and improving data quality, monitoring, and enforcement, are critical to protection of food web components, which include target and non-specified species, PSC species, HAPC biota, marine mammals and seabirds. Management measures, such as revised procedures for ABC, MSST setting, incorporating precaution, and spatial/temporal allocation for TAC (Section 4.10.4.2); additional bycatch reduction measures (Section 4.10.4.4); further gear modifications for seabird protection (Section 4.10.4.5); procedures to identify MPAs and no-take marine reserves (Section 4.10.4.6) and improvements to the Observer Program coverage (Section 4.10.4.9), that are proposed as improvements beyond the baseline in the PA provide increased protection to a variety of food web components. See the policy analysis in those sections for details on the level of protection provided by the PA to these individual components.

Goals, Objectives	**Corresponding Management Measures**	
	FMP Component	**Management Measure**
Goals • Precautionary approach that incorporates forward looking conservation measures that address differing levels of uncertainty • Incorporate ecosystem-based considerations into management decisions • Accelerate precautionary management measures through ecosystem-based principles that protect managed species from overfishing • Take into account NAS Sustainable Fisheries policy recommendations • Promote sound conservation of living marine resources Objectives • Develop indices of ecosystem health as targets for management • Improve the procedure to adjust ABCs as necessary to account for uncertainty and ecosystem factors • Continue to protect the integrity of the food web through limits on harvest of forage species • Incorporate ecosystem-based considerations into fishery management decisions as appropriate	TAC-setting Process	Prohibit directed fishery for forage fish
		Procedures to incorporate precaution and uncertainty into ABCs
		Procedure to develop and use key ecosystem indicators in TAC-setting

This alternative specifically attempts to incorporate ecosystem considerations into fishery management decisions through advancements in how uncertainty and ecosystem factors are used in ABC adjustment. It will continue to prohibit directed fisheries for forage fish, and develop ecosystem indicators. Analysis of the ecosystem effects of the PA involved selection of indicators that would show changes in key members or ecosystem characteristics that are important to the structure and function of marine food webs. Changes in pelagic forage, top predators, spatial/temporal availability of prey, exotic species introductions, energy removal and redirection through fishery catch removals and discards/offal production, and various measures of diversity were evaluated with respect to the potential of fishing to cause changes sufficient to bring these attributes below population, community, or ecosystem thresholds, if such thresholds could be defined. Most of these indicators showed there were insignificant impacts of this alternative on these ecosystem attributes. There were unknown effects of this alternative on top predator species and species diversity due to our lack of knowledge of abundance levels and life history characteristics of species such as skates, sharks, and grenadiers, although breaking these species out of the other species group and giving each its own TAC (PA.2) would provide additional protection. The additional area closures, including the Aleutian Islands management area to protect corals and live bottom habitat, proposed in PA.2, would result in improvements relative to the comparative baseline in spatial/temporal availability of forage to marine mammals and birds and protection of corals. Qualitative analysis with respect to the ecosystem effects of the TAC-setting process in Appendix F-1, Alternative 3, which is similar to the PA in terms of the TAC-setting process, showed that increased protection would be provided to stocks that need it most, such as slower-growing, long-lived species such as rockfish, skates, and sharks, and would thus reduce the possibility of adverse impacts to those groups and to their role in the food webs of these ecosystems. Thus, if these improvements are implemented, this alternative has the potential to decrease ecosystem impacts relative to the comparative baseline.

As a whole, through its goal to accelerate precautionary management measures through ecosystem-based principles, and its objectives to develop indices of ecosystem health and to take ecosystem factors into account in ABC setting, this alternative is successful in making many improvements beyond the status quo in achieving the goal of preserving the food web. The emphasis in this alternative is on using the best scientific information available to determine catch levels, but also on providing additional protection against uncertainty by designation of MPAs and reserves. If these improvements are implemented, this strategy is likely to provide protection to a broad range of food web components.

4.10.6.5 Manage Incidental Catch and Reduce Bycatch and Waste

Several policy changes adopted in the PA would change the incidental catch of target and non-target species, and bycatch (regulatory and economic discards). Under PA.1, the cap on OY is maintained, so the absolute amount of target and non-target groundfish catch is unlikely to change. The calculation of OY caps would be revisited under PA.2 to determine if the caps are still relevant to environmental conditions and the current knowledge of stock levels. However, the amount of incidental catch of groundfish and subsequent discard of groundfish (bycatch) is likely to decrease due to the policy emphasis on rationalization. Other measures would likely lead to reductions of incidental catch for various species including prohibited species. These additional measures include the uncertainty correction and reduced rockfish F_{OFL} described in PA.2, and the separation of sharks and skates from the other species complex (PA.2). The latter would ensure that these species are not harvested above the maximum fishing mortality threshold. Furthermore, criteria for defining the membership within species complexes and the circumstances when species should be broken out of complexes would be developed.

The comprehensive rationalization of the groundfish fisheries, in PA.1 and PA.2, will address bycatch reduction objectives (a review of bycatch in existing programs is initiated), by eliminating the race-for-fish, and providing internal incentives to minimize catches of less valued groundfish and PSC. It is expected that with rationalization in all groundfish fisheries, incidental catch and discards (bycatch) may be reduced by as much as 20 percent. Even without predicted reductions in PSC resulting from rationalization, a moderate reduction of PSC limits would be adopted as an intermediary step. Habitat and bycatch concerns would also be addressed by reducing concentrated effort in the fisheries.

Impacts of Policy

The PA is expected to encourage the development of practical measures that reduce bycatch and incidental catch of target and non-target species. With respect to the impact on the sustainability of prohibited species that are currently in a depressed or overfished condition (BSAI and GOA chinook salmon, *C. bairdi* crab, *C. opilio* crab, BSAI and GOA red king crab, and BSAI blue king crab [Table 4.10-2b]). The impacts of mortality and change in biomass associated with the PA policy are likely to be positive, but are unlikely to be significant overall. Cumulative impacts are considered conditionally significant adverse due to mortality for BSAI chinook and other salmon and GOA chinook salmon. The PA is expected to have an insignificant impact on forage fish, but is none-the-less expected to reduce bycatch of these species. The impact of the PA on other species and non-specified groups is unknown.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	**Management Measure**
Goals • Accelerate precautionary management measures through increased bycatch constraints where appropriate and practicable • Minimize human-caused threats to protected species • Promote sound conservation of living marine resources Objectives • Continue and improve current incidental catch and bycatch management program • Develop incentive programs for bycatch reduction including the development of mechanisms to facilitate the formation of bycatch pools, VBAs, or other bycatch incentive systems • Encourage research programs to evaluate current population estimates for non-target species with a view to setting appropriate bycatch limits as information becomes available • Continue program to reduce discards by developing management measures that encourage the use of gear and fishing techniques that reduce bycatch which includes economic discards • Continue to manage incidental catch and bycatch through seasonal distribution of TAC and geographical gear restrictions • Continue to account for bycatch mortality in TAC accounting and improve the accuracy of mortality assessments for target, PSC bycatch, and non-commercial species • Control the bycatch of prohibited species through PSC limits or other appropriate measures • Reduce waste to biologically and socially acceptable levels	Spatial/ Temporal Management of TAC	Spatial/temporal distribution of TAC
	MPAs and EFH, Bycatch and Incidental Catch Restrictions, Gear Restrictions and Allocations	Seasonal, gear/fishery specific, and total closure areas identified to reduce bycatch; reviews to develop appropriate bycatch closure areas in the GOA
	Bycatch and Incidental Catch Restrictions	Reduce existing PSC limits, or other appropriate measures, for prohibited species, establish PSC limits for prohibited species other than halibut in the GOA
		Procedure to develop mortality rate-based approach to setting limits
		Retention standards for DSR, and IR/IU for pollock, Pacific cod, shallow-water flatfish in the GOA, and groundfish retention standard for other groundfish species in the BSAI
		Review bycatch reduction incentive programs (repeal/maintain VIP)
		Bycatch restrictions (including in-season)/ repeal or modify MRBs and establish system of caps and quotas

The PA policies as illustrated by PA.1 and PA.2 are consistent with the goal of accelerating precautionary management measures through increased bycatch constraints where appropriate and practicable. The PA policies are also consistent with the objective of controlling prohibited species bycatch. Increased precaution regarding bycatch would be achieved through reductions in PSC limits. Bycatch reduction objectives (0-10 percent for PA.1 or 0-20 percent for PA.2) are likely to be achieved due to the incentives for more efficient use of fisheries resources under cooperatives, comprehensive rationalization of fisheries, or other bycatch incentive programs implemented under this alternative.

4.10.6.6 Avoid Impacts to Seabirds and Marine Mammals

The PA policy sets goals and objectives to avoid impacts to seabirds and marine mammals, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
<u>Goals</u> • Minimize human-cause threats to protected species • Promote sound conservation of living marine resources <u>Objectives</u> • Continue to cooperate with USFWS to protect ESA-listed species, and if appropriate and practicable, other seabird species • Maintain or adjust current protection measures as appropriate to avoid jeopardy to ESA-listed Steller sea lions • Encourage programs to review status of endangered and threatened marine mammals stocks and fishing interactions and develop fishery management measures as appropriate • Continue to cooperate with NOAA Fisheries and USFWS to protect ESA-listed marine mammal species, and if appropriate and practicable, other marine mammal species	TAC-setting Process, Steller sea lion Measures	Steller sea lion prey species low biomass rules
	TAC-setting Process	Prohibit directed fishery for forage fish
	Spatial/ Temporal Management of TAC	Spatial/temporal distribution of TAC
	MPAs and EFH, Steller sea lion Measures, Gear Restrictions and Allocations	Maintain/modify as scientifically appropriate the seasonal, gear/fishery- specific, and total closure areas identified to protect walrus and Steller sea lions
	Seabird Measures	Short-tailed albatross take restrictions
		Develop further gear modifications to protect seabirds (trawl and longline)

Impacts of Policy

This alternative seeks to provide conservation of living marine resources and minimize human-caused threats to protected species. It will accomplish those goals through continued cooperation with USFWS to protect seabird species in the longline and trawl fleets, cooperation with NOAA Fisheries and USFWS to protect marine mammal species, maintenance or possible adjustment of current protection measures for Steller sea lions to avoid jeopardy, and review of endangered or threatened marine mammal and fishery interactions and development of appropriate fishery management measures for mitigation, if needed. Management measures that are improvements beyond those provided in the status quo include modification of closure areas for walrus and Steller sea lion protection as appropriate scientific information becomes available, and possible gear improvements to protect seabirds. Elimination of the race-for-fish in this alternative may also tend to decrease direct takes of marine mammals and seabirds. Impacts of the alternative with respect to seabirds were evaluated with respect to the potential for fisheries to cause direct mortality through fishing gear and vessel strikes, changes in prey availability (including offal), and changes in benthic habitat that might affect certain prey species of seabirds. Impacts for marine mammals were evaluated with respect to the potential for fishery incidental take or entanglement in marine debris, harvest of prey species, spatial/temporal concentration of fishing on prey, and fishing vessel disturbance.

These indicators showed that the PA provides increased protection to seabirds and marine mammals relative to the comparative baseline. As in Alternative 1, incidental take of albatross, fulmars, shearwaters, and gulls is substantially reduced due to new mitigation measures in the longline fleet. In addition, mitigation measures for the trawl fleet, currently under development through cooperation between industry and USFWS, are likely to reduce collisions with trawl third wires. The Seabird Protection Measures paper (Appendix F-6) analyzed components of Alternative 3 that are similar to the PA, and noted that the potential expansion of the Observer Program would improve the collection of seabird/fishery interaction data that measure the effectiveness of mitigation measures. The groundfish fishery is not expected to have population level effects on any seabird species through mortality, changes in food availability, or benthic habitat. The impact of the policy on Steller sea lions is likely to be similar to Alternative 1, except as new research indicates appropriate modifications will be made to existing protection measures.

The goal of minimizing human-caused threats to protected species, and if appropriate and practicable, other seabird and marine mammal species, is largely met in the PA by actively adjusting seabird and marine mammal protection measures, and status review of endangered and threatened marine mammal fishery interactions. This approach, which may provide additional conservation measures in response to scientific evidence, is likely to maintain protection to ESA-listed marine mammals and seabirds, and may increase protection for other seabirds and marine mammal species.

4.10.6.7 Reduce and Avoid Impacts to Habitat

The PA sets goals and objectives to reduce and avoid impacts to habitat, as well as recommending a range of management measures that would implement these objectives.

Impacts of Policy

The PA addresses impacts to habitat by having specific goals and objectives that focus on living marine habitat. This policy accelerates habitat protection where appropriate and practicable and could result in a gradual-to-rapid reduction and avoidance of impacts to habitat depending on how quickly management measures are implemented. Development of a procedure to identify MPAs and no-take marine reserves and identification of EFH mitigative features are identified as specific management measures.

In addition to the objectives specifically designed to address habitat concerns, the PA policies are designed to prevent overfishing, reduce and avoid bycatch, incorporate ecosystem considerations, and improve data quality and enforcement. These goals are important ancillary objectives that could provide reduced impacts to habitat. Management measures such as revised procedures for ABCs that incorporate greater precaution can potentially reduce impacts to habitat if fishing effort is reduced. Closures for marine mammal protection, especially if they are year round for all target species, can also provide protection to specific habitat types. Measures to avoid and reduce impacts could occur on a rapid time line, especially if precautionary measures are implemented before complete scientific information is available.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Accelerate precautionary management measures through increased habitat protection where appropriate and practicable • Maintain a healthy marine resource habitat • Promote sound conservation of living resources Objectives • Review and evaluate efficacy of existing habitat protection measures for managed species • Identify and designate EFH and HAPC pursuant to MSA rules, and mitigate fishery impacts as necessary and practicable to continue the sustainability of managed species • Develop an MPA policy in coordination with national and state policies • Encourage development of a research program to identify regional baseline habitat information and mapping, subject to funding and staff availability • Develop goals, objectives and criteria to evaluate the efficacy of MPAs and no-take marine reserves as tools to maintain abundance, diversity, and productivity • Implement MPAs if and where appropriate	MPAs and EFH, Bycatch and Incidental Catch Restrictions, Gear Restrictions and Allocations	Existing system of closed areas including Sitka Pinnacles, modify based on MPA process
		Establish Aleutian Island special management area to protect coral/live bottom habitats (PA.2)
	MPAs and EFH	Develop procedure to identify MPAs and no-take marine reserves, including definition of terms
		Identify and designate EFH and HAPC, determine extent of adverse effects from fishing, if any, and implement mitigation measures if necessary

The PA addresses habitat protection by developing and adopting a methodology for establishing MPAs and, in PA.2, adopting a MPA closure system. A composite of several different concepts for habitat protection and mitigation were qualitatively analyzed. After the concepts were analyzed, specific implementations of the concepts were analyzed and results compared to the comparative baseline. The basis for these conceptual closures is to illustrate how the effects of fishing on EFH can be mitigated by reducing the impacts caused by a particular fishery by closing specific areas. The conceptual strategies are:

- Reduce the impacts caused by a particular fishery by closing specific areas.

- Protect a diversity of habitat types across a range of geographic areas where closures do not encompass entire habitat types or areas of fishing intensity, incorporating a "band-approach" where appropriate with closures oriented perpendicular to depth contours from near shore to deep water.

- Develop a special conservation area in the Aleutian Islands to protect sensitive cold water coral communities.

- Limit size of closures in heavily fished areas to minimize displaced effort.

All of these approaches are variations of MPAs. Concepts 1-3 have the most potential for benefits to habitat. However, careful placement of the MPAs is required to avoid unintended consequences. Displacement of effort to new areas with more sensitive habitat may be an unintended consequence. If closures are placed primarily in areas with high fish densities and displace effort into areas of low densities then increased effort in a given area could lead to more habitat impacts. For closures to be most effective they should be combined with some effort controls. Ancillary management measures associated with the PA that result in reduced effort could result in increased effectiveness of MPAs. However, closures alone, if they are strategically placed within historically fished areas, can provide benefits to habitat without necessarily requiring a reduction in TACs. Benefits to habitat could occur with closure areas strategically placed that do not encompass entire habitat types or clusters of fishing intensity. To be most effective, closure areas should include some portion of areas where high fishing intensity has occurred, but need not be so large that they encompass entire habitat types or clusters of fishing intensity. Placement of small closures within areas of high fishing intensity could also promote scientific understanding of the effectiveness of such management measures. The specific location of MPAs could have serious social and economic consequences. Determining where to locate MPAs for habitat goals should include consultation with the fishing industry and nearby communities.

Analysis of specific management measures indicated mixed ratings relative to the comparative baseline for effects to mortality and damage to living habitat under PA.2. These mixed ratings result from the specific location of bottom trawl closure MPAs (see Figure 4.2-9) and the uncertainty of how changes in TAC will interact with MPAs. For example, in the GOA many of the specific strategy (1) closed areas on the slope encompass high effort areas which would be expected to have higher target fish densities. This could result in a much higher effort to catch fish in lower density open areas. This higher effort could result in enough of an increase in habitat impacts to negate impact reduction in the closed areas. Whether decreased TACs for some species will offset this increase in habitat impacts is uncertain. This uncertainty in predicted impacts led to an insignificant or possibly significantly adverse change to mortality and damage to living habitat relative to the baseline in the GOA.

This policy could, however, lead to improved benthic community diversity and geographic diversity of impacts. Analysis of specific management measures in the Bering Sea under PA.2 indicated some improvement in the geographic diversity of impacts. Large expanses of high fishing intensity could still remain open in the Bering Sea, but there is at least one closure area that covers a portion of a high fishing intensity area, providing some improvement in the geographic diversity of impacts. In the Aleutian Islands, the example closure areas that represent the established management area to protect coral and live bottom habitat, bisect apparent historic clusters of fishing patterns, thus providing a diversity of impacts for the habitat being fished. In the GOA closures also often encompass clusters of historically high fishing intensity, leaving little diversity or contrast of fishing intensity and thus leading to no improvement over the baseline.

From a cumulative impacts perspective, the baseline condition is adversely impacted due to historical impacts that have potentially caused long-term and possibly irreversible loss of living habitat, especially to long-lived, slow-growing species which are slow to recover. Although some benefits accrue to habitat within the proposed MPAs in PA.2, impacts from fishing are not totally eliminated, and TAC/effort is likely to remain high. While there is an incremental expansion of no-take MPAs, the closures analyzed under this FMP are not refined and may not be effective at preventing mortality or protecting benthic community structure. However, if properly designed and located, future closures could provide successful mitigation of the effects of fishing and, over time, adversely impacted habitat could recover. The cumulative impact predicted for this alternative is a split rating of conditionally significant adverse/conditionally significant beneficial. The existing adverse impact to the baseline condition coupled with continued damage and mortality to living habitat results in a conditionally significant adverse impact, because the extremely slow growing corals that have already been impacted are not likely to recover from their current impacted state. However, the alternative has strong potential to provide mitigative protection to habitat.

Overall, this policy has the potential to reduce and avoid future impacts to habitat by careful placement of closures. Placement of closures in lightly fished or not fished areas could result in avoidance of future habitat impacts, if effort expands to new or lightly fished areas. Placement of small closures within heavily fished areas can potentially mitigate impacts, reduce unintended consequences, and achieve overall benefits to habitat and meet policy goals and objectives. Strategic placement of small closures will also help meet the policy objective of evaluating the efficacy of MPAs. In the long-term, scientific information gained from this policy can potentially lead to modification of MPAs to help meet the policy objective to assess the necessary and appropriate habitat protection measures and reduce unnecessary impacts to the fishing industry.

4.10.6.8 Promote Equitable and Efficient Use of Fishery Resources

This policy would seek to accelerate the existing precautionary management measures through community or rights-based management and ecosystem-based management principles. Under this approach, additional conservation and management measures would be taken as necessary to respond to social, economic or conservation needs, or if scientific evidence indicated that the fishery was negatively impacting the environment. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management.

Impacts of Policy

The PA promotes increased social and economic benefits through the promotion of rights-based allocations to individuals, sectors and communities. For this reason the alternative is likely to increase the commercial value generated from the groundfish fisheries. In addition, this alternative promotes ecosystem-based management which could increase the specificity of the species reporting, could increase the areas in which fishing is restricted, and places additional emphasis on the reduction of bycatch. For that reason this policy alternative has some potential to increase non-market value and the benefits derived from recreational, subsistence and tourism activities related to the Bering Sea and GOA marine ecosystems. Overall benefits derived from the ecosystem (the combination of commercial and non-commercial values) are likely to be positive. See Section 3.9.8 and Section 4.10.4.3 for additional information on ecosystem values.

As the race-for-fish is eliminated, the alternative could result in positive effects in terms of producer net revenue, consumer benefits, and participant health and safety. For additional information on the effects of the race-for-fish and rights-based management see the discussion under Alternative 3 in the overcapacity qualitative analysis paper in Appendix F-8. The PA provides economic stability to fishery participants and communities by maintaining current allocation percentages to sectors. However, the elimination of the race-for-fish will likely result in a decrease in overall participation levels. In the long-run, communities are likely to see fewer persons employed in jobs related to the fishing industry (fishing, processing, or support sectors), but the jobs that remain could be more stable and provide higher pay.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Goals • Accelerate precautionary, adaptive management measures through community or rights-based management • Take into account National Academy of Science Sustainable Fisheries policy recommendations • Provide socially and economically viable fisheries and fishing communities • Recognizes need to balance different social and economic goals for sustainable fishery management Objectives • Provide economic and community stability to harvesting and processing sectors through fair allocation of fishery resources • Maintain LLP program, and modify as necessary, and further decrease excess fishing capacity and overcapitalization by eliminating latent licences and extending programs such as community or rights-based management to some or all groundfish fisheries • Provide for adaptive management by periodically evaluating the effectiveness of rationalization programs and the allocation of access rights based on performance • Develop management measures that, when practicable, consider the efficient use of fishery resources taking into account the interest of harvesters, processors, and communities.	Gear Restrictions and Allocations	Allocate by gear for certain directed fisheries
	Overcapacity	Maintain existing restricted access programs (LLP and moratorium, AFA, IFQ sablefish, etc.)
		Development of rights-based management programs for the groundfish fisheries, to include protections that maximize benefits in rural communities

With an end to the race-for-fish and implementation of rights-based allocations, participants are expected to be better able to adapt to the additional restrictions placed on the fishery because of increased emphasis on ecosystem management. To the extent participants are able to adapt, the rights-based allocations within the alternative are expected to decrease the number of direct participants and activities of support industries, Remaining participants however, are likely to have increased stability and incomes. The alternative's promotion of rights-based allocations is also expected to increase consumer benefits and health and safety of participants. Additionally, because the disincentives for bycatch reduction inherent in the race-for-fish are reduced, the alternative could reduce bycatch, even if additional bycatch regulations are not imposed.

The alternative also promotes, in PA.2, expanding the range of data reporting required by industry. The collection of additional economic data could be critical in the development and eventual acceptance of additional ecosystem regulations. Regulations such as bycatch restrictions and the creation of MPAs have the potential to have negative effects at least in the short-term on industry participants; if additional data can reduce the uncertainty of social and economics effects associated with these types of restrictions, then it may increase the probability that these regulations could be approved and implemented. A further discussion of the benefits of additional socioeconomic data can be found under Alternative 3 in the Data and Reporting Requirements qualitative analysis paper in Appendix F-11.

4.10.6.9 Increase Alaska Native Consultation

The PA sets objectives to increase Alaska Native consultation, as well as recommending a range of management measures that would implement these objectives.

Goals, Objectives	Corresponding Management Measures	
	FMP Component	Management Measure
Objectives • Continue to incorporate local and Traditional Knowledge in fishery management • Consider ways to enhance collection of local and Traditional Knowledge from communities, and incorporate such knowledge in fishery management where appropriate • Increase Alaska Native participation and consultation in fishery management	Alaska Native Issues	Develop and implement procedures to incorporate local and Traditional Knowledge into fisheries management/ do local and Traditional Knowledge research
		Increase consultation with Alaska Natives
		Encourage increased participation/ representation of Alaska Natives in fishery management
		Allow for subsistence uses consistent with Federal law

Impacts of Policy

Under the PA, there would be some changes to current management policies and measures used by NOAA Fisheries and the NPFMC regarding Alaska Native consultation. These changes increase efforts to collect local and Traditional Knowledge, and develop and implement measures to incorporate it into fishery management. NOAA Fisheries staff anthropologists would increase the collection of existing local and Traditional Knowledge, expand an in-house local and Traditional Knowledge database, and continue informal consultation with individuals in Alaska Native communities. NOAA Fisheries and the NPFMC would work with Alaska Natives to evaluate and develop measures to incorporate Traditional Knowledge. Formal consultation with federally recognized tribal governments during NEPA compliance under EO 13175 would also continue at current levels during NEPA scoping activities and public comment periods on draft NEPA documents, but other forms of consultation would also be considered. Similarly, opportunities for Alaska Native participation in NEPA compliance and NPFMC deliberations would continue to be available during NEPA scoping, public comment periods on draft NEPA documents, review of NPFMC documents, and at NPFMC meetings. However, other forms of outreach and information exchange would be considered to increase participation.

Increased participation and representation of Alaska Natives in fishery management would be encouraged under the PA. NOAA Fisheries and the NPFMC would work with Alaska Natives to identify and develop measures that would increase participation and representation in fishery management.

Under the PA, Alaskan Native participation in the fisheries will be affected by rationalization of fisheries. CDQ groups fishing in the BSAI would continue to benefit from rationalization. Non-CDQ Alaska Native participants in the GOA would also benefit from rationalization of fisheries. Benefits to Alaska Native communities would be mixed, with CDQ communities receiving increased revenues, while non-CDQ Native communities could experience a reduction in employment and support services due to rationalization of fisheries.

Reduced levels of salmon bycatch and additional area closures under PA.2 could benefit subsistence harvest of Steller sea lions and salmon in western Alaska, although cumulative effects have a greater influence on the availability of both subsistence resources. The potential for Environmental Justice impacts as a result of this alternative would be limited to any adverse effects of rationalization on non-CDQ Alaska Native communities.

Under the PA, subsistence uses would continue consistent with federal law. Joint production of subsistence resources, where Alaska Natives who participate in groundfish fishing take advantage of their commercial fishing efforts to harvest subsistence resources, would continue at current levels.

4.10.6.10 Improve Data Quality, Monitoring and Enforcement

The PA accelerates precautionary management of the groundfish fisheries. The policy sets goals and objectives to improve data quality, monitoring, and enforcement, as well as recommending a range of management measures that would implement these objectives.

Impacts of Policy

The goal of the PA, as with all the alternatives, is to base fishery management on the best scientific information available. The PA objectives are to increase the utility of observer data, and to improve the Observer Program; to improve economic impact assessments by changing data reporting requirements; to utilize advances in technology to improve the quality of monitoring and enforcement data; to encourage an ecosystem monitoring program; to work with research institutions to identify research needs and to develop programs to address them; and to promote enforceability.

The Observer Program objective would be implemented through management measures that would either maintain or expand existing coverage but allow more flexible deployment of observers; improve species identification in observer data, and develop uncertainty estimates; and identify alternate funding mechanisms. Building more flexibility into observer deployment, so that coverage can be adjusted rapidly to respond to monitoring needs for data or compliance, would be beneficial and was an original intent of the Research Plan that preceded the interim Service Delivery Model program currently in place (for further historical description, see the Observer Program paper in Appendix F-10). Expanding coverage from 30 percent to 100 percent on the 60 to 125 ft LOA component of the fleet would provide more data on those vessels and address the issue of non-random coverage, but would not resolve lack of coverage issues with the <60 ft vessels.

Implementing improvements to observer data under the PA is accomplished through measures addressing the level of species identification in observer samples and uncertainty estimates. Historically, observers have identified only fish that are managed to the species level; however, the Observer Program has responded to requests to further identify other organisms, most recently skates, sculpins, and some coral species. The program must maintain a balance in consideration of the amount of time to teach identification and to record these species in the field, so as not to sacrifice target species data. A pilot project to determine the recording time required in the field is currently underway, with the goal of understanding the cost-benefit relationships of increasing the specificity of identification. This program would be expanded under PA.2. Regarding the setting of uncertainty estimates, currently there are no established confidence intervals for observer data. A 1997 analysis has indicated, however, that while statistical procedures may be appropriate for the most abundant species in the catch, the statistical precision decreased for rarer species, and the adoption of statistical estimators may need to be paralleled with an increase in the current level of observer coverage and the amount of hauls sampled (see discussion under Alternative 3 of the Observer Program paper in Appendix F-10 for additional information).

Goals, Objectives	**Corresponding Management Measures**	
	FMP Component	**Management Measure**
<u>Goals</u> • Precautionary approach that applies judicious and responsible fisheries management practices, based on sound scientific research and analysis • Base management on the best scientific information available <u>Objectives</u> • Increase the utility of groundfish fishery observer data for the conservation and management of living marine resources • Improve groundfish Observer Program, and consider ways to address the disproportionate costs associated with the current funding mechanism • Improve community and regional economic impact costs and benefits through increased data reporting requirements • Increase the quality of monitoring and enforcement data through improved technological means • Encourage a coordinated, long-term ecosystem monitoring program to collect baseline information and compile existing information from a variety of ongoing research initiatives • Cooperate with research institutions such as the NPRB in identifying research needs to address pressing fishery issues • Continue to cooperate and coordinate management and enforcement programs with state and federal agencies, the IPHC and other organizations • Promote enhanced enforceability	Observer Program	Observer Program coverage expanded or modified based on compliance or data needs, scientifically based; coverage to all vessels regardless of length (less than 60' or 60' or greater).
		Explore alternate funding mechanisms
		Improve observer species identification, develop uncertainty estimates (PA.2)
	Data and Reporting Requirements	Require broader range of economic data from industry participants, verified through third party (PA.2)
		Require VMS for Steller sea lion prey species; modify to incorporate new technology and system providers

The Observer Program funding objective issue stems from the appearance of a conflict of interest arising from the direct financial relationship between the observer's employer and industry. The PA explores changes to the funding mechanism in order to alleviate any taint on the credibility of observer data, and proposes a range of solutions that include full federal funding, industry fee-based funding and setting aside a portion of TAC (see discussion under Alternative 3 of the Observer Program paper in Appendix F-10 for additional information).

The implementation of changes to the data and reporting requirements under PA.2 expands the range of economic data requested from industry participants, and sets up a third party verification system, potentially in aggregate, for reported data. New information would include data on employment, variable harvesting and processing costs, and fixed/annual costs (see Appendix F-11, the Data and Reporting Requirements paper, Alternative 3). This additional information would enhance the ability of analysts to provide accurate estimates of the costs and benefits of proposed regulatory actions. Additionally, third party data collectors would be able to verify revenue data currently submitted. While authenticated data would allow for more accurate and credible economic impact assessments, a funding source would need to be identified to support the independent verification system.

The use of available technology to improve monitoring data is addressed in the FMPs through the ability to modify VMS to incorporate new technology and system providers. This may lead to a reduction in costs or improvements in technology and usage.

Establishing an effective ecosystem monitoring plan would accelerate precautionary management by providing an appropriate baseline against which to measure the impacts of fishing. Various ongoing research initiatives would contribute to this program, and new areas of research would be identified. The results would be compiled into a comprehensive monitoring plan. Funding for such a program would need to be identified, but the results would be a beneficial step in understanding the ecosystem impacts of fishery interactions.

The PA expands research efforts by seeking out partners, such as the North Pacific Research Board, to help identify research needs and to source funding for the research programs to address these data needs.

The objective to promote enhanced enforceability would encourage NPFMC to continue to prioritize enforcement considerations in designing management measure and program changes to the groundfish fisheries. It is likely that this objective may result in increased consultation with the Coast Guard in the design of management measures.

Cooperation, consultation, and coordination by the NPFMC and NOAA Fisheries with the State of Alaska agencies, federal agencies such as the USFWS and USCG, and organizations such as the IPHC, facilitate effective and efficient management and enforcement measures that promote conservation and sustainability.

The PA data quality, monitoring, and enforcement objectives conform with the overall policy intent of the alternative, namely to accelerate precautionary management in two ways: where appropriate, to take steps to incorporate uncertainty and ecosystem considerations into fishery management, and at the same time, to increase efforts to improve scientific understanding and diminish uncertainty. The objectives in the PA result in data collection on direct fishery impacts and interactions as well as on broader ecosystem relationships and indirect effects, and emphasize the importance of enforcement concerns in fishery management.

4.11 Comparison of Alternatives at the Policy Level

In Section 4.10 the impact analysis of the alternatives were summarized. In this section, we first compare the alternatives against the relevant requirements of Federal law, as well as other national recommendations that pertain to groundfish fishery management. Then, after summarizing the impact analysis of the alternatives from Section 4.10. Then the alternatives are compared against each other in regard to their impacts on the human environment.

4.11.1 Comparison of Alternatives Against Laws and National Recommendations

The alternatives developed for this Programmatic SEIS are policy statements that present a "vision"; one that is based on a management approach and a suite of goals and objectives, on how Alaska groundfish resources can be managed for the common good. Each policy alternative was designed to meet the minimum federal statutory requirements applicable to fisheries management and in most cases exceed those minimum requirements. The range of policy alternatives encompass the range of social values expressed by Congress, NOAA Fisheries, the NPFMC, and the public.

This section presents a policy review of each alternative against key federal laws that apply to fisheries management, national policy goals, and other recommendations for management of fishery resources in order to illustrate how well each policy alternative satisfies various statutory requirements. A detailed summary of all applicable federal laws and EOs is presented in Chapter 2 (Section 2.2.2) and will not be repeated here.

4.11.1.1 Federal Statutory Requirements

NOAA Fisheries is mandated by a variety of federal statutes to manage, conserve, and protect the Nation's living marine resources. Some of the main tenets of the agency's legislative mandates require a balancing of objectives. For instance, the MSA directs the agency to manage living marine resources for optimum sustainable utilization, while the MMPA prohibits exploitation of marine mammals and directs the agency to protect and maintain them at optimum sustainable population levels. The alternatives under examination in this Programmatic SEIS consider all of the statutory requirements and EO mandates relevant to fisheries management. The alternatives represent different ways in which the objectives embodied in the statutes and EOs can be balanced. The following statutes and EOs are at the heart of federal fisheries management and play an integral part in defining the scope of the policies, goals, and objectives contained in, and management measures that flow from, an FMP:

- The Magnuson Stevens Fishery Conservation and Management Act of 1976 (MSA).
- Endangered Species Act of 1973 (ESA).
- Marine Mammal Protection Act (MMPA).
- EO 12866 – Regulatory Planning and Review.
- EO 12898 – Environmental Justice Guidance Under NEPA.

- EO 13084 – Consultation and Coordination with Indian Tribal Governments.
- EO 13158 – Marine Protected Areas.

Table 4.11-1 compares the above-mentioned statutes and EOs with each alternative and describes how the alternatives take into account the statutory and EO requirements. The table also points out possible inconsistencies between the alternatives and the statutory and EO requirements.

4.11.1.2 NOAA Fisheries Strategic Plan

In 1998, the NOAA Fisheries published its strategic plan outlining its mission and its goals for guiding marine resource management decisions. In the spirit of the Government Performance and Results Act, the agency focused its plan on measurable results which were viewed as important to the American people, rather than on specific activities or programs. NOAA Fisheries intentionally set ambitious standards for itself against which its performance can be measured. The agency, after five years, could review its performance, celebrate its accomplishments, and learn from its shortcomings. NOAA Fisheries is currently conducting its five-year assessment and, based on its findings, will revise its strategic plan for the next five years.

In order to fulfill its stewardship mission, NOAA Fisheries has structured its divisions around three broad strategic goals:

1. Rebuild and maintain sustainable fisheries.
2. Promote the recovery of protected species.
3. Protect and maintain the health of coastal marine habitats.

Rebuild and Maintain Sustainable Fisheries

A sustainable fishery is one in which the rate of fishing mortality does not jeopardize the capacity of the stock to produce the maximum sustainable yield on a continuous basis. By building and maintaining sustainable fisheries, NOAA Fisheries ensures that fish stocks are available for many uses such as commercial, recreational, and subsistence. To realize this goal, they will:

- Maintain healthy stocks important to commercial, recreational, and subsistence fisheries.
- Eliminate overfishing and rebuild overfished stocks important to commercial, recreational, and subsistence fisheries.
- Increase long-term economic and social benefits to the nation from living marine resources.
- Promote the development of robust and environmentally sound aquaculture (where applicable).

Promote the Recovery of Protected Species

As part of its stewardship responsibility, NOAA Fisheries must ensure that our nation's living marine resources will be protected and enhanced for future generations. Protected species under the agencies' jurisdiction include all cetaceans and pinnipeds (excluding walruses) in addition to those marine species listed as threatened or endangered under the Endangered Species Act. NOAA Fisheries will provide effective leadership to conserve and recover marine species protected by statute or international treaty through conservation programs that are based on sound scientific research and decision-making. They will also provide for non-consumptive uses of protected resources which are compatible with their long-term conservation. To realize this goal, they will:

- Recover and maintain protected species populations.

- Reduce conflicts that involve protected species.

Protect and Maintain the Health of Coastal Marine Habitats

All living marine resources are vulnerable to habitat degradation, which can threaten the biodiversity on which they depend. These habitats are at risk from human activities which degrade or destroy habitat quality and quantity. NOAA Fisheries recognizes that protection of living marine resource habitat is crucial to the success of management and conservation efforts. To realize this goal, they will:

- Protect, conserve, and restore living marine resource habitat and biodiversity

<u>Evaluation of Policy Alternatives</u>

NOAA Fisheries is committed to achieving its strategic goals when making its management decisions. It will evaluate reasonable alternative management measures for achieving these goals and objectives, with appropriate consideration to competing interests and demands for fishery resource use. All the policy alternatives in this Programmatic SEIS comply with the strategic goals. The BSAI and GOA groundfish resources and their essential habitats can be destroyed if harvest is not carefully controlled or their important habitat goes unprotected. But with proper management, healthy stocks can be maintained, and diminished fish, Steller sea lion, and other populations can be restored to bring greater wealth to coastal communities. Policy Alternatives 1, 3, 4, and the PA provide the greatest management control over the harvest of groundfish. BSAI and GOA groundfish fisheries that are sustainable over the long-term allow United States citizens to reap the greatest economic and social benefits which include a continuing supply of high-quality seafood and recreational and subsistence fishing opportunities.

Sound scientific research is the basis for sustainable fisheries. However, unaccounted factors may unknowingly create or exacerbate stock declines, giving rise to crisis management of fisheries. Examples include the effects of noise on marine mammal health and behavior and the impact of habitat modification by fishing gear. Currently, NOAA Fisheries must make management decisions without having conducted sufficient investigations of the spectrum of ecological and anthropogenic factors that contribute to the equilibrium of natural systems. To help ensure productive future harvests, NOAA Fisheries scientists study the life history, stock size, habitat, and ecology of economically important fishes, and the effects of climate and ocean processes on their populations. This information is used by fishery managers to set TACs, fishing seasons, bycatch limits, and gear restrictions each year. All of the policy alternatives rely on continued scientific research and monitoring of the fisheries. Alternatives 3, 4, and the PA commit the agency to explore additional funding to support an expanded research program aimed at filling the scientific data gaps identified through preparation of this Programmatic SEIS. Such data is needed to measure progress in achieving policy goals and objectives and to answer the many questions about the effects of fishing on the marine ecosystem.

Many marine mammals, such as Steller sea lions, whales, and seals, as well as seabirds, listed albatross, salmon and sea turtles, are all protected by federal law. These valuable species comprise important members of the BSAI and GOA ecosystem. The protected species can be affected by fisheries, other human activities, and by environmental change. NOAA Fisheries seeks to reduce the impacts of fishing activities on protected species while ensuring the viability of valuable fisheries. All of the policy alternatives in this Programmatic SEIS include protection measures determined to avoid jeopardizing the recovery of Steller sea lions and short-tailed albatross and avoid adverse modification of critical habitat for Steller sea lions. Alternatives 1 and 2 commit the agency to its current protection plan and its continuing relationship with the USFWS. Policy Alternative 3 and the PA builds on this commitment by indicating it will adjust protection measures as appropriate based on new scientific evidence supporting a need for change. Policy Alternative 4 would result in immediate adjustments to the level of groundfish harvest and suite of other protection measures, including the possibility of temporary suspension of the fisheries as a precautionary measure, until scientific information is obtained that would support a relaxation of precautionary measures. All alternatives explicitly prioritize as a policy objective the recovery of threatened and endangered species.

Coastal habitats, such as estuaries, offshore pinnacles and gullies, and a variety of physical substrates, provide food and shelter for marine fish and shellfish during important stages of their life cycle. NOAA Fisheries monitors development, water and sediment contamination, dredging and filling activities, and oil development projects off Alaska. The agency is a major force in maintaining the health of marine ecosystems by leading research to identify and restore damaged habitat, and by recommending measures to offset development and use impacts. Alternatives 1, 2, 3, 4, and the PA all explicitly recognize through specific policy objectives the importance of protecting EFH and other marine habitat from human activities. Alternative 3 and the PA builds on current policy, legal requirements, and protection initiatives by recognizing the use of MPAs (in all their forms) as a legitimate management tool, and based on scientific review, the NPFMC and the agency will develop a MPA policy in coordination with national and state policies. Alternatives 3, 4, and the PA would establish large MPAs as a precautionary measure until scientific evidence shows they are not needed.

4.11.1.3 Ecosystem Principles Advisory Panel and National Research Council Recommendations

The SFA strengthened the MSA by mandating new conservation measures. One provision of the Sustainable Fisheries Act was the appointment of a NOAA Fisheries Ecosystem Principles Advisory Panel. The Panel was tasked with reporting to Congress the extent to which ecosystem principles are being applied in fishery conservation and management activities, including research activities, and to propose actions that should be undertaken to expand the application of ecosystem principles in fishery conservation and management. The Panel's report was published in 1999, and thus provides updated information on ecosystem-based management of fisheries (EPAP 1999).

The Panel developed a list of basic ecosystem principles and policies, and recommended that Fisheries Ecosystem Plans (FEPs) be developed as a first step towards a full ecosystem-based fisheries management approach. Components of the plan include food web models, habitat needs, estimates of total removals, an assessment of uncertainty and buffers, indices of ecosystem health and use, long-term monitoring plans, and an assessment of other elements. The basic principles outline the complex and dynamic nature of marine systems that are composed of interconnected groups of living organisms and their habitats and form the foundation of ecosystem based management strategies.

Building on these principles, the Panel developed six general ecosystem-based management policies to guide fishery managers. These policies reflect the importance of the ecosystem-based principles associated with the limitations on extraction, uncertainty, and the role of humans within ecosystems. A description of these six policies, as provided by the Panel, is listed below.

1. Change the burden of proof. – We live in a world where humans are an important component of almost all ecosystems. Thus, it is reasonable to assume that human activities will impact ecosystems. The modus operandi for fisheries management should change from traditional mode of restricting fishing activity only after it has demonstrated an unacceptable impact, to a future mode of only allowing fishing activity that can be reasonably expected to operate without unacceptable impacts.

2. Apply the precautionary approach. – The precautionary approach is a key element of the United Nations Agreement for Straddling Stocks and Highly Migratory Species (United Nations 1996) and the Food and Agriculture Organization of the United Nations (FAO) Code of Conduct for the Responsible Fisheries (FAO 1995). The U.S. is a signatory of both.

3. Purchase "insurance" against unforseen, adverse ecosystem impacts. – Even under the precautionary approach, there is a risk of unforeseen, adverse impacts on ecosystems. Insurance can be used to mitigate these impacts if and when they occur.

4. Learn from management experiences. – Management actions and policies can be considered as experiments and should be based upon hypotheses about the ecosystem response. This requires close monitoring of results to determine to what extent the hypotheses are supported.

5. Make local incentives compatible with global goals. – Changing human behavior is most easily accomplished by changing the local incentives to be consistent with broader social goals. The lack of consistency between local incentives and global goals is the root cause of many "social traps," including those in fisheries management (Costanza 1987). Changing incentives is complex and must be accomplished in culturally appropriate ways.

6. Promote participation, fairness, and equity in policy and management. – Ecosystem approaches to management rely on the participation, understanding and support of multiple constituencies. Policies that are developed and implemented with the full participation and consideration of all stakeholders, including the interests of future generations, are more likely to be fair and equitable, and to be perceived as such.

The overall recommendation of the Panel was to expand the application of ecosystem principles, goals, and policies to fishery management and research. The mechanism to accomplish this is through development of an FEP that would be developed for each major ecosystem. A requirement for regional councils to develop FEPs is being considered now by Congress. A comparison of the four policy alternatives in this Programmatic SEIS against these six recommended ecosystem-based management policies reveals that most of these principles are incorporated into the alternatives.

Change the Burden of Proof

Only Alternative 4 meets this principle in the strictest sense. This alternative represents a paradigm shift in management policy and in the near term would likely lead to significant restrictions placed on commercial groundfish fisheries off Alaska. However, Alternatives 1, 3 and the PA do informally meet the principle in certain circumstances. For example, the NPFMC does now restrict the development of certain fisheries for lack of information and concern over unknown impacts, thereby assuming some of the burden of proof due to uncertainty.

Apply the Precautionary Approach

Alternatives 1, 3, 4, and the PA all incorporate this management principle. Alternatives 3, 4 and the PA would accelerate precautionary measures to address uncertainty. Under the PA, the OY caps in the BSAI and GOA are kept in place even though the ABCs for many groundfish stocks would support greater harvests. Alternative 2 would pose the greatest risk to the ecosystem compared to the other alternatives.

Purchase "Insurance" Against Unforseen, Adverse Ecosystem Impacts

Alternatives 1, 3, 4, and the PA all apply the precautionary principle and therefore institute various buffers and other safeguards to reduce the risk of overfishing and to mitigate the adverse effects of fishing on the ecosystem. The aggressive harvest policy illustrated by Alternative 2 poses the greatest risk of harming the environment compared to the other alternatives.

Learn from Management Experiences

All five alternatives were structured based on a historical review of the lessons learned from over 25 years of groundfish fisheries management. Each alternative is adaptive and as new scientific information is obtained, changes to the groundfish FMPs are likely to occur.

Make Local Incentives Compatible with Global Goals

All five alternatives aim to achieve their policy objectives (e.g., "global goals") through use of specific FMP components and management measures. To varying degrees, the alternatives illustrate a range of potential management actions, many of which are designed to influence fishermen and processor behavior. The PA and Alternative 3 are similar in this regard. Past experience in managing the Alaska groundfish fisheries has shown the value of consulting with various stakeholders and the public to ensure that the eventual measures are meaningful and will achieve the intended goals and objectives.

Promote Participation, Fairness, and Equity in Policy and Management

The MSA and regional council process rely heavily on public involvement throughout the decision-making process. Public involvement would continue under all four policy alternatives. Under Alternative 1, the NPFMC has already begun to incorporate these ecosystem policies into its groundfish management program. The NPFMC has established a Ecosystem Committee, comprised of scientists, stakeholders, and interested public, to review the scientific literature and provide advice to the NPFMC. The Ecosystem Considerations Appendix to the SAFE report that is prepared annually by the NOAA Fisheries AFSC, together with what is provided in this Programmatic SEIS, already assembles most of the information required for an FEP. Should Congress require that councils prepare an FEP for their respective regions, the NPFMC has in many ways already gathered the necessary information to put such a document together under any of the four alternatives. Under Alternative 2, it may prove difficult to build on the information base needed to keep an FEP current. Alternative 2 policy presumes that there are no adverse effects of fishing on the ecosystem and such a presumption may serve as the basis for curtailing existing research and monitoring programs. Alternative 3, 4, and the PA would seek to expand on current data gathering programs, and the FEPs prepared under these alternatives would certainly be more thorough and easier to update over time.

Evaluation of Alternatives relative to National Research Council's Ecosystem Based Management Standards

In 1999, the NRC, an agency organized by the National Academy of Sciences, published new performance standards for fishery management in "Sustaining Marine Fisheries" (NRC 1999). The publication reviews the status of global fisheries, the problems facing fishery managers, and provides recommendations on how to improve management to achieve sustainable marine fisheries. The overall recommendation of the NRC was the adoption of an ecosystem-based approach for fishery management with the goal "to rebuild and sustain populations, species, biological communities, and marine ecosystems at high levels of productivity and biological diversity, so as not to jeopardize the wide range of goods and services from marine ecosystems, while providing food, revenue, and recreation for humans" (NRC 1999). To achieve an ecosystem-based approach, the NRC made several specific recommendations (see inset on this page).

Summary of the National Research Council's recommendations for ecosystem-based management to achieve sustainable fisheries.

1. Adopt conservative harvest levels for single species fisheries.
2. Incorporate ecosystem considerations into fishery management decisions.
3. Adopt a precautionary approach to deal with uncertainty.
4. Reduce excess fishing capacity and define and assign fishing rights.
5. Establish marine protected areas as a buffer for uncertainty.
6. Include bycatch mortality in TAC accounting.
7. Develop institutions to achieve goals.
8. Conduct more research on structure and function of marine ecosystems.

Although neither the MSA nor the NOAA Fisheries Strategic Plan has been amended to specifically incorporate the NRC's recommendations, a comparison of the alternatives to the NRC recommendations is useful.

Conservative Single Species Management of Commercially Important Fisheries

Relative to elsewhere in the world, the management of commercially important groundfish fisheries under Alternative 1 is conservative. Low harvest rates, combined with other management elements, provide for conservative single species management of commercially important species to achieve sustainable groundfish fisheries in the North Pacific. All groundfish stocks are considered relatively healthy after experiencing 20 years of sustained annual harvests of about two million metric tons. No fish stocks have been deemed overfished, approaching an overfished condition, or subject to overfishing in a recent evaluation of the status of U.S. fisheries (NOAA Fisheries 1999). Existing single species management of North Pacific groundfish meet the conservative and risk-averse approach standard recommended by the NRC. None of the groundfish stocks are subject to overfishing as defined under the MSA. The NPFMC is considering revising its harvest rate strategy for rockfish.

Alternative 2, which would adopt a more aggressive harvest policy, would seek to prevent single species overfishing while maximizing yield. Such a policy would increase the risk of overfishing, especially for those fish stocks where there is little information on stock status. Alternatives 3, 4 and the PA would all institute a more precautionary management policy where harvest strategies, if modified, would more likely be reduced. In the case of Alternative 4, reductions in single species ABCs and TACs would occur after adoption of policy by NOAA Fisheries until scientific information were available to show that a higher exploitation rate would not adversely impact the stock.

The North Pacific Fishery Management Council's Working Draft for Ecosystem-Based Management.

Definition: Ecosystem-based management, as defined by the NPFMC, is a strategy to regulate human activity towards maintaining long-term system sustainability (within the range of natural variability as we understand it) of the North Pacific, covering the GOA, the eastern and western Bering Sea, and the Aleutian Islands region.

Objective: Provide future generations the opportunities and resources we enjoy today.

Goals:
1. Maintain biodiversity consistent with natural evolutionary and ecological processes, including dynamic change and variability.
2. Maintain and restore habitats essential for fish and their prey.
3. Maintain system sustainability and sustainable yields of resources for human consumption and non-extractive uses.
4. Maintain the concept that humans are components of the ecosystem.

Guidelines:
1. Integrate ecosystem-based management through interactive partnerships with other agencies, stakeholders, and public.
2. Utilize sound ecological models as an aid in understanding the structure, function, and dynamics of the ecosystem.
3. Utilize research and monitoring to test ecosystem approaches.
4. Use precaution when faced with uncertainties to minimize risk; management decisions should err on the side of resource conservation.

Understanding:
1. Uncontrolled human population growth and consequent demand for resources are inconsistent with resource sustainability.
2. Ecosystem-based management requires time scales that transcend human lifetimes.
3. Ecosystems are open, interconnected, complex, and dynamic; they transcend management boundaries.

Incorporating Ecosystem Considerations into Fishery Management

The NPFMC has been actively developing an ecosystem-based approach to managing fisheries. A working draft of their approach is provided at right. The NPFMC's approach under Alternative 1 involves public participation, reliance on scientific research and advice, conservative catch quotas, comprehensive monitoring and enforcement, bycatch controls, gear restrictions, temporal and spatial distribution of fisheries, marine protection areas, and other biological and socioeconomic considerations. Management measures are also taken to minimize potential impacts of fishing activities on sea floor habitat and other ecosystem components such as marine mammals and seabirds.

The public, scientists, and policy makers have all contributed to the development of an ecosystem-based management strategy. Since 1995, the groundfish plan teams have added an Ecosystem Considerations section to their SAFE document that provides an annual assessment of the ecosystem, a review of recent ecosystem-based management literature, updates of ongoing ecosystem research, local observations from coastal people and fishermen, and available new information on the status of seabirds, marine mammals, habitat and other components of the North Pacific ecosystem. The NPFMC also has an Ecosystem Committee, which was established to discuss and recommend possible approaches to incorporating ecosystem concerns into the fishery management process. A major role of this committee has been to provide the NPFMC and stakeholders with information on ecosystem-based fishery management in the North Pacific. While a full understanding of North Pacific ecosystem dynamics remains beyond our grasp, the NPFMC and NOAA Fisheries are striving to achieve a better understanding of this system and, in the interim, are attempting to incorporate what we do know into the fisheries management process.

Although the NRC report provides some guidance on ecosystem-based management, there is no roadmap to follow or other examples to emulate. In a recent international meeting on the ecosystem effects of fishing, the NPFMC's efforts on ecosystem management (Witherell *et al.* 2000) were considered to be state-of-the-art.

All alternatives would incorporate ecosystem considerations into the fishery management decision-making process. The difference in alternatives is reflected in both the level of commitment toward ecosystem-based management principles (as illustrated by their stated management approach and objectives and further defined by their FMP bookends) and the commitment for expanded research. Alternatives 3, 4, and the PA more fully capture the NRC recommendations compared to Alternative 2.

A Precautionary Approach to Deal with Uncertainty

The primary sources of scientific uncertainty in fishery management are the uncertainty about fishing effects on ecosystems and the uncertainty associated with stock assessments. For stock assessments, uncertainty can be associated with catch statistics (e.g., observer estimation error, misreporting), biological parameters (e.g., maturity, mortality, growth), resource assessment survey measurement error, and natural variability in dynamics such as recruitment.

In the North Pacific fishery management arena, uncertainty under Alternative 1 is dealt with in several ways. In the case of establishing acceptable harvest rates the ABCs are based on a system of tiers corresponding to information availability on population dynamics parameters. The Pacific cod stock assessment went an additional step of evaluating uncertainty regarding specific model parameters. The ABC for the 2003 fisheries was based on a risk-averse optimization procedure that adjusts for uncertainty in the selectivity coefficients and natural mortality rate. This type of analysis will likely be expanded to other assessments in coming years.

Uncertainty regarding species interactions, environmental factors, and human actions is addressed with other management measures under Alternative 1. Regulatory changes that have to some degree addressed these sources of uncertainty include establishment of marine protected areas, the OY cap in the BSAI and GOA, the forage fish prohibition, and spatial/temporal restrictions to reduce adverse affects to Steller sea lions and walrus.

Alternatives 3 and 4 present two dramatically different approaches to applying the precautionary principle to fisheries management. Similar to Alternative 1, Alternative 3 presents an adaptive approach to management where the FMPs are modified as scientific information indicates that the ecosystem is stressed or that there are unacceptable environmental impacts caused by fishing. Alternative 3 differs from Alternative 1 by formalizing a procedure for addressing uncertainty in stock assessments and other information, where at present uncertainty factors are treated on an ad hoc basis. The PA commits to completing its scientific review of current harvest strategies and adopting any improvements necessary to provide protection to target groundfish species. The NPFMC will also look for ways to better manage species currently not targeted or managed using a species-assemblage approach. Alternative 4 shifts the burden of proof from demonstrating adverse impacts in order to prohibit or proscribe a fishery to demonstrating no adverse impacts in order to authorize a fishery. Under this policy, substantial restrictions on the current levels of harvest among other actions, would protect the resource until scientific information could be collected to determine whether a more liberal harvest could be authorized. Such information would have to possess a higher level of certainty than presently exists for most fisheries and stocks.

Reducing Excess Fishing Capacity and Assignment of Fishing Rights

There is no doubt that the groundfish industry in the North Pacific is overcapitalized due to limited quotas and the race-for-fish. The NRC report tends to link overcapacity with overfishing, because some fisheries (e.g., New England groundfish and scallops) have been traditionally managed with effort control, rather than quotas. Because catch is limited under Alternative 1 by TACs in the North Pacific, overcapacity does not necessarily increase the potential for overfishing. However, participants in overcapitalized fisheries can exert strong pressure for liberal catch quotas and other risk prone management measures, though there has been little evidence of that in fisheries under NPFMC jurisdiction. Also, in extreme cases, excess harvesting capacity may shorten seasons to a point that fishing quotas cannot be accurately monitored. The GOA pollock fishery is an examples of a fishery where quota overages have occurred in the North Pacific.

Under Alternative 1, the NPFMC has developed several programs to address overcapacity in the fisheries. Groundfish management programs generally limit the number of vessels that are allowed to fish off Alaska. In addition, halibut and fixed gear sablefish are managed under an IFQ program, which does not limit the number of vessels, but instead, grants permission to individuals to harvest a specified percentage of the TAC each year.

The AFA, passed in late 1998, among other things limited the number of harvesting and processing vessels that would be allowed to participate in the BSAI pollock fishery. Only harvesting and processing vessels that met specific requirements, based on their participation in the 1995-97 fisheries, are eligible to harvest BSAI pollock. Twenty-one catcher processors and 120 catcher vessels qualified under the AFA. Nine large capacity catcher processors were retired from the fishery by the AFA. Under the fishery cooperative structure now in place, not all 21 eligible catcher processors have chosen to fish in the late winter and early spring pollock seasons. The AFA also restricts eligible vessels from shifting their effort into other fisheries. “Sideboard” measures, as they have become known, prevent AFA eligible vessels from increasing their catch in other fisheries beyond their average 1995-97 levels. Sideboard restrictions reduce the likelihood that the fishing capacity of AFA eligible vessels will be increased to better compete in those fisheries. The fishery cooperative has proven to be an effective and efficient operating structure for fishermen and processors.

Adoption of Alternative 2 would result in a systematic review of existing license limitation and rights-based management programs (with the exception of those mandated under the AFA and MSA) and based on that review, the NPFMC and NOAA Fisheries could determine that such programs are not working and that these programs should be modified or eliminated. Such actions would not be consistent with the NRC recommendation to reduce excess fishing capacity and assign fishing rights. More consistent are Alternatives 3, 4 and the PA, all of which seek as a matter of policy to further reduce overcapacity and explore various means of achieving that objective. Alternative 3 and the PA seek to provide economic and community stability to the harvesting and processing sectors through fair allocation of fishery resources. This policy alternative also would seek to eliminate the race-for-fish in all groundfish fisheries by eliminating latent licenses and extending programs such as community or rights-based management cooperatives.

Alternative 4 emphasizes ecosystem considerations above economic and community considerations, but otherwise shares the objectives of Alternative 3 and the PA. One notable difference is that Alternative 4 formally incorporates the concept of non-consumptive use valuation into the fishery management decision-making process.

Marine Protected Areas

It has been long recognized that sea floor habitat is essential for maintaining productivity of fishery resources. Habitat that provides structural relief on an otherwise featureless bottom can be particularly important to fish for food, reproduction, and shelter from predators. Structural habitat includes boulders, corals, anemones, kelp, and other living organisms attached to the ocean bottom.

Because structural habitat has the potential for being disturbed by fishing gear, regulations have been implemented to protect areas where this habitat type is known to occur. Vast areas of the North Pacific have been permanently closed under Alternative 1 to groundfish trawling and scallop dredging to reduce potential adverse impacts on vulnerable habitat and to protect juvenile crab. Other closures occur on a seasonal basis, and additional closures to mobile fishing gear are under consideration. A unique nearshore pinnacle off Cape Edgecumbe in southeast Alaska has been closed to groundfish fishing for all gear types.

The NRC considers permanent marine protected areas to be an important and useful tool for fisheries managers. MPAs would provide a hedge against uncertainty, provide habitat protection, and allow for species and ecosystem protection. The NRC defines marine protected areas as those where all commercial fishing or activities are prohibited. Furthermore, the NRC suggests that 20 percent of the potential fishing area be considered for marine protected areas. In this Programmatic SEIS, we use the term "no-take marine reserves" rather than "marine protected area," to make clear that such an area would be closed to all commercial fishing. The term "marine protected area", or MPA, is used in this Programmatic SEIS to distinguish an area where some form of gear or fishery restriction is in place, but that it is not totally closed to all gear types or fisheries.

MPAs (as defined in the Programmatic SEIS; e.g., areas subject to some form of gear or fishery restriction but not totally closed) comprise a relatively large portion of the continental shelf (29 percent of the shelf and slope to a depth of 1,000 m; termed fishable area in this Programmatic SEIS; Figure 4.2-1). In the BSAI, MPAs encompass about nine percent of the EEZ, or about 22 percent of the fishable area. The GOA closures encompass about 14 percent of the EEZ, or 46 percent of the fishable area. Some environmental advocates and scientists have suggested that no-take marine reserves should be at least 20 percent of available habitat in order to be effective. The current suite of closed areas under both the BSAI and GOA falls far short of this objective, with less than one percent of the EEZ/fishable area closed to all groundfish fishing.

Alternative 2, the more aggressive harvest policy, assumes that there are no adverse impacts of commercial fishing on the environment and that there is no need to establish a Alaska groundfish MPA program. Adoption of this policy would be inconsistent with the NRC recommendation to establish a MPA program and EO 13158.

Adoption of Alternative 3, a more precautionary management policy, would at a minimum initiate a formal review of the applicability of an MPA program off Alaska and develop the necessary criteria and process for review of existing closed and restricted areas and to identify new areas as candidates under such a formalized program. This policy would also commit the agency to increased research on EFH. Under Alternative 3, both no-take reserves and MPAs would be considered viable management tools for achieving habitat protection and ecosystem-based management objectives. As such, this alternative is fully consistent with the NRC and Ecosystem Advisory Panel management standard.

Alternative 4 is also consistent with this standard. It differs from Alternative 3 by increasing policy emphasis on establishing no-take marine reserves as a means of ensuring that ecological processes and individual species protection objectives are met. It is recognized elsewhere in this Programmatic SEIS that considerable care is needed in determining where such reserves should be established and that such care requires considerable public and community involvement.

The PA is a modified version of the Alternative 3 policy in reference to habitat protection and the use of MPA and no-take reserves. Under the PA, the NPFMC would commit to developing a MPA policy for Alaska and coordinate its development with both state and federal MPA committees recently established. Under the PA, the NPFMC recommends that the agency maintain all existing closures until criteria can be developed for evaluating the effectiveness of all current closed areas in achieving habitat protection objectives as well as identify possibly new areas as candidates for MPA designation. For purposes of analysis and illustration, the PA uses the maps developed for Alternative 3 as examples of the range of concepts that will be pursued in the designation of EFH and HAPC and the development of MPAs (Figures 4.2-8 and 4.2-9). Figure 4.2-8 illustrates the system of closed areas and MPAs currently in effect. Figure 4.2-9 illustrates a expansion of closures up to 20 percent of the EEZ/fishable area. It should be noted that Figure 4.2-9 illustrates a true composite of MPA concepts that could be used to protect habitat as well as other closures to protect Steller sea lions and king and Tanner crab. It is not likely that all the concepts would be implemented simultaneously. It is also unlikely that all the areas shown as closed in the illustration would be implemented. Detailed analysis conducted in conjunction with this Programmatic SEIS revealed that some of these areas provided questionable benefits to habitat. In addition, the scale of the mapped closures are too crude to satisfy legal requirements and are only intended to provide conceptual representation of MPAs. [The reader should refer to the NPFMC's EFH EIS analysis for more detail on EFH and the range of possible mitigation alternatives.]

Bycatch and Discards

The issues of bycatch, discard, and waste of fish resources stem from social, economic, and conservation concerns. From an ecosystem perspective, mortality of unwanted and prohibited species may reduce spawning potential, reduce biodiversity, alter regular paths of energy flow and balance, enhance the growth of scavenger populations, and add uncertainty to estimates of total removals.

The NRC notes that conservation concerns are raised in world fisheries where bycatch and discards are treated as side effects of fishing. Under Alternative 1, all bycatch and discarded groundfish are counted toward the TAC established for individual stocks. Additionally, because observers sample the entire catch, not just the retained portion, the information on bycatch and discards is available and is directly incorporated into the annual stock assessments.

Fish are discarded for two reasons: either they are required to be thrown back due to regulations (prohibited species), or they are unwanted for market reasons. In the North Pacific, discards of unwanted groundfish (so-called economic discards) result when fishermen do not have markets, sufficient equipment, time, or economic return to retain and process the catch. In the 1997 BSAI groundfish fisheries, a total of 258,000 mt of groundfish were discarded, equating to about 15 percent of the total groundfish catch. Although this discard rate is much lower than most of the world's groundfish fisheries, which average about 19.9 percent discards, and it is deducted from the TAC, the sheer volume of discards is troublesome to many people who consider economic discards as a waste of food and as having an unnecessary impact to the ecosystem.

Bycatch management measures implemented for groundfish fisheries of the EBS under Alternative 1 have focused on reducing the incidental capture and injury of species traditionally harvested by other fisheries. These species include crab, herring, halibut, and salmon. Collectively, these species are called "prohibited species," as they cannot be retained as bycatch in groundfish fisheries and must be discarded with a minimum of injury.

In addition to bycatch limits, gear restrictions and other regulatory changes have also been implemented to reduce bycatch and waste. Biodegradable panels are required for pot gear to minimize waste associated with ghost fishing of lost gear. Tunnel openings for pot gear are limited in size to reduce incidental catch of halibut and crabs. Gillnets for groundfish have been prohibited to prevent ghost fishing and reduce bycatch of non-target species. With the implementation of an IFQ system for halibut and sablefish longline fisheries in 1995, bycatch and waste were reduced because the race-for-fish was eliminated, allowing for more selective fishing practices and significant reductions in actual gear deployment/loss. BSAI Amendment 57 prohibited the use of non-pelagic trawl gear for vessels targeting pollock in the Bering Sea, and made a concomitant reduction of allowable prohibited species bycatch of halibut and crabs.

To reduce groundfish economic discards, the NPFMC adopted an improved retention and utilization (IR/IU) program for all groundfish target fisheries. Beginning in 1998, 100 percent retention of pollock and Pacific cod was required, regardless of how or where it was caught. Only fish not fit for human consumption can be legally discarded. This measure has dramatically reduced overall discard of groundfish. For example, in 1997, about 22,100 mt of Pacific cod (8.6 percent of the cod catch) and 94,800 mt of pollock (8.2 percent of the pollock catch) were discarded. In 1998, discard amounted to only 4,300 mt of Pacific cod (2.2 percent) and 16,200 mt of pollock (1.6 percent). A proposed rule requiring full retention of all demersal shelf rockfish species (e.g., yelloweye rockfish) has been published.

Waste of salmon and halibut has been reduced by allowing bycatch of dead fish to be donated to food banks. The food banks in turn distribute the fish to needy people in the northwestern United States. Many fishing companies voluntarily participate in the donation program. Through 2001, over 4 million pounds of donated fish have produced an estimated 14 million meals for underprivileged persons.

Numerous regulations have been implemented to reduce bycatch and discards of groundfish and crabs. It is unlikely that discards can be significantly reduced below the 5 percent rate projected under current regulations, without requiring full retention of fish species unwanted for human consumption. In other words, a full retention requirement for sculpins and other species would likely result in less discards, but more fishmeal production. Bycatch and discard of crabs, halibut, and herring are a function of regulations. If full retention of all species was required, there would be virtually no bycatch or discard.

Adoption of Alternative 2 would result in a review and potential relaxing of bycatch control measures currently in effect. As mentioned previously, adoption of this policy alternative assumes that there are no adverse environmental effects of groundfish fishing and that bycatch at present levels is not adversely affecting the ecosystem. Under Alternative 2, groundfish harvests could be increased substantially, with little effort controls in place. Bycatch and discards are predicted to increase significantly under this alternative, even if the underlying assumption of no adverse effect to the ecosystem is proven true. Adoption of this policy would be inconsistent with this standard and NOAA Fisheries' own national bycatch reduction program.

Alternative 3 and the PA are similar to Alternative 1 but they further commit the NPFMC and the agency to achieving bycatch and waste reduction objectives. Bycatch accounting mechanisms would be improved and consideration given to establishing additional bycatch limits and/or reducing existing bycatch limits. As a result, the Alternative 3 and PA policies are consistent with this standard and national policy objectives.

Adoption of Alternative 4 would commit the NPFMC and NOAA Fisheries to much lower harvest rates and perhaps even temporary suspension of the fisheries until more information is known about the effects of fishing on the ecosystem. Such reductions in overall groundfish TACs would result in much lower fishing effort and lower bycatch of non-target groundfish and prohibited species.

Institutions

The NPFMC is one of eight regional councils established by the MSA to manage fisheries in the 200-mile EEZ. The NPFMC primarily manages groundfish in the GOA and BSAI, including Pacific cod, pollock, flatfish, Atka mackerel, sablefish, and rockfish species harvested mainly by trawlers, hook-and-line longliners, and pot fishermen. The NPFMC also makes limited entry decisions for halibut, though the U.S.-Canada IPHC biologically manages the resource, and has oversight for BSAI crab fisheries and the Alaska scallop fishery. The State of Alaska (specifically ADF&G) manages groundfish, crab, salmon, and herring fisheries in state waters, and also manages the BSAI scallop and BSAI crab fisheries on a day-to-day basis.

The NPFMC has eleven voting members, six from Alaska, three from Washington, one from Oregon, and a federal representative, the Alaska Regional Administrator of NOAA Fisheries. Voting members represent state fisheries agencies, industry, fishing communities, and academia. The NPFMC's four non-voting members represent the U.S. Coast Guard (USCG), U.S. Fish and Wildlife Service (USFWS) Department of State, and the Pacific States Marine Fisheries Commission. The NPFMC's staff resides in Anchorage, Alaska. The NPFMC receives advice at each meeting from an Advisory Panel representing user groups, environmentalists, recreational fishermen, and consumer groups, and from an SSC of highly respected scientists who review information brought to the NPFMC.

Each NPFMC decision is made by a recorded vote in a public forum following public comment. Final decisions then go to NOAA Fisheries formulated as recommendations for FMP or regulatory amendments. NOAA Fisheries reviews the Council's submission, issues proposed amendments and regulations for public review and comment, and then makes a decision on whether to approve, disapprove, or partially approve the action. Decisions must be consistent with the MSA, NEPA, ESA, MMPA, and other applicable law s including several EOs. Regulatory changes may take up to a year or longer to implement particularly if they are complex or contentious.

The NPFMC and NOAA Fisheries have successfully worked towards achieving the goal of sustainable fisheries. The structure of the NPFMC's numerous committees (e.g., Advisory Panel, SSC, Plan Teams, Ecosystem Committee) allows for incorporation of diverse views from interested parties. The NPFMC and NOAA Fisheries coordinate their activities with other institutions including the IPHC, ADF&G, USFWS, USCG, and others.

The NPFMC, its committees, and its well established public process described under Alternative 1 would continue under all of the policy alternatives. Specific changes to this existing institutional structure could occur under Alternatives 3, 4 and the PA. Under Alternative 3, the NPFMC and NOAA Fisheries would pursue ways to increase Alaska Native participation and consultation in fisheries management. Such methods may include adding more Alaska Native representatives on the NPFMC Advisory Panel and video conferencing. The agency might consider adding a tribal government coordinator to its staff to enhance its government-to-government consultation abilities and serve as a liaison to Native organizations and Native communities. Other options include establishing a student intern program to provide opportunities for Native students to learn more about fisheries management and to share information. Alternative 3 (and the PA) would also build on the existing relationship with USFWS and ADF&G to expand cooperative research programs. Alternative 4 would expand on these concepts by increasing participation of Native and non-Native subsistence users when making fishery management decisions.

Information Needs

While the fisheries in the North Pacific are managed with the best available science in the world, there is an ongoing need to increase our current understanding of the biological and socioeconomic factors in the fisheries. There is also a mandate to achieve some level of understanding of overall ecosystem dynamics and incorporate this into our management approach.

The NOAA AFSC, along with other institutions such as the University of Alaska, ADF&G, the Prince William Sound Science Center, and others have all been conducting ecosystem level research. This research is expected to continue at its current level unless funding is increased. An integral part of this Programmatic SEIS has been to identify data gaps and research needs for improved management of the Alaska groundfish fisheries. Due to the importance of this subject and the heavy reliance of any successful application of a management policy on adequate scientific information, NOAA Fisheries has prepared a separate chapter on this subject (Chapter 5) in this Programmatic SEIS.

Ongoing research and monitoring of the Alaska groundfish fisheries are essential to ensure the sustainability of these fisheries for future generations, regardless of which policy alternative or vision for management is adopted. Each of the four policy alternatives must be supported by research and monitoring. Alternative 2 requires decreased level of commitment, while Alternatives 1, 3, 4 and the PA all require expanded data quality, monitoring, and enforcement programs to ensure that policy goals are achieved. Such programs are typically funded by Congress through the federal appropriations process. Generally, NOAA Fisheries and the regional councils have been well funded though all research and agency expenditures are usually not. Decisions must be made by the agency as to what projects and programs get funding and which ones are put aside until funds become available. Recently, a new organization, the North Pacific Research Board, has been formed which could provide funds for ecosystem-related research. The fishing industry also has a long history of supporting research.

One area of anticipated growth and understanding is in the form of local and Traditional Ecological Knowledge. Local and Traditional Knowledge is comprised of historical observation of the environment accumulated over time by Native people who have relied on natural resources and the environment as a way of life. Recent sharing of this knowledge has begun to enter into the realm of fishery management decision-making. Under Alternative 1 and 2, these efforts would continue. Alternatives 3, 4, and the PA would seek to enhance collection and study of such information and consider new ways of incorporating local and Traditional Knowledge into the decision-making process. Such methods might include increasing Alaska Native involvement in fisheries management, through co-management agreements and cooperative research initiatives. All four policy alternatives are consistent with this ecosystem-based management standard.

4.11.2 Comparison of Alternative Impacts on the Human Environment

The alternatives are analyzed in detail from a policy perspective in Section 4.10 of this document. The sections below present the results of that analysis in a format that allows for comparison of the alternatives. The discussion is organized around the eight major goals identified as key components of North Pacific groundfish fishery management.

Table 4.11-2 presents the information summarized below in table format, and uses a color key to indicate the direction of effect associated with each alternative. The intent of the summary below, and in Table 4.11-2, is to provide a broad, policy-level understanding of the general impacts of the alternative. The analysis deals with effects at the population or fishery level, rather than calling out impacts to individual components (a more detailed analysis of the FMP bookends provides a basis for the policy-level analysis; see Section 4.10.1 for further information.) Where the impacts within a policy goal are substantially different for major component groups, the color key is split in half and two colors are assigned. The bulleted language in the table explains the rationale.

The colors assigned to the effects are red, yellow, light green, and dark green. Red indicates an adverse effect in the judgement of the analysts, but does not distinguish the degree of uncertainty associated with that effect. Yellow indicates that there is a high potential for adverse impacts if any of the assumptions used to manage the resource are wrong. Light green indicates a potentially beneficial effect is expected and that the rating incorporates some precaution against the potential that incorrect assumptions may result in an adverse effect. Dark green indicates a beneficial effect, and incorporates a high level of precaution against uncertainty.

Prevent Overfishing

Alternative 1 prevents overfishing of target stocks and thus meets the goal of ensuring the sustainability of the fisheries. Alternative 1 also includes automatic stock rebuilding provisions which have proven to be effective. A weakness of this alternative is that there is no incentive to research fishery impacts on Tier 4-6 stocks in order to change their management status. It is also possible under this alternative to overharvest a vulnerable member of a stock complex.

Alternative 2 would maximize economic yield while preventing overfishing of target stocks, but it is not effective at preventing stocks from becoming overfished. The weaknesses of this alternative are that it increases the chance of unintentionally overfishing a stock and that catch estimates may be uncertain under this alternative if the Observer Program is repealed. Also, as in Alternative 1, there is no incentive to change the management status of stocks where the impact of fishing is unknown, and it is still possible to overharvest vulnerable members of a managed stock complex.

Alternative 3 prevents overfishing of target stocks and reduces the likelihood that stocks will become overfished, through precautionary harvest policies, and imposition of rebuilding regulations when stocks fall below the level capable of producing MSY. This alternative would formally define criteria for determining the status of stocks relative to an overfished condition in order to better satisfy the requirements of the National Standard 1 Guidelines. Efforts would be accelerated to identify methods for reducing the number of stocks where the status relative to an overfished condition is unknown.

Alternative 4 establishes a very conservative harvest policy which is likely to prevent overfishing and reduce the chance that stocks would become overfished. Constraints to commercial harvest coupled with systems of closed areas would effectively reduce impacts from the race-for-fish and therefore from spatial/temporal concentration of catch. Catch monitoring would also increase under this alternative, resulting in more complete fisheries data. As with Alternative 3, this alternative would define criteria for determining the status of all managed stocks relative to an overfished condition in order to better satisfy the requirements of the National Standard 1 guidelines. In the long-term, this alternative would protect the most vulnerable species of the complex, but the resulting management of many stocks with low biomass would be difficult to implement.

The PA prevents overfishing of target stocks and reduces the likelihood that stocks will become overfished through precautionary harvest policies and imposition of rebuilding regulations when stocks fall below the level capable of producing MSY. Efforts would be accelerated to improve the current harvest strategy, including in PA.2, additional procedures to incorporate uncertainty and develop spawning stock biomass estimates, in particular for Tiers 4-5.

Promote Sustainable Fisheries and Communities[1]

Alternative 1 continues to provide economic and community stability within the current system, while adapting management programs if the need arises. Some fisheries and communities are stressed due to the negative effects of the race-for-fish.

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[1] This policy goal was explicitly identified only in the PA; in other alternatives, this goal was addressed under the policy heading of "Allocation Issues".

Long-term sustainability of fisheries and communities may be problematic if Alternative 2 policies, as illustrated in FMP 2.1, are implemented. In the short-term, fisheries and communities will likely see improved economic conditions. If less aggressive actions are pursued, the alternative is likely to be no better or worse than Alternative 1.

The rationalization of the fisheries under Alternative 3 holds the promise of improved fishery and community sustainability. Extensive area closures associated with more aggressive ecosystem-based management may reduce small boat and Alaska community involvement in fisheries.

The extensive TAC reductions and area closures under Alternative 4 reduce the viability of fisheries and fishery-dependent communities. Some fisheries may survive if the assumptions of impacts are correct.

The goal of promoting sustainable fisheries and communities under the PA is likely to be successful. The precautionary adjustments made to quota management decrease the risk of inadvertently overfishing managed species. Additionally, the transition to rights-based management under this alternative will promote the objectives of increasing efficiency, stability and safety in the long-term.

Preserve Food Web

Alternative 1 is partially successful in achieving the goal of preserving the food web through its protection measures for dominant target species, forage species, and ESA-listed species. However, it will likely make slow, incremental progress in protecting food web components. Alternative 1 will likely protect food web components that are more well-studied than those that are not or those that are at critical population thresholds, but it is uncertain whether sufficient protection is provided to food web components where less comprehensive information is available.

There is a high potential to create adverse food web impacts under Alternative 2 through its lack of precaution, which leaves no room for uncertainty. The possible lack of catch monitoring results in the potential for adverse food web impacts to go undetected until dramatic food web changes are seen. This alternative provides less precautionary management to many components of the food web.

Alternative 3 is successful in making many improvements relative to the baseline in achieving the goal of preserving the food web. The emphasis of this alternative is not only on using the best scientific information available to determine catch levels but also on providing additional protection against uncertainty by designation of MPAs and reserves. If these improvements are implemented, this strategy is likely to provide protection to a broad range of food web components.

Alternative 4 would meet the goal of preserving the food web, by providing large buffers against scientific uncertainty about ecosystem impacts resulting from fishing. The assumption that the present level of scientific information is insufficient to manage fisheries without excessive risk to the ecosystem results in the implementation of highly precautionary measures. This strategy provides improvements over the baseline and achieves protection of virtually all food web components and thus ecosystem functions. Although the alternative is successful in producing a food web that is less influenced by fishing activity, predictions about the abundance changes of individual food web components that might result are uncertain due to the difficulty in accurately predicting predator-prey relationships.

As a whole, through its goal to accelerate precautionary management measures through ecosystem-based principles, and its objectives to develop indices of ecosystem health and to take ecosystem factors into account in ABC setting, the PA is successful in making many improvements beyond the status quo in achieving the goal of preserving the food web. The emphasis in this alternative is on using the best scientific information available to determine catch levels, but also on providing additional protection against uncertainty by designation of MPAs and reserves. If these improvements are implemented, this strategy is likely to provide protection to a broad range of food web components.

Reduce Incidental Catch, and Reduce Bycatch and Waste[2]

The bycatch management program under Alternative 1 is effective at limiting incidental catch of non-target species and reducing bycatch through incentive programs and monitoring. The weaknesses of Alternative 1 is that bycatch is often reported as a complex rather than as individual species, and that observers are not present to monitor catch on vessels less than 60 ft LOA, which may result in inaccurate estimates of bycatch. This alternative may therefore not provide adequate protection for non-target species.

Alternative 2, as illustrated in FMP 2.1, would not be consistent with the objective of monitoring prohibited species catch, as repeal of the Observer Program would negatively impact catch monitoring. Alternative 2 policies, as illustrated by FMP 2.2, would be less severe. As in Alternative 1, additional weaknesses of the alternative are that bycatch is often reported as a complex rather than as individual species and that the absence of observer monitoring of catch on vessels less than 60 ft LOA may result in inaccurate estimates of bycatch. Therefore, Alternative 2 may not provide adequate protection for non-target species.

The bycatch and incidental catch reduction policies in Alternative 3 are consistent with accelerating precautionary management measures through additional bycatch constraints and monitoring. Bycatch reduction objectives and reductions in incidental catch are likely to be achieved without a major cost to industry due to the incentives for more efficient use of fishery resources under cooperatives, comprehensive rationalization of fisheries or other bycatch incentive programs implemented under this alternative.

The bycatch and incidental catch reduction policies under Alternative 4 are effective. Reduced bycatch and incidental catch would be achieved through extreme reductions in target groundfish catch and strong bycatch and incidental catch limits.

The bycatch and incidental catch reduction policies in the PA are consistent with minimizing human-caused threats to protected species and accelerating precaution through additional bycatch constraints, such as reduced PSC limits. Bycatch reduction objectives and reductions in incidental catch are likely to be achieved without a major cost to industry due to the incentives for more efficient use of fishery resources under cooperatives, comprehensive rationalization of fisheries, or other bycatch incentive programs implemented under this alternative.

Avoid Impacts to Seabirds and Marine Mammals

Alternative 1 is effective at providing protection to listed seabirds and marine mammals as a result of its explicit objectives for ESA-listed species. Although not an explicit policy goal, some protection may also

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[2] For Alternatives 1-4, this policy goal is worded as “Reduce and Avoid Bycatch”.

be provided to non-listed seabirds through reduced incidental take as a result of implementing additional seabird protection measures.

Alternative 2 retains seabird and marine mammal protection measures for ESA-listed species, but does not go beyond ESA-required protection measures. Additionally, other goals and objectives under this alternative remove management measures currently in place in the baseline. The more aggressive harvesting policy, the relaxation of area closures, and the possible repeal of the Observer Program create a high potential to increase fishery interactions with seabirds and marine mammals that may result in adverse impacts to those species.

The goal of minimizing human-caused threats to protected species is largely met in Alternative 3 by actively adjusting protection measures, by actively reviewing the status of marine mammal fishery interactions, and through research. This approach, which may provide additional conservation measures in response to scientific evidence, is likely to provide increased protection to marine mammals and seabirds.

Alternative 4 is very successful at avoiding impacts to seabirds and marine mammals through its specific objectives to protect all seabirds from fishing interactions, and extending protection measures for Steller sea lion critical habitat and prey base. This largely increased level of protection provides a substantial buffer against uncertainty with regards to protection of marine mammals and seabirds.

The goal of minimizing human-caused threats to protected species, and if appropriate and practicable, other seabird and marine mammal species, is largely met in the PA by actively adjusting seabird and marine mammal protection measures, and status review of endangered and threatened marine mammal fishery interactions. This approach, which may provide additional conservation measures in response to scientific evidence, is likely to maintain protection to ESA-listed marine mammals and seabirds, and may increase protection for other seabirds and marine mammals.

Reduce and Avoid Impacts to Habitat

Alternative 1 emphasizes incremental implementation of habitat protection measures as scientific information becomes available. As a result, impacts to habitat may be alleviated. This strategy is likely to be effective in protecting habitat components that are more well-studied than others, but it is uncertain whether sufficient protection will be provided to habitat components for which there is less complete information. Cumulatively, continued adverse impacts result from historical impacts that have potentially caused long-term and possibly irreversible loss of living habitat, especially to long-lived, slow-growing species that are slow to recover.

Alternative 2 could result in increased impacts to habitat because of less precautionary management measures. Possible elimination of current closed areas and increases in TAC have the potential to result in adverse impacts to habitat that could be hard to reverse, especially for long lived, slow-recovering living habitats. The policy goal of developing practical measures to minimize adverse effects to EFH could be difficult to achieve if such irreversible impacts occur.

Alternative 3 has the potential to reduce and avoid impacts to habitat by careful placement of closures. Placement of closures in lightly fished or not fished areas could result in avoidance of future habitat impacts if fisheries were to move effort into surrounding areas. Placement of closures in heavily fished areas can mitigate impacts, reduce unintended consequences, and achieve overall benefits to habitat if closures do not encompass entire habitat types or areas of fishing intensity. In the short-term, information from the Observer Program could be used to locate such closures. In the long-term, scientific information gained from this policy can potentially lead to modification of the placement of MPAs and help meet the policy objective to assess the necessary and appropriate habitat protection measures. Cumulatively, the alternative results in a split environmental impact rating, as the adverse condition of the baseline is coupled with continued damage and mortality to living habitat, however the alternative has strong potential to mitigate these adverse impacts.

The emphasis of the Alternative 4 policy on habitat provides large buffers against scientific uncertainty about the impacts of fishing on habitat. The combination of highly precautionary measures associated with increasing marine reserves and other closure areas will likely achieve protection and avoidance of impacts to habitat. Cumulatively, the alternative has a environmental split rating, as the existing adverse condition of the baseline includes damage to slow-growing species unlikely to recover within the time period predicted in this analysis, however this alternative provides strong protection for habitat and potential for mitigation.

The PA has the potential to reduce and avoid impacts to habitat by careful placement of closures. Placement of closures in lightly fished or not fished areas will provide mitigation and result in avoidance of future habitat impacts if fisheries were to move effort into surrounding areas. Closures in heavily fished areas should be small to minimize displaced efforts and reduce chances of unintended consequences. To achieve overall benefits, closures should not encompass entire habitat types or areas of fishing intensity. In the short-term, information from the Observer Program could be used to locate such closures. In the long-term, scientific information gained from this policy can potentially lead to modification of the placement of MPAs and help meet the policy objective to assess the necessary and appropriate habitat protection measures. Cumulatively, the alternative results in a split environmental impact rating, as the adverse condition of the baseline is coupled with continued damage and mortality to living habitat, however the alternative has strong potential to mitigate these adverse impacts.

Promote Equitable and Efficient Use of Fishery Resources[3]

Alternative 1 is expected to continue to provide economic and community stability within the current management system while adapting management programs when the need arises. The alternative could eliminate the race-for-fish and, by doing so, would increase net-revenues to producers and provide benefits to consumers, but would create fewer, although possibly higher paying, fishery related jobs. Non-market, recreation, and tourism values could decrease in the short-run before the transition to rights-based systems is completed.

Alternative 2 has the potential to increase allowable catches to maximum biological levels and could eliminate the cushion between ABC levels and levels that result in OFLs. This alternative is expected to significantly increase revenues but would also increase operating costs with the elimination of the LLP and IFQ programs. While fishery production is maximized, product quality and the health and safety of participants suffer. Of particular importance may be the amount of variability in harvests, which could increase significantly and therefore make it much more difficult to make long-term business and infrastructure decisions. Finally, non-market, recreation, and tourism values that accrue to the ecosystem could be reduced substantially.

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[3] For Alternatives 1-4, this policy goal is worded as "Allocation Issues".

Alternative 3 promotes increased social and economic benefits through the elimination of the race-for-fish while also emphasizing the long-term economic value of the fishery through the promotion of rights-based allocations to individuals, sectors, and communities. In addition, this alternative promotes ecosystem-based management and is likely to increase non-market, recreational, and tourism values assigned to the ecosystem. It is not possible to determine the long-term effect on overall ecosystem value (commercial and non-market values combined) because it is not known whether the fishing sectors, even with rights-based allocations, will be able to adapt to the changes resulting from the increased emphasis on ecosystem tools and, in particular, the additional number and significance of closed areas.

The Alternative 4 goals of incorporating and enhancing non-consumptive use values are met, but at the expense of commercial value and potentially the continued viability of coastal communities. The precautionary policies in Alternative 4 could result in substantial reductions in allowable catches and could also result in the closure of large portions of traditional fishing areas. The alternative is likely to result in a substantial increase in the non-market values of the ecosystem, but is also likely to result in a substantial decrease in efficiency, net revenues, and the number of participants in the fisheries.

The PA promotes increased social and economic benefits through the elimination of the race-for-fish while also emphasizing the long-term economic value of the fishery through the promotion of rights-based allocations to individuals, sectors, and communities. In addition, this alternative promotes ecosystem-based management and is likely to increase non-market, recreational, and tourism values assigned to the ecosystem. It is not possible to determine the long-term effect on overall ecosystem value (commercial and non-market values combined) because it is not known whether the fishing sectors, even with rights-based allocations, will be able to adapt to the changes resulting from the increased emphasis on ecosystem tools and, in particular, the potential addition to the number and significance of closed areas.

Increase Alaska Native Consultation

The Alternative 1 goals and policies for Alaska Native consultation and participation in fishery management would continue at the current levels and comply with relevant EOs and other federal law. Traditional Knowledge in fishery management would continue to be incorporated in environmental documents as available and appropriate. Subsistence uses would continue consistent with federal law.

As in Alternative 1, the goals and policies for Alaska Native consultation and participation in fishery management under Alternative 2 would continue at the current levels and comply with relevant EOs and other federal law. Traditional Knowledge in fishery management would continue to be incorporated in environmental documents as available and appropriate. Subsistence uses would continue consistent with federal law. Other goals and objectives in Alternative 2 would affect Alaska Natives by the increase in economic benefits accruing to participants in the fishery, particularly the CDQ pollock fishery. The increased fishing effort under this alternative may however result in increased salmon bycatch, which could have adverse effects on salmon fisheries particularly in the western Alaska Yukon-Kuskokwim river system.

The goals and policies for Alaska Native consultation and participation in fishery management under Alternative 3 would increase current levels by expanding informal and formal consultation between the NPFMC/NOAA Fisheries and Alaska Native participants and tribal governments. Traditional Knowledge would be more formally incorporated in fishery management and additional data would be collected. Other goals and objectives in Alternative 3, such as reductions in PSC limits, may benefit subsistence salmon use by reducing bycatch levels in the groundfish fisheries.

Alternative 4 would directly involve Alaska Natives in fishery management through the development of co-management or cooperative research programs. Consultation and participation objectives would focus on subsistence uses and cultural values of living marine resources. However, other goals and objectives in Alternative 4 that greatly reduce or eliminate commercial fishing would adversely impact Native communities, including CDQ communities, through the loss of employment, economic activity, and community revenues.

The goals and policies for Alaska Native consultation and participation in fishery management under the PA would increase current levels by expanding informal and formal consultation between the NPFMC/NOAA Fisheries and Alaska Native participants and tribal governments. Local and Traditional Knowledge would be more formally incorporated in fishery management and additional data would be collected. Other goals and objectives in the PA, such as reductions in PSC limits, may benefit subsistence salmon use by reducing bycatch levels in the groundfish fisheries.

Improve Data Quality, Monitoring and Enforcement[4]

The Alternative 1 policy would result in a data collection program that will continue to meet minimum acceptable standards for scientific management of the fisheries. Although aspects of the catch collection program could be improved, such as non-random coverage in the 30 percent component of the fleet, current practices do provide useful data for fishery management while remaining mindful of the cost burden on industry of the monitoring program.

Alternative 2 objectives maintain a minimum level of data collection to meet conservation requirements. The consideration to repeal the Observer Program may compromise management on the best science available as a result of reduced accuracy and breadth of fishery data. However, because the presumed risk of adversely impacting the environment is assumed in this alternative to be low, the costs to industry of funding the Observer Program to gather fishery data may not be considered necessary.

Through data collection measures that would result in reducing uncertainty, Alternative 3 is likely to be effective in achieving the goal of accelerating the use of precautionary management measures. The objectives to improve the Observer Program and observer data would increase the quality of fishery data by implementing increased flexibility of, and potentially expanding, observer coverage. Additionally, the expanded economic data and potential for independent verification would allow for more accurate and credible economic impact assessments. A funding source would, however, need to be identified to implement improvements to these programs.

Alternative 4 expands research and monitoring programs to obtain information necessary to fulfill the requirements of this alternative. The policy objectives are successful in increasing fisheries data by expanding the Observer Program to full coverage for vessels over 60 ft LOA, and instituting 30 percent coverage on smaller boats. Additionally, the requirements to improve the accuracy of data through

[4] For Alternatives 1-4, this policy goal is worded as "Data Quality, Monitoring, and Enforcement".

technological means such as at-sea scales and VMS will improve monitoring and enforcement under this alternative.

Through data collection measures that would result in reducing uncertainty, the PA is likely to be effective in achieving the goal of accelerating the use of precautionary management measures. The objectives to improve the Observer Program and observer data would increase the quality of fishery data by implementing increased flexibility of, and potentially expanding, observer coverage. Additionally, the expanded economic data and potential for independent verification would allow for more accurate and credible assessments of economic impacts. A funding source would, however, need to be identified to implement improvements to these programs. The alternative also emphasizes the importance of enforcement concerns in fishery management.

Chapter 5

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Chapter 5 Research and Management

Preparing this Programmatic Supplemental Environmental Impact Statement (SEIS) has highlighted areas where scientists and managers need to pursue greater information about the resource, the effects of fishing, and the social and economic impacts of management decisions. Accordingly, this chapter reviews research and practical management components of the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) Fishery Management Plans (FMPs) and discusses the research and enforcement needs implicated by the alternatives.

Section 5.1 provides an overview of the existing data gaps and plans to fill those gaps. This section is intended to serve as a further reference for those impact ratings in the Chapter 4 analysis where the conclusion was 'unknown'.

Section 5.2 focuses on management and enforcement issues and examines the effects of each Alternative from the perspective of management complexity.

5.1 Information Gaps and Research Needs

The policy alternatives analyzed in this Programmatic SEIS all require that certain monitoring and research plans continue such that uncertainties associated with management and the environmental effects of the Alaska groundfish fisheries can be addressed. This section reviews current and planned research projects and identifies the information gaps and research needs for the BSAI and GOA marine ecosystem. Section 5.1.1 discusses the major research priorities, funding process and ongoing research. Section 5.1.2 then goes on to describe specific information gaps and research needs by resource category.

5.1.1 Major Research Priorities, Funding Process and Ongoing Research

The following sections outline the major research priorities, and ongoing research activities currently being conducted on groundfish and the marine and human environment of the North Pacific. Scientific research and the necessary funding in support of federal fisheries management in the Exclusive Economic Zone (EEZ) off Alaska, come from various sources in addition to National Marine Fishery Service (NMFS or National Oceanic and Atmospheric Administration [NOAA] Fisheries) own facilities and budget; the Alaska Department of Fish and Game (ADF&G), the North Pacific Research Board (NPRB), various academic institutions, industry groups, grant programs such as SeaGrant and the Saltonstall-Kennedy Program, and other public and private entities. To the extent that current funding continues, NOAA Fisheries will continue to conduct and avail itself of existing research activities. Expanded research to collect new information and fill existing data gaps in dependent on the agency's receiving additional research funding. While additional funds are not certain, NOAA Fisheries intends to pursue the funding necessary to meet future research needs and improve the scientific information available for managing the fisheries.

5.1.1.1 NOAA Fisheries

NOAA Fisheries is responsible for ensuring that management decisions are based on the best available scientific information relevant to the biological, social, and economic status of the fisheries. The agency strives for information that is comprehensive, objective, credible, and effectively communicated. Along these lines, the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996, requires the Secretary of Commerce to develop and publish a strategic plan for fisheries research. The MSA mandates strong action to conserve and manage fishery resources that contribute to the food supply, economy, and health of the Nation. Furthermore, MSA provisions require NOAA Fisheries to end overfishing, rebuild all overfished stocks, and conserve essential fish habitat (EFH) through research and consultations on federal and state actions that may adversely affect such habitat. These are among the agency's primary stewardship responsibilities.

To meet these responsibilities, the agency developed and, in December 2001, published the *NMFS Strategic Plan for Fisheries Research* (the Strategic Plan) (http://www.st.nmfs.gov/st2/strategic_plan.html) (NMFS 2001c). This plan, which updates the original *Strategic Plan for Fisheries Research* released in 1998, outlines NOAA Fisheries' proposed research efforts for the subsequent five years. The scope of this plan includes fisheries, habitat, and protected species research that addresses requirements of the MSA. The mission of NOAA Fisheries scientific enterprise is to ensure that the science products produced and disseminated by NOAA Fisheries is of the highest quality. The Strategic Plan outlines the following broad goals and objectives for NOAA Fisheries: 1) to improve scientific capability; 2) to increase science quality assurance; 3) to improve fishery research capability; 4) to improve data collection; 5) to increase outreach/information dissemination; and 6) to support international fishery science. The following bulleted list details the actions called for in meeting these goals and objectives.

Improve Scientific Capability

- Implement National Research Council (NRC) recommendations (NRC 1998) to ensure state-of-the-art resource assessments through NOAA Fisheries' Stock Assessment Improvement Plan (NMFS 2001d).

- Continue to incorporate economic and social factors into the agency's decision-making. As part of this continuing effort, NOAA Fisheries will periodically publish the report *Our Living Oceans: The Economic Status of United States (U.S.) Fisheries.* The report will measure the economic health of U.S. fisheries relative to current conditions versus desired future conditions of long-term sustainability.

- Increase the agency's ability to predict natural living marine resource variation through improved data collection, improved understanding of how living marine resources respond to environmental variability and climate change, and coordinated bio-socioeconomic modeling, which will result in more accurate assessments and estimations of the uncertainty associated with them.

- Increase NOAA Fisheries' ability to identify, conserve, protect, and restore those habitats essential to managed fishery resources and to estimate the impact of pollution, wetland and estuarine degradation, and fishing gear on the abundance and availability of fish.

Increase Science Quality Assurance

- Implement policies to ensure that the agency's science programs, analyses, and products are sound, credible, and provide an objective basis for management.

- Improve the agency's professional standards for research and scientific advice by establishing national guidelines for technical program and staff performance evaluations, performance award programs, and professional career development opportunities.

- Expand and improve the agency's system for peer review of scientific advice by establishing panels of knowledgeable scientists from both within and outside government.

- Solicit input from external scientists in topical areas when identifying research initiatives for the various NOAA Fisheries' grant programs.

Improve Fishery Research Capability

- Implement NOAA Fisheries' fishery research vessel replacement plan (NMFS 1998a) that integrates government, university, and industry vessel capabilities to provide the state-of the-art facilities necessary for the accomplishment of the agency's varied at-sea research programs.

Improve Data Collection

- Implement NRC recommendations (NRC 2000) to improve the agency's data collection and analysis techniques and fishery data management systems.

- Provide a core fishery statistics program based on strategic and operational needs.

Increase Outreach/Information Dissemination

- Involve constituents in research programs. To the extent practicable, NOAA Fisheries will charter fishing vessels to participate in research projects, invite constituents to participate aboard NOAA Fisheries' research vessels during resource surveys, encourage frequent contact and cooperation between scientists and constituents, and develop methods to incorporate scientifically valid observations by fishers and others into fish stock assessments and other analyses related to living marine resources and their habitat.

- Coordinate with the NOAA Fisheries' Constituent Affairs and Outreach Team to develop an internet web-centralized resource for neutral science-based information to educate the public and user groups and answer questions on various topics on the status of the nation's fisheries, including how NOAA Fisheries research is conducted and how stock assessments are performed.

- Develop a new series of reports and presentations to communicate scientific results in simplified language that is easier to understand than traditional scientific publications.

Support International Fishery Science

- Participate in international scientific initiatives, such as the United Nations Intergovernmental Panel on Climate Change, Program for the Conservation of Arctic Flora and Fauna, Commission for the Conservation of Antarctic Marine Living Resources, Food and Agriculture Organization of the UN, Global Oceans Observing Program, North Pacific Marine Science Organization, International Council for the Exploration of the Seas, International Whaling Commission, United Nations Atlas of the Oceans, and Global Ocean Ecosystems Dynamics.

- Participate in bilateral scientific initiatives with neighboring countries, Canada and Mexico, and in scientific exchange programs with foreign countries that are developing their fishery resources.

Because fisheries are managed on a regional basis, the focus of NOAA Fisheries' research programs varies among the five regional science centers. Science center directors and their division chiefs develop annual research priorities, based upon regional and national needs, through dialogue with their Regional Administrator, regional councils, the program offices in NOAA Fisheries headquarters, and user groups and other interested parties. Teams of researchers at each science center work together to develop research plans.

NOAA Fisheries provide annual stock assessment information and management advice to support the their stewardship mission for the living marine resources in their regions. These cross-disciplinary efforts are undertaken in cooperation with other Federal and state agencies, international organizations, the fishing industry, and academia, and are based on long-standing cooperative research agreements. In addition to these basic responsibilities, each regional science center has unique capabilities to focus on special research needs.

The Alaska Fisheries Science Center (AFSC) is the research branch of NOAA Fisheries responsible for research on living marine resources in the coastal oceans off Alaska. The AFSC has research facilities in Alaska (Auke Bay and Kodiak Island), Washington (Seattle), and Oregon (Newport). Organizationally, the AFSC consists of the Auke Bay Laboratory, the National Marine Mammal Laboratory, the Resource Assessment and Conservation Engineering Division, the Resource Ecology and Fisheries Management Division, and other administrative units. The AFSC has a permanent staff of about 325 employees who conduct fisheries and marine mammal research in the coastal and offshore waters off Alaska. This marine region of nearly three million square miles includes over 50 percent of the U.S. coastline and over 70 percent of the U.S. continental shelf. The region supports some of the most important commercial fisheries in the world, particularly groundfish and Pacific salmon species, and is host to some of the world's largest populations of marine mammals and seabirds.

The 2001 *NMFS Strategic Plan for Fisheries Research* (NMFS 2001c) outlines the AFSC's research priorities for Fiscal Year (FY) 2001-2006. These priorities were developed in collaboration with state and other federal agencies, academic institutions, foreign research institutions, the fishing industry, and resource conservation organizations. Summarized below are the AFSCs research priorities grouped into four major research areas: research to support fishery conservation and management; conservation engineering research; research on the fisheries themselves; and information management research. The following list details the specific research being undertaken to support each of these major research areas.

I. Research to Support Fishery Conservation and Management

A. Biological research concerning the abundance and life history parameters of fish stocks

- Conduct an annual summer bottom trawl survey on groundfish and crabs in the eastern Bering Sea (EBS) shelf with chartered fishing vessels.

- Conduct Midwater trawl-acoustic surveys to assess the off-bottom component of pollock stock in the Bering Sea every two years (2002, 2004, 2006) and the GOA (2003, 2005) with the NOAA Research Vessel (R/V) *Miller Freeman.*

- Conduct an EBS slope survey on groundfish every two years (2002, 2004, 2006) with a chartered fishing vessel.

- Conduct an annual March survey on spawning pollock resources in the Bogoslof Island area by the NOAA Fisheries R/V *Miller Freeman* or with cooperating foreign research vessels.

- Conduct an annual spring survey of pollock resources in the Shelikof area by the NOAA Fisheries R/V *Miller Freeman.*

- Conduct a summer bottom trawl survey on groundfish in the GOA with chartered fishing vessels every two years (2001, 2003, 2005).

- Conduct a summer bottom trawl survey on groundfish in the Aleutian Islands region with chartered fishing vessels every two years (2002, 2004, 2006).

- Conduct an annual summer longline survey on sablefish resources in the GOA by a chartered vessel.

- Conduct a triennial summer bottom trawl survey on shelf groundfish off the Pacific west coast with two chartered vessels in 2001.

- Conduct an autumn bottom trawl survey on slope groundfish off the Pacific west coast with the NOAA Fisheries R/V *Miller Freeman* in 2001.

- Conduct a triennial summer hydroacoustic-bottom trawl survey on Pacific whiting off the Pacific west coast with the NOAA Fisheries R/V *Miller Freeman* in 2001.

- Conduct an annual April Fisheries Oceanography Coordinated Investigation egg-larvae survey in the GOA and a May survey on late-larvae by the NOAA Fisheries R/V *Miller Freeman*.

In addition to the above surveys, the AFSC is also planning to conduct many field operations to study marine mammal-fish interactions, with particular emphasis on sea lion-pollock/cod/Atka mackerel interactions in the GOA and the BSAI areas.

The following observer programs are planned for the groundfish fisheries that occur off Alaska:

- 100 percent observer coverage of fishing and processing vessels longer than 125 feet (ft).

- 100 percent observer coverage of most fish processing plants onshore.

- 30 percent observer coverage of fishing vessels that are 65-125 ft.

- 100 percent observer coverage (with multiple observers) of special category vessels that engage in community development quota (CDQ) and American Fisheries Act (AFA) fishing operations.

The AFSC will assess the status of stocks, estimate their biological production potentials (maximum sustainable yield (MSY), acceptable biological catch [ABC], overfishing levels [OFLs]), bycatch requirements, and other parameters required for their management. The following stocks will be assessed annually and be published in Stock Assessment and Fishery Evaluation (SAFE) reports:

- All BSAI and GOA groundfish stocks, including pollock, cod, sablefish, Atka mackerel, yellowfin sole, rock sole, flathead sole, Greenland turbot, other flatfish, Pacific ocean perch, and other rockfish species.

- King and Tanner crabs in the Bering Sea.

The National Marine Mammal Laboratory will assess the population dynamics, ecosystem interactions, and abundance of marine mammal stocks and their incidental take requirements. Some specific programs and activities that will be pursued are:

- Implement the Steller Sea Lion Recovery Plan.
- Implement the Steller Sea Lion - Fishery Interactions Research Plan.
- Implement the Northern Fur Seal Conservation Plan.
- Implement the Alaska Harbor Seal Research Plan.
- Analyze existing aerial survey data and harvest monitoring data on Alaskan ice seals.
- Analyze data collected during the international Antarctic pack ice seal cruise.
- Implement the Humpback Whale Recovery Plan.
- Implement the Northern Right Whale Recovery Plan as it pertains to the North Pacific.
- Implement an extended 5-year research and monitoring plan for the eastern North Pacific gray whale.
- Analyze data collected during the 1997-1999 small cetacean surveys in Alaska.
- Implement the West Coast Pinniped-salmonid Research Plan.
- Monitor the Makah gray whale harvest.

B. Social and economic factors affecting abundance levels

- Expand sociological and economic research and incorporate results into the fishery management process.
- Conduct research on vessel over-capitalization and impacts of their fishing effort levels on fisheries.

C. Compilation and analysis of data on harvesting and processing sector behavior

D. Interdependence of fisheries or stocks of fish

- Collect biological specimens of spawning pollock throughout its range for genetic marker studies through deoxyribonucleic acid (DNA) and other genetic techniques. Cooperation with foreign scientists is required for sampling non-U.S. waters.
- Analyze survey and observer data to determine spatial distributions of different species clusters that would indicate separation or interdependence of stocks.

- Develop genetic baseline information on salmonids to identify stocks or area of origin.

- Conduct winter surveys to estimate distribution and abundance of pollock (acoustic) and Pacific cod (bottom trawl) in Steller sea lion critical habitat areas in southeast Bering Sea, Shumagin Islands, and Kodiak Island to determine dependence of sea lions on localized food supplies and assess feasibility of annual time series.

E. Identifying, restoring, and mapping of EFH

- Conduct studies on the impacts of logging, urbanization, and mining on coastal salmon resources in southeast Alaska. NOAA Fisheries will work with the Corps of Engineers and local organizations to restore an urban impacted salmon stream.

- Conduct restoration studies related to the *Exxon Valdez* oil spill (EVOS) in Prince William Sound (PWS). The research will build upon the results reported in the accomplishments section, including a study of the effects of oil on the biology, homing, and survival of pink salmon.

- Impact of anthropogenic factors and environmental changes on fish populations

- Investigate mortality and pathogens of shellfish and groundfish.

- Conduct Fisheries Oceanography Coordinated Investigations: a cooperative research program with the Pacific Marine Environmental Laboratory of NOAA's Oceanic and Atmospheric Research Office to investigate the causes of variation in annual recruitment in fish stocks.

F. Assessment of effects of fishing on EFH and development of ways to minimize adverse impacts

II. Conservation Engineering Research

A. Continue to conduct research to measure direct effects of bottom trawling on seafloor habitat according to a five-year research plan.

B. Conduct fishing gear performance and fish behavioral studies to reduce bycatch and bycatch mortality of prohibited, undersized, or unmarketable species, and to understand performance of survey gear.

C. Work with industry and North Pacific Fishery Management Council (NPFMC) to develop bycatch reduction techniques.

III. Research on the Fisheries

A. Social and economic research

- Continue to build upon the economic data collection program, initiated by AFSC. This program collects cost, earning, and employment data for the Alaska groundfish fishery. AFSC will continue to work with the NPFMC, AFD&G, and the Alaska Fisheries information network to identify the elements of a broader program to collect economic and social data.

- Assess the economic impact of different fishing and conservation strategies that are proposed throughout the year by NOAA Fisheries and NPFMCs.

- Compile the economic status of Alaska's groundfish fisheries as part of the annual groundfish SAFE reports.

- Assess economic performance of the Alaska groundfish and halibut fisheries and research to improve these assessments.

B. Seafood safety research

- No research activities identified.

C. Marine aquaculture

- Study the growth, distribution, behavior, and early marine survival of salmon; conduct research on salmon biology and enhancement technology in Alaska.

IV. Information Management Research

- Continue to build data infrastructure and resources for easy access and data processing. The AFSCs key databases are its survey data bases from the 1950s (or earlier) and the scientific observer database that extends back to the foreign fishing days of the 1960s.

- Continue to provide information products based on experts and technical data that support NOAA Fisheries, the regional office, NPFMC, international scientific commissions, and the overall research and management community.

5.1.1.2 North Pacific Fishery Management Council

NPFMC relies on its Scientific and Statistical Committee (SSC) to assist NPFMC in interpreting biological, sociological, and economic information. The SSC also plays an important role in providing NPFMC with recommendations regarding research direction and priorities based on identified data gaps and research needs. At its March 2003 meeting, the SSC reviewed the list of research priorities as developed by NPFMC's BSAI and GOA groundfish plan teams in November 2002. The SSC used this list to develop the following short list of research topics needing immediate attention in 2003:

I. Critical Assessment Problems

A. For rockfish stocks there is a general need for better assessment data, particularly investigation of stock structure and biological variables.

- Supplement triennial trawl survey biomass estimates with estimates of biomass or indices of biomass obtained from alternative survey designs.

- Obtain age and length samples from the commercial fishery, especially for Pacific ocean perch, northern rockfish, and dusky rockfish.

- Increase capacity for production ageing of rockfish so that age information from surveys and the fishery can be included in stock assessments in a timely manner.

- Further research is needed on model performance in terms of bias and variability. In particular, computer simulations, sensitivity studies, and retrospective analyses are needed. As models become more complex in terms of parameters, error structure, and data sources, there is a greater need to understand how well they perform.

B. There is a need for life history information for groundfish stocks, e.g., growth and maturity data, especially for rockfish.

- There is a need for information about stock structure and movement of all FMP groundfish species, especially temporal and spatial distributions of spawning aggregations.

II. Stock Survey Concerns

- There is a need to explore ways for inaugurating or improving surveys to assess rockfish, including nearshore pelagics.

- There is a need to develop methods to measure fish density in habitats typically inaccessible to NOAA Fisheries survey gear, i.e., untrawlable habitats.

III. Expanded Ecosystem Studies

- Research effort is required to develop methods for incorporating the influence of environmental and climate variability, and their influence on processes such as recruitment and growth into population models, especially for crab stocks.

- Forage fish are an important part of the ecosystem, yet little is known about these stocks. Effort is needed on stock status and distribution for forage fishes such as capelin, eulachon, and sand lance.

- Studies are needed to identify essential habitat for groundfish and forage fish. Mapping of nearshore and shelf habitat should be continued for FMP species.

IV. Social and Economic Research

- Development of time series and cross-sectional databases on fixed and variable costs of fishing and fish processing.

- Pre- and post-implementation economic analyses of crab and GOA groundfish rationalization.

- Identification of data needed to support analyses of community level consequences of management actions.

- Development of integrated multi-species/multi-fishery models for use in analyses of large scale management actions, such as PSEIS and EFH.

V. Bycatch

- Identify sources of variability in actual and estimated bycatch rates.

VI. Monitoring

- Promote advance in video monitoring of otherwise unobserved catch for improved estimation of species composition of total catch and discrimination of retained and discarded catch

VII. Research Priorities Identified by the NRC Steller Sea Lion Committee

The SSC held a brief discussion on the research and monitoring recommendations of the NRC Steller Sea Lion Committee, as presented in the Executive Summary of their report. The SSC noted that their recommendations are consistent with recognized needs, but also that there is considerable ongoing Steller sea lion research. Among the NRCs recommendations, the SSC wishes to particularly identify their recommendation for a spatially-explicit, adaptive management experiment to definitively conclude whether fishing is playing a role in the current lack of Steller sea lion recovery. As noted in the SSCs February 2003 minutes, there are a number of scientific, economic, and Endangered Species Act (ESA) regulatory considerations that must be addressed before such a plan can be seriously considered for implementation. However, the SSC supports further exploration of the merits of this adaptive management approach.

5.1.1.3 North Pacific Research Board

The NPRB was created by Congress in 1997 to recommend research relating to fisheries or marine ecosystems in the North Pacific Ocean, Bering Sea, and Arctic Ocean, with emphasis on cooperative research designed to address pressing fishery management or marine ecosystem information needs. NPRB's long-term goal is to develop a high caliber, comprehensive research program for the regions and fisheries under its purview. The program's foundation rests on science planning, prioritization of pressing fishery management and ecosystem information needs, coordination and cooperation among research programs, competitive selection of research projects, increased information availability, and public involvement. NPRB strives to avoid duplicating other research.

NPRB uses an open, competitive process for gathering research proposals. Criteria for project submission and evaluation are specified in an annual request for proposals that is normally released each fall. NPRB's enabling legislation is quite broad in defining who can receive research grants. Research grants may be made available to federal, state, private or foreign organizations or individuals. NPRB receives advice from various panels and committees, and recommends grants based on the merits of the request and the extent to which the proposed research meets the priorities established by NPRB. Research recommendations of NPRB are reviewed by the Secretary of Commerce, through his designee, the Alaska Regional Administrator for NOAA Fisheries. The Secretary is not free to use the recommended funding amount in some other way; it can only be used to fund some other grant recommended by NPRB.

NPRB's research funds are based on the interest earned by the Environmental Improvement and Restoration Fund, also created by Congress and derived from the Dinkum Sands case. Each year, 20 percent of the interest is made available to the Secretary without further appropriation to carry out marine research activities. NPRB approved about $2.2 million in marine research beginning in 2002, and $7 million in new research in 2003. Of the 156 proposals submitted for research in 2003, thirty proposals were approved by NPRB on March 20, 2003. NPRB's recommendations for 2003, however, still need to be given final approval by the Secretary of Commerce acting through his designee, the Alaska Regional Administrator for NOAA Fisheries. The following 29 proposals were recommended by NPRB for funding in 2003:

- Evaluation of emergent structure in low-relief benthic habitats as criterion for defining the EFH of juvenile North Pacific flatfish.
- A continuous plankton recorder survey of the North Pacific and southern Bering Sea.
- North Pacific Anadromous Fish Commission (NPAFC) Cooperative Research: salmon community structure and response to environmental change in the Bering Sea.
- Deep sea coral distribution and habitat in the Aleutian Archipelago.
- Monitoring and modeling predator-prey relationships.
- Species identity and life history of *Hematodinium*, the causative agent of vitter crab syndrome in Northeast Pacific snow (*opilio*) and Tanner (*bairdi*) crabs.
- Forage fishes in the western GOA: variation in productivity.
- Sperm whale and longline fisheries interactions in the eastern GOA.
- Estuaries as EFH for salmonids: assessing residence time and habitat use of coho and sockeye salmon in Alaska estuaries.
- NPAFC Cooperative research: genetic stock identification of chum salmon in the Bering Sea and adjacent waters.
- Establishing a statewide data warehouse of salmon size, age and growth records.

- Ice seal bio-monitoring in the Bering-Chukchi Sea regions.

- Effects of prey availability and predation risk on the foraging ecology and demography of harbor seals in PWS: development and test of a dynamic state variable model.

- Thermal habitat preferences of Pacific halibut and the potential influence of hydrographic variability on local coastal fishery.

- Continuation of long-term observations on the Bering Sea shelf: biophysical moorings at Sites 2 and 4.

- EFH for blue king crab, Phase I: development of cultivation techniques for blue king crab larvae.

- Pre-season forecast of Bristol Bay sockeye salmon migration timing based on oceanographic and biological variables.

- Pilot project for development of comprehensive baseline commercial fishing community engagement and dependency profiles for the BSAI and western GOA regions.

- Retrospective study of pigmented macrophage aggregates as markers of Pacific herring population health.

- Effects of inter-annual climate change on food availability, diet composition and productivity of planktivorous and piscivorous seabirds.

- Evaluation of alternative hypotheses to explain the collapse of the Kvichak sockeye salmon: a project to catalyze a comprehensive, hypotheses-driven research program.

- Spatial and temporal interactions between endangered short-tailed albatrosses and North Pacific commercial fisheries.

- Assessment of trawl third wires as a threat to seabirds, including the endangered short-tailed albatross.

- NPAFC cooperative research: use of genetic stock identification to determine the distribution, migration, early marine survival, and relative stock abundance of sockeye, chinook, and chum salmon in the Bering Sea.

- Bering Sea wintering grounds of beluga whales.

- Regime forcing and ecosystem response in the Bering Sea: Phase II.

- Video monitoring aboard Bering Sea factory trawlers—a pilot study.

- Enhancing rural high school involvement in North Pacific resource issues through participation in Alaska Regional National Ocean Sciences Bowl.

- Early marine ecology of juvenile chum salmon in Kuskokwim Bay, Alaska.

5.1.2 Specific Information Gaps and Research Needs by Resource Category

This section provides a brief summary of specific information gaps and research needs identified by PSEIS resource category. Most of these data gaps and research needs are fairly consistent across all of the alternatives; however, those data gaps and research needs pertaining to a specific alternative are highlighted and discussed. While the information gaps are many and the research needs important, it is beyond the scope of this section to examine the tradeoffs between the cost of collecting this new information versus the potential value of the new knowledge. As such, no attempts were made at prioritizing these research needs. However, expanded research to collect new information and fill existing data gaps is dependent on the agency's receiving additional research funding. While additional funds are not certain, NOAA Fisheries intends to pursue the funding necessary to meet future research needs and improve the scientific information available for managing the fisheries.

5.1.2.1 Physical Environment

At present, there is a considerable lack of environmental information from which to relate climate to the ecosystem in the North Pacific. NOAA is the primary steward for the living marine and protected resources and is responsible for the provision of long-term ecosystem observations. As such, a system should be developed for sustained measurement of climate and ecosystem variability; discern from those measurements significant changes; comprehend the underlying mechanisms for those changes; and develop and test prognostic ecosystem models. Research associated with the development of this system should focus on the following:

- Establish an observation system for the U.S. North Pacific marine environment for sustained monitoring of climate and ecosystem variability.

- Establish an infrastructure for the dissemination, interpretation and analysis of climate and ecosystem data.

- Conduct process studies to understand the underlying mechanisms relating climate change and ecosystem response.

- Integrate emerging scientific knowledge into prognostic models for resource management decisions.

- Provide annual reports on observed and predicted ecosystem changes.

- Improve understanding of interactions between the environment and society.

5.1.2.2 Target Groundfish Species

The significance of the impacts on target groundfish species were evaluated with respect to five effects: 1) fishing mortality; 2) change in biomass level; 3) spatial/temporal concentration of the catch; 4) prey availability; and 5) habitat suitability. When evaluating the significance of these effects, it was considered whether the impacts of effects could reasonably be expected to jeopardize the sustainability of each target species or species group. Related to this evaluation was the assignment of each species to one of six "Tiers" based on the availability of information about that stock (Appendix F-1). Tier 1 has the most information and Tier 6 has the least.

Species or species complexes that fall within Tiers 1 through 5 have estimates of the current fishing mortality rates and were evaluated with respect to exceeding the overfishing mortality rate (fishing mortality effect). Species or species complexes that fall within Tiers 1, 2, or 3 have reliable estimates of maximum stock size threshold (MSST) and were evaluated for the effects of spatial/temporal concentration of the catch, prey availability, and habitat suitability. The significance of these effects could not be evaluated for species or species complexes that fall within Tiers 4, 5, or 6, as these species do not have reliable estimates of MSST. This inability to evaluate the significance of the effects also occurs for the forage, prohibited and non-specified species. Additional research is needed so that the information base for Tiers 4-6 species will expand to the point where they can be move into Tiers 1-3. What follows are data gaps and research needs highlighted by many of the PSEIS target groundfish species authors.

Research is needed to reduce the uncertainty of survey biomass estimates for many of the target groundfish species. While there are adequate collections of biological data (e.g., lengths, weights, otoliths) for many of the target groundfish species from fishery independent bottom trawl surveys, these surveys may do a poor job of estimating abundance trends and biomass for some of the species. A major problem is that the survey's stratified random design for selecting haul locations may not be adequate for a species with a very patchy distribution. Biomass estimates in some years are greatly influenced by extremely large catches in just one or two hauls, and variance of these biomass estimates is consequently very high. This results in much uncertainty regarding abundance trends. Also, the surveys may not adequately sample rocky habitats where some target species may live, and so survey catchability *(q)* is uncertain.

A survey designed specifically for species with known patchy distributions (e.g., Pacific ocean perch, northern rockfish) would be an improvement. The objective of the present survey is to provide information on distribution and abundance of all groundfish species within the geographic area it covers. Because of the patchy distribution of some species, we need to sample many more locations than are possible given the constraints of the present survey methodology. It appears that a new survey that combines trawling with hydroacoustics may be the best future approach, but additional research is needed to determine how and if hydroacoustics can be used. Instead of the present survey net, a more up-to-date survey net equipped with tire gear on the footrope would also be useful for trawling over rougher bottoms.

Bayesian type analyses may be useful to quantify the effect of estimate uncertainty and improve stock assessments for target groundfish species. Particular attention should be given to estimates of q, and natural mortality (M) which have been shown to have a large influence on stock assessment model output. Also, updated studies on fecundity, size at maturity, age methodologies and validation, selectivity schedules at age, and weight at age information would be helpful in moving those groundfish species in Tiers 4-6 into Tiers 1-3.

Genetic research is needed to assess the risk of localized depletion on the genetic integrity of a given stock. Identification of stock structure is an essential part of examining whether a particular management scheme is providing the level of conservation as intended. Alternative 1 apportions ABC for many of the target groundfish species geographically among management areas in order to spread the effort and reduce the likelihood of localized depletion. However, information on stock structure for many of these species is inadequate, and for some species (e.g. many of the rockfish species), tag-and-release studies are not possible to elucidate stock structure. A number of genetic studies on Pacific ocean perch have been done, but the results have been equivocal. The most recent mitochondrial DNA studies suggest that some stock structure may exist, and additional studies are planned (Gharrett, personal communication 2000).

The development and application of molecular markers to studies of marine fish species have provided insight into the genetic connectivity of marine populations managed as stocks. Recent studies have focused on species supporting commercial fisheries, such as walleye pollock, using microsatellite, allozyme, mitochondrial DNA, and pantophysin markers. However, there is a considerable need to expand this approach to other directly exploited species (e.g., skates, flatfishes), species impacted as bycatch (e.g., sculpins), and ecologically important forage fishes (e.g., eulachon, capelin) in order to identify and assess the autonomy or connections among component stocks and their potential response to environmental or fishery-mediated changes.

Research is needed to assess the utility of rationalizing the fishery in order to reduce the risk of overfishing by eliminating the race for fish. Under Alternative 1, the groundfish trawl fishery is compressed in time and may increase the risk of overfishing. Consequently, the spatial concentration of catch could result in a negative impact on the reproductive success of the stock and subsequently on stock sustainability. However, more research is needed before the impacts can be fully known.

Research is needed to assess the utility of existing and proposed refugia to improve the reproductive success of various groundfish stocks. Under Alternative 1, a portion of the eastern Gulf is closed to trawling and may serve as *de facto* refugium allowing for increased survival of larger and older fish that produce significantly more eggs and larvae to replenish Gulfwide populations. Consequently, the spatial concentration of catch could result in a positive impact on the reproductive success of the stock and subsequently on stock sustainability, but more research is needed before the impacts can be fully known.

Research is needed to assess ecosystem considerations for single species management for many of the target groundfish species. There is currently insufficient information to conclude that existing trophic interactions would undergo significant qualitative change under Alternative 1. Consequently, the impacts of Alternative 1 on prey availability and the subsequent impact on stock sustainability can not be fully known without more research.

More research is needed to identify the habitat requirements of adult and juvenile target groundfish species and to assess impacts from fishing on habitat suitability. The habitat preferences of many of the groundfish species are poorly known. The trawl survey gear is able to sample flat, smooth substrates fairly well, but cannot sample rough, steep substrates. So for those species occupying the rougher substrates, the current trawl surveys may be doing an inadequate job of assessing them and their respective habitats. Juvenile habitat requirements are not known for many of the target groundfish species. For example, very few Pacific ocean perch less than 20 to 25 centimeters fork length are caught in the survey, and it is presumed these young fish live in habitats that cannot be sampled by the survey's nets.

Bottom trawling or other fishing gear in contact with the ocean could negatively impact the habitat of adult and juvenile groundfish species and may reduce survival of juvenile fish. Consequently, the change in habitat suitability could result in a negative impact on rearing success of the various groundfish stocks and subsequently on stock sustainability, but more research is needed before the impacts can be fully known.

5.1.2.3 Prohibited Species

Pacific herring populations in PWS are still recovering from the EVOS. It is unknown how, when, and if these populations will eventually recover and to what extent. Habitat contamination in PWS is also lingering but it has not been determined what the long-term effects of the EVOS will have on herring and its habitat. Additional research could be helpful in identifying physiological changes that may be occurring in those populations (some populations are showing signs of recovery while others are not). It is also unknown how the EVOS and its related lingering contamination have affected prey availability for herring, if at all.

It is known that Pacific herring form dense schools which make them more vulnerable to spatial/temporal effects of fishing. Currently the movement of herring schools throughout Alaskan waters has not been studied to the extent that one could predict their location and timing. Thus, additional research to elucidate the spatial/temporal characteristics of herring populations could prove extremely valuable in the management of this species.

There are data gaps for spawning habitat for all salmon. Since these fish spawn in fresh water, impacts from state subsistence fishing, sport fishing, and land management practices have not been studied to the extent that impacts are known. Degradation of watersheds (mainly from land management practices) used as salmon spawning grounds could impact reproductive success and stock sustainability, but no specific trends over time have been reported to date.

It has been thought that climatic changes are also playing a role in the current poor stock status of salmon runs in western Alaska, but specific effects are unknown. The potential for climate change, degradation of spawning habitat, change in prey availability, and increased mortality (fishing and natural events) to effect all species of salmon is recognized as a fruitful area for future research.

Determining relationships between prey catch and salmon prey availability is also a data gap and an area of potential research. Composition of prey for salmon are unknown. Identifying essential prey items in the diets of salmon could provide information to minimize prey competition between salmon and fisheries.

Focusing research efforts on depressed stocks of salmon in Alaska and chinook salmon originating in the Pacific Northwest that are currently listed species under ESA, may provide additional data that could help manage and protect this species until recovery begins to occur. Research collaboration between ADF&G and NOAA Fisheries could encompass the different phases of salmon's life cycles, thus, maintaining and improving the complex management of all species of salmon throughout Alaskan waters.

5.1.2.4 Other Species

NOAA Fisheries has increasingly been charged to conduct assessments on progressively more species. This is particularly true in the case of stock assessments for non-target species in Alaskan waters. A strong need exists for research in the following areas of concern regarding management of species that are caught as bycatch in other fisheries:

- When species are not identified as a single fisheries management unit, quotas may not adequately protect the reproductive potential of the less abundant members of a complex.

- When stocks are managed in complexes that include species with different life history characteristics, quotas may not adequately protect the reproductive potential of the slower growing, long-lived, less fecund members of a complex.

- Rare species may be vulnerable to overfishing because of their low stock size and patchy distributions.

- Traditional fishery independent assessment surveys are not designed to assess rare species and biomass estimates for these species may be uncertain.

The AFSC has collected specimens of skate species from previous surveys conducted in the BSAI and GOA that are difficult to classify. Some samples exhibit characteristics that may be indicative of a new species. Research funds are needed to allow staff to travel to various museums to compare EBS/GOA skate specimens with museum specimens for verification of species identification. This work will not only improve assessment of skates but will also improve the assessment of new fisheries in the GOA targeting on skates. Research is also needed on the biology and identification of North Pacific cephalopods. The life history and identification of these species are not well understood. Such research will improve the identification of cephalopods taken in commercial fisheries and during resource assessment surveys.

Detailed information on the age composition and fisheries catch are seldom available for bycatch species. This situation leads to increased reliance on survey biomass estimates. A catchability coefficient is needed to scale survey abundance estimates to total abundance. Research is needed to evaluate the catchability of non-target species to the EBS survey trawl used in the annual EBS bottom trawl survey.

5.1.2.5 Forage Species

The abundance of ecologically important forage species is unknown in much of Alaska. This information is critical for understanding the Alaska marine ecosystem and managing the commercially important species within this ecosystem. Research is needed to measure abundance of ecologically important forage species including: eulachon, herring, capelin, and in southeast Alaska: pollock. Assessment of forage species is difficult because of their diffuse, patchy distribution and unknown stock structure. Pre-spawning and overwintering aggregations, however, appear to be more discrete and concentrated, potentially enabling more efficient surveys (e.g., with acoustic and mid-water sampling) and stock-specific assessment data. As such, research should be conducted to determine where these winter aggregations of forage species occur in time and space.

Research should be conducted to measure how reliability of forage location and nutritional value affect susceptibility to predation. Different forage species appear to have different strategies to reduce predation. For example, overwintering herring concentrations occupy predictable depths, but are diffusely distributed. The numerical response of predator species affiliated with these prey can be collected simultaneously with measurement of forage species abundance.

The lack of population level assessments for some of the species in the forage species group means that species level effects on those are unknown. Better understanding of the factors influencing forage species dynamics and spatial/temporal distribution will help us better separate the role of climate and fishing in influencing the dynamics of these species.

5.1.2.6 Non-Specified Species

Non-specified species is a huge and diverse category encompassing everything not listed in the FMP as a target, prohibited, forage, or other species. Unfortunately, basic information is lacking for nearly all of the species in this group. They are caught in small or unknown amounts (due to a lack of reporting requirements in this category) and formal stock assessments are not conducted. Research is needed to gain a better information base (e.g., estimates of total biomass, spawning biomass, age and size structure, sex ratios, temporal and spatial distribution, fishing mortality rates, etc.).

Grenadier species represent the major catch from the non-specified FMP category. They are ecologically important and appear to be one of the most abundant species in the northeastern Pacific, but their true abundance and life history are poorly known. This information is critical for understanding the Alaska marine ecosystem and managing the commercially important species within this ecosystem. Only limited assessment work has been done for the grenadier species. Research should be conducted to examine avenues for preparing quantitative assessments for these species based on data from longline surveys.

5.1.2.7 Essential Fish Habitat

The largest fisheries in the continental U.S. occur in waters off Alaska. The region has five FMPs and encompasses the largest shelf and geologically most complex area of the U.S. coastal zone. There is a wide diversity of habitat types in this region ranging from the extensive soft-bottom areas of the Bering Sea shelf to the complex high-relief habitats of the Aleutian Islands and portions of the GOA. Alaskan fisheries that target groundfish, crab, and scallops all use gear that may adversely impact benthic habitat. This gear includes bottom trawls, longlines, pots, and dredges.

Since 1996, the AFSC has been conducting research on the effects of fishing gear on benthic habitat. This research has led to important findings that increase our understanding of fishing gear effects on benthic habitat. Research has focused on 1) understanding the direct effects of bottom trawling on seafloor habitat; 2) the associations of fish and invertebrate species with habitat features that may be affected by fishing gear; 3) the evaluation of technology to determine gear effects and benthic habitat features; and 4) retrospective analyses of spatial/temporal patterns of bottom trawling. Most of the field-oriented studies (i.e., 1-3 above) have focused on small geographic areas in specific habitat types.

Research efforts over larger geographic areas and a variety of habitat types will provide fisheries managers the information needed to develop measures for minimizing the adverse impacts of fishing gear, as required in the MSA.

During a three-day workshop held in January 2000 in Juneau, Alaska, research projects were identified and a time-table for completion was drafted. This plan has been subsequently revised as research is completed or priorities change. The suite of projects identified takes a comprehensive and scientific approach to the issue of fishing gear effects on habitat. During the initial phase of this research, the focus is on identifying the effects of the various gear types on fish habitat for a range of habitat types, mapping habitat, examining the associations between habitat features and fish utilization, and defining the geological processes that will allow comparison of natural versus gear effects processes. After this initial phase, studies will transition to those that establish the connections between habitat and fish production and population dynamics. This research plan will be implemented through collaborative projects with the ADF&G, the University of Alaska, and others.

Two themes emerged in this research plan: (A) The need to better determine the effects of fisheries on benthic habitat; and (B) The need to study the spatial extent of fishing ten individual projects hve been identified that fall into three major categories: 1) effects of specific gear on specific habitat; 2) linkage of fishing induced disturbance to population dynamics of commercial and non-commercial species; and 3) mitigation related studies. Some of these projects represent continuance and expansion of existing projects and others are new projects.

I. Determine Effects of Fishing on Benthic Habitat

Three experimental approaches are applicable to this general research objective and suitable research sites are generally available in the BSAI and GOA.

(A) *Compare conditions in heavily fished and lightly fished/unfished areas that are in close proximity and otherwise similar.* This approach allows an assessment of long-term (chronic) effects of fishing activity on physical features of the seabed as well as effects on the structure and function of associated benthic invertebrate communities. High quality fishing effort data are required to identify appropriate experimental sites, which may or may not straddle closed area boundaries. Replicated biological sampling with grabs, trawls, and underwater video or submersible observations are needed to characterize relevant population and community-level attributes in the disturbed and undisturbed sites, such as biomass, numbers of individuals, body size, species richness, species diversity, and the physiological states of biostructure, prey, and resident FMP species. Acoustical surveys with multi-beam, side scan, or single beam devices, coupled with grab and video groundtruthing, would be the basis for comparison of physical features such as sediment texture and bedforms.

(B) *Compare conditions before and after fishing to identify effects on the benthos. Unfished controls are necessary to evaluate the effects of fishing where existing closures do not provide a necessary contrast in fishing intensity*. Recovery can be examined in unfished controls with continued sampling. Replication with multiple (paired) sites is required to avoid spurious outcomes. Otherwise, longer-lived individuals or species will be under-represented in the samples thereby biasing results. In addition to sampling methods and gears described in (1) above, effective contrasts of conditions before and after fishing requires highly accurate positioning of fishing and sampling gear within the disturbed (experimentally fished) and undisturbed (control) sites, especially when destructive sampling methods are used.

(C) *Determine rates of disturbance with repetitive fishing of specific grounds. Incremental and cumulative catch rates can be used to measure the rates of depletion of benthic fauna, changes in community structure, and alteration of seabed properties as a function of fishing intensity.* Similar to (2) above, these sites should have limited or preferably no prior fishing disturbance history in order to obtain a full measure of effects. Once again, careful positioning of fishing and sampling gear is required for meaningful results.

II. Specific studies:

A. Effects of specific gear on specific habitat

1. <u>Effects of bottom trawling on soft bottom habitat of the GOA</u>
Extensive trawling occurs over soft-bottom habitats in the GOA. Immediate and long-term changes in soft substrates and associated animal communities will be evaluated through comparisons of adjacent open and closed fishing areas and through intensive trawling experiments. In areas with soft substrates, sea whip colonies are vulnerable to gear damage. Sea whips can be removed, dislodged, or broken by fishing gear. Previous studies conducted by the AFSC on soft-bottom habitat have shown that areas with sea whips appear to have greater productivity (greater biomass and numbers of megafauna) than adjacent areas devoid of sea whips. Since sea whips are believed to be long-lived, recolonization rates may be very slow. Sea whip biological characteristics and their resistance to levels of trawling will be studied. The study will also provide an opportunity to assess recolonization in future years. The study will

provide information for evaluating measures to minimize fishing effects such as area closures or gear modifications.

2. Effects of bottom trawling on soft-bottom habitat of the Bering Sea shelf
The relatively recent and well-documented development of large-scale commercial fisheries in the EBS presents a rather unique opportunity for studying the potential impacts of trawling on benthic habitats. Areas closed to trawling are adjacent to heavily fished areas allowing for comparison of the effects of fishing activities on seabed habitat utilized by nationally important stocks of groundfish and crab. Physical and chemical characterizations of the seabed, in addition to biological assessments, are needed to evaluate fishing effects on these habitats. Current studies in the Bering Sea have identified possible adverse effects of bottom trawls on soft-bottom benthos, including chronic effects on community diversity and on individual megafauna populations. However, interpretation of these findings and effective use for management purposes requires some understanding of the underlying processes. To address this need, a multi-year study is required to investigate acute effects and recovery from bottom trawling. Project findings will address management issues related to the need for and efficacy of bottom trawl prohibitions, as well as operational considerations related to management of closed areas.

3. Effects of scallop dredging on benthic communities
A research program is urgently needed to examine the effects of scallop dredging on the scallop's life history, population dynamics, and associated benthic community and habitat. A scallop dredge is a heavy fishing gear with maximum contact with the seafloor. Worldwide, scallop dredges have been implicated in negative, neutral, and positive effects on benthic animals and habitats depending on local environments. Typically, dredges catch only 5 to 35 percent of scallops in their path, so dredge paths are towed repeatedly during intense fishing seasons before vessels move to new fishing areas. In Alaska, the main target species, the weathervane scallop, overlaps in geographic distribution and habitat with a number of other important commercial species, including Tanner crabs whose stocks are depressed and/or overfished throughout Alaska. In Alaska, large areas of the coast are permanently closed to scallop dredging without evaluation of potential effects. We propose a multi-agency program with industry cooperation to study the biological and physical effects of scallop dredging in Alaska. A carefully planned research program was developed by internationally acclaimed scientists during a workshop sponsored by the ADF&G and University of Alaska in Kodiak, during June 10-12, 1999. A set of integrated field and laboratory projects will focus on process-oriented research directed at individual, population and community levels.

4. Effects of longline and pot gear on sensitive habitats
Considerable attention and some research has been directed at the effects of bottom trawling on benthic habitat. However, large scale fisheries that target crab, sablefish, rockfish, and Pacific cod use longline or pot gear. These gears can have an impact on certain sensitive habitat as evidenced by limited underwater observations. The actual capture of gorgonian and stony corals, as examples, has been verified by commercial fisheries observers and NOAA Fisheries surveys. Damage can be caused to corals, sponges, and some other sessile organisms by hooking, by crushing and plowing by pots and anchors, and from shearing by groundlines upon retrieval. On the other hand, a large proportion of this gear is set on soft substrate where effects are

considered negligible. Estimating cumulative effects for a variety of substrates and the behavior of gear in contact with the bottom are two topics that require study. These studies will involve underwater observation of longline and pot deployment and retrieval with remote and manned submersibles.

5. Effects of fishing on hard-bottom habitat of the Aleutian Islands
The narrow shelf areas of the Aleutian Islands, characterized by swift currents and very irregular terrain, support a very diverse and lush community of benthic organisms, including commercially important fish and shellfish. The taxonomy, life history and ecology of many of the invertebrate species are poorly known. Initial studies in the Aleutian Islands focused on the Seguam Pass area, where a trawl fishery for Atka mackerel has operated over the past two decades. This research identified six distinct bottom habitats and documented potential impacts from the historical trawl fishery. This study also considered potential recolonization of coral following trawl closures established to protect sea lion foraging areas. Additional work is needed to investigate impacts from other fisheries (e.g. cod, halibut, crab and rockfish) and gears types that occur in other key areas of the Aleutians. Because of limited habitat data, extreme tides and currents, and overall high biodiversity throughout the Aleutian Archipelago, research in the area is challenging. More exploratory studies will be the basis for development of specific research hypotheses that will emerge as more knowledge and experience is gained in the region.

6. Impacts of fishing on crab resources and habitat
Crab populations that support major commercial fisheries are perceived to be highly vulnerable to bottom trawling, given crab life cycles and behavioral patterns. Over the past 30 years, crab stocks have undergone significant fluctuations in abundance and currently are at very low levels. Juvenile crab, particularly juvenile king crab, are dependent on a variety of epibenthic organisms which are themselves vulnerable to bottom trawls. Also, large pods of juvenile king crab and female Tanner crab form during the mating season in very localized areas, and substantial numbers could be removed or injured if bottom trawling were to occur at these locations. Fishery management regulations for crab and groundfish have been directed at protecting the productivity of the crab resources in order to expedite their recovery. Large areas have been closed to bottom trawling and restrictive bycatch limits for crab have been imposed. However, because of interactions with other fisheries, effective use of these measures requires a clear understanding of factors affecting spatial/temporal patterns of crab distribution. In particular, podding behavior must be thoroughly investigated so that protective time and area closures can be accurately devised not only to reduce unintended mortality but also to minimize consequences for trawl fisheries. Similarly, research is needed to observe and document species associations that are critical to juvenile growth and survival. Furthermore, impacts of lost crab pots on EBS habitats must be investigated. In some years, tens of thousands of crab pots are lost due to rapidly moving ice flows. Derelict crab pots may alter habitat by adding hard structure to an otherwise flat and featureless soft bottom. Traditional dump sites for trawl-caught derelict pots would serve as natural laboratories for documenting effects on the benthos, and controlled laboratory and/or in-situ field studies would subsequently evaluate long-term impacts on productivity.

7. Effects of bottom trawling on shelf break and upper continental slope habitats
   Some of the highest density of bottom trawl effort occurs in the narrow zone that constitutes the upper continental slope and shelf break. This zone is a geologically unique area used by species of high commercial value such as sablefish, shortraker and rougheye rockfish, and Pacific ocean perch. Studies are needed to understand how bottom trawls affect the habitats that constitute this zone. These studies will focus on determining effects of bottom trawling in this zone and identification of habitat types that are sensitive to fishing-induced disturbance.

B. Linkage of fishing induced disturbance to population dynamics

1. Laboratory and field studies
   In instances where fishing gear has measurable effects on the seafloor, follow-up research is required to quantify the biological responses. Overall productivity could change as a result of gear-induced disturbances. Individual rates of growth, survival, settlement and reproduction could also be affected. Except in instances where change is inherently unacceptable, it is paramount to know whether these changes are positive or negative in nature. The ecological relationships in affected areas will be extremely complex. Variation in the responses of different taxa, life history stages and even individuals can be expected. Thus, only the dominant linkages will be understood or practical to investigate, at least initially. Controlled experiments over the range of observed impacts will be required. Specific hypotheses will be designed in laboratory and field settings as dictated by the needs for specific environmental conditions or variability, treatment groups, controls, and statistical replication. Experimental work will be conducted in seawater laboratories or *in-situ* at selected sites in the BSAI or GOA. These sites may require protection from further human disturbances throughout the experimental period.

2. Modeling
   An understanding of the natural processes of seabed disturbance (storms, erosion, deposition, bioturbation, landslides etc.) is required for comparison with the disturbance effects of fishing gear. Once disturbed naturally or with fishing gear, does the habitat return to the original undisturbed state or to some new equilibrium condition? Models of natural seabed sediment dynamics and seafloor geologic and biologic disturbance will be developed and applied to different physical and biological settings to allow comparison with fishing gear disturbance.

   Because potential management decisions are typically evaluated with respect to their effect on the population attributes (stock size, recruitment, etc.) of specific stocks, it is necessary to consider the linkage between fishing-induced disturbances and population dynamics. This process would minimally require information on the critical life history stages where substantial mortality takes place, the habitats associated with those critical life history stages, and how changes in habitat quality affect mortality rates and other vital population parameters. The field projects identified in the other parts of this initiative should provide the basic information to guide modeling efforts.

C. Mitigation related studies

1. Evaluation of mitigation measures and impacts with research closures
The MSA mandates the protection of EFH of the Nation's fishery resources. As the regulatory agency for federally managed fisheries, the NOAA Fisheries is particularly responsible for adverse effects to EFH due to fishing activities. As a result of that responsibility NOAA Fisheries is in the process of determining alternative measures to minimize to the extent practicable the adverse effects to EFH. Due to a considerable lack of available information, there is a great deal of uncertainty about the type and extent of measures that would actually be necessary or effective. The EFH Final Rule instructs that establishment of research closures be considered to evaluate the impacts of fishing activities. This research plan is an attempt to design and utilize research closures as a method to obtain information needed to protect habitat in a practicable manner. We will first provide a design to be implemented under baseline conditions, then attempt to modify the design as needed for the various minimization alternatives being considered.

The long-term goal of this research is to understand effects of fishing on habitat and validate whether adopted minimization measures are necessary and effective. Objectives are to determine whether fishing does or does not reduce or alter benthic habitat and whether such alterations effect the shelter, food, species composition, and ultimately the productivity, or MSY of important FMP species. Specific objectives of the research closures would be to compare, under contrasting (fished versus not fished) levels of fishing, information such as habitat condition, the abundance, composition, and size of habitat forming organisms, and possibly local abundance of fish and prey. These research closures are not expected to be able to demonstrate differences in stock productivity due to fishing impacts on habitat, but are a first step in seeing whether habitat features that provide shelter, prey, and other functions are altered.

2. Reducing fishing gear effects through gear modification
The modification of fishing gear has potential to substantially reduce seafloor effects. Fishing gear research has greatly improved both the effectiveness and the selectivity of fish harvests and similar success is likely if efforts are turned toward reducing seafloor effects. Some promising concepts are already apparent (i.e., fishing trawl doors off-bottom and using lighter groundgear) while others would emerge from focused research and development. Since gear effects are habitat-and community-specific, appropriate gear modifications are likely to vary between fisheries and locations. Failing to develop such options would exclude an entire class of mitigation possibilities.

A survey of fishing gears and the ecosystems where they operate will be examined for situations where modifications could have greatest effect. Development of seafloor-friendly gear will start by identifying which parts of the fishing gear generate adverse effects and what characteristics of those components can be changed to make those effects less severe. From this information, appropriate modifications will be developed and tested. Methods will be developed to quantify component-specific effects to allow measurement of the resulting improvements. Expected is that most improvements will involve some reduction in catch rates. Measuring such losses will also be a component of testing. To maximize the relevance and acceptance of the resulting gears, this project will be conducted in cooperation with the fishers and fishing gear designers.

II. Spatial Extent of Fishing-Induced Disturbance

A. Habitat evaluation in current FMP fisheries

Of urgent need is the examination of benthic habitat in the vicinity of major FMP bottom trawl fisheries. Currently, NOAA Fisheries is the defendant in a lawsuit that claims NOAA Fisheries violated EFH provisions in the MSA. The lawsuit expresses concern that "in the North Pacific, bottom trawling and other fishing activities harm EFH in various ways" and cite evidence that bottom trawls will damage benthic marine life, such as sponges and sea whips. The suit claims practicable measures to minimize adverse impacts were not adopted and proposes that NOAA Fisheries prepare assessments of measures that could be taken to protect EFH from fishing effects. As very little is actually known about the bottom habitat where major FMP bottom trawl fisheries currently occur, particularly in the GOA there is little information to assess the necessity and effectiveness of any measures that may be proposed. While a variety of measures, such as further area closures, can be proposed without any information, ideally measures should be chosen that have a high likelihood of being effective while retaining benefits of the fishery.

Observations of the Alaska seafloor have been made with manned submersible and Remote Observation Vehicles; however, these observations have covered only limited areas. Because the costs and logistic limitations of manned submersible observations necessary to survey the fishery area are prohibitive, the AFSC has been developing remote camera devices to lower costs and reduce the limitations. The initial phase of this study would sample current heavily-fished grounds to see where and to what extent different habitat types occur. Habitat types that are physically vulnerable to fishing may be of particular concern. Subsequent phases of the study would provide groundtruth information on habitat type to complement NOAA/U.S. Geological Survey (USGS) mapping efforts (see item 3, below). Later phases of the study would be to survey fishing grounds to evaluate any measures that may have been adopted to protect EFH.

B. Mapping of habitat features of major fishing grounds

Little of the continental shelf and slope of the Alaska EEZ has been adequately characterized. This project proposes to target limited areas of the Alaska EEZ for geomorphic/geologic mapping using state-of-the-art technology. These areas would correspond with areas most at risk to FMP fishing activities. NOAA Fisheries will determine the essential benthic ecological characteristics from ground truth surveys to allow useful habitat characterization and classification. Geological aspects will include assessing sediment dynamics to allow comparison of natural processes versus gear impact processes. High-resolution multi-beam systems that include coregistered calibrated backscatter are capable of mapping the continental shelf at spatial resolutions of less than 4 meters (m). The deeper water depths of the upper continental slope can now be mapped at spatial resolutions of ~8 m. Together, accurate, high-resolution bathymetry and backscatter provide quantitative insights into the geology and distribution of the surficial sediments and rock outcrops of benthic habitats. The bathymetry and calibrated backscatter can be combined with accurately georeferenced groundtruth sediment, biota and rock samples to predict the sediment types and habitats in zones where no groundtruth exists.

C. Retrospective analysis of seafloor geologic and biologic character

An analysis of existing data sets can improve current management practices and guide future field studies. These analyses consist of identification of the spatial/temporal occurrence of target fisheries (defined by species composition), and identification of species assemblages using cluster analysis. The data available for this analysis include those collected from NOAA Fisheries observer program and the NOAA Fisheries surveys. The identification of target fisheries builds upon the previous analyses of bottom trawl effort in Alaska and would be extended to include other gear types. This study will also provide large regional perspective and retrospective of the character of the shelf and upper slope sediments and outcrops based on existing geological and biological data collected by the USGS and others. The identification of fish/invertebrate assemblages provides key information that, when combined with geological characteristics, reveals which habitats have particular biological significance. In cooperation with the USGS maps and data bases summarizing the present adequate and inadequate state of knowledge of the seafloor off Alaska will be produced and maintained. These products would form the basis for extrapolating site specific (postage stamp) studies and for targeting priority areas for high resolution habitat mapping and groundtruthing.

D. Quantify abundance of habitat types over large geographic areas

Essential for both fisheries managers and researchers are estimates of the amount of specific habitats by management area. Interagency consultations and evaluation of management alternatives require this information in order to evaluate habitat effects of permitted actions. However, given the immense shelf and upper slope areas of the GOA and the Aleutian archipelago a long-term, multi-year study is required. High-resolution multi-beam systems can cover relatively large areas of the continental shelf (>20 kilometers^2 per hour), collecting georeferenced bathymetry and backscatter. The initial effort for this task will be to design an approach to improve the ability to quantify habitat abundance over large areas. High-resolution habitat studies over large geographic regions are currently difficult with today's technological and likely funding limitations. The project will involve extensive acoustic and video transects that can map depth, substrate type, and benthic organisms. Currently available mapping databases will be used where practicable. The project will also tie into projects that intensively map small areas of high priority, such as intensively fished grounds and dense coral and sponge habitats. From this project will come area estimates by habitat type, improved description of fish and shellfish habitats, and a general overlay of habitats throughout the GOA and Aleutian Island areas.

E. Characterization of benthic habitat in habitat areas of particular concern

Recently adopted amendments to FMPs in Alaska address areas of the marine environment that provide habitat necessary for completion of part or all of a managed species' life history cycle. EFH that is especially sensitive to human-induced impacts (such as fishing) may be further classified as a habitat area of particular concern (HAPC). HAPCs that have been identified, or are currently being proposed, in Alaska include living substrates in shallow or deep waters, seamounts or pinnacles, and the continental shelf break. All three habitat types are characterized by a high degree of biological productivity, and living substrates also provide areas of high microhabitat diversity. Deep-water corals have been classified as an HAPC. NOAA Fisheries trawl surveys have identified several sites in Alaska that may harbor colonies of deep-water gorgonian coral. Gorgonians such as red-tree coral (*Primnoa* sp.) colonies provide complex benthic habitat, and may be ancient and extremely slow growing. That, coupled with their arborescent nature, makes them highly susceptible to damage by commercial fishing activities. The goal of this study is to use geomorphic and geologic mapping tools along with a research submersible or towed video imaging system to survey particular locations that are being considered for protection as HAPCs by NPFMC. Investigators will initially assess abundance and distribution of red-tree and other gorgonian coral, identify fish and invertebrate species associated with the colonies, document evidence of damage (if any) to the colonies from human and non-human influences, and ascertain substrate morphology and composition in areas of coral abundance. Research in outlying years will focus on characterizing and linking physical and biological aspects of the seabed on seamounts/pinnacles, and along the continental shelf break.

5.1.2.8 Seabirds

The Draft Programmatic SEIS (NMFS 2001a, pp 4.3-1 and 4.3-50) and the Ecosystem Considerations for 2003 report (NPFMC 2002) have identified the major gaps in our knowledge of seabird ecology with respect to the groundfish fisheries and recommend the following:

- Compile existing data on diet, distribution, and abundance of seabirds into a common, accessible database.
- Initiate new research on seabird diets and foraging ecology, especially during the non-breeding seasons.
- Update population estimates for all seabird species.
- Improve knowledge about the distribution, abundance, and ecology of forage fish, especially with regard to management of predatory groundfish and climate change.
- Initiate studies to examine potential fishery impacts at the breeding colony level.
- Analyze Observer Program data to identify particular areas and time periods with the most adverse seabird/fishery interactions.

- Continue to improve collection of species-specific incidental take data through the Observer Program and collaborative efforts to develop and test effective take reduction measures in the longline and trawl fleets.

- Quantitative modeling of fishery impacts on selected seabird species at the population level.

- Examine role of fishery discards and offal in seabird reproduction and survival as a function of the spatial/temporal distribution of fishing efforts.

- Employ new research techniques (i.e. satellite telemetry) to examine at-sea distributions of sensitive species like short-tailed albatross.

Many of these efforts are underway but will require long-term commitments of resources and patience on the part of administrators and the public before scientists can reach meaningful conclusions.

For the purposes of analyzing regional population trends, adequate data exists for only a few species of seabirds that breed in Alaska, notably black-legged kittiwakes, red-legged kittiwakes, common murres, and thick-billed murres. More limited population and reproductive data is available for several other species (Dragoo *et al.* 2001). Unless U.S. Fish and Wildlife Service (USFWS) receives substantial increases in their future research budgets, the murres and kittiwakes will most likely continue to be the most useful species for fishery impact assessments. Population trends for the three albatross species can also be monitored fairly accurately because of their limited number of tropical breeding colonies, although assumptions must be made regarding the number of non-breeders that do not return to the colonies every year. The albatross species in the BSAI/GOA traverse huge distances and are impacted by many different kinds of human activities across international boundaries. Their frequent interactions with the groundfish fisheries and the important management implications of the ESA necessitate ongoing cooperation with other regional and international conservation agencies and institutions.

In addition to basic reproduction and population trend data, fishery impact assessment also requires an explanation of the mechanism(s) of action. For species that are thought to be impacted primarily through direct fishery-related mortality, such as the albatross species, population modeling can be combined with measurements of incidental take in the fisheries to calculate the degree of population impact (Cousins and Cooper 2000). The accuracy and completeness of incidental take levels should continue to be monitored by independent observers and tracked over time as new seabird avoidance techniques are introduced. Several other factors that influence seabird incidental take, such as overall nutritional state of the birds and seasonal distribution of fishing effort, should be monitored as well so that the effectiveness of the new avoidance techniques can be assessed with less uncertainty. For species thought to be affected primarily through fishery-induced changes in food availability, quantitative changes in prey availability (which includes elements of prey abundance, schooling behavior, and the "patchiness" of distribution) are much more difficult to measure. The complexity of the issue may be best addressed by trying to measure and compare the physiological state of birds in areas that are fished versus areas that are not fished. While traditional studies of this nature require the collection of birds for stomach and tissue samples, newer serological methods only require live capture and drawing blood samples (Piatt *et al.* 1998, Suryan *et al.* 1998a, Suryan *et al.* 1998b, Suryan *et al.* 2000).

The key to this kind of comparative analysis is finding suitable study areas for comparison. The establishment of no-fishing reserves around selected breeding colonies would greatly facilitate such studies. Comparative studies of this nature could be conducted for both fish-eating and plankton-eating seabird species. Ideally, nutritional studies would be conducted in conjunction with reproductive and population trend studies in order to link the impact mechanism with the potential effect. While it would not eliminate all uncertainty about potential impacts, a system of research reserves offers some hope of scientifically deciphering the ecosystem complexities of marine life. It is important to note that no-fishing reserves that were within 3 nautical miles of shore would have to be established in conjunction with the State of Alaska. The effect of a federal reserve would obviously be nullified if state-managed fisheries were allowed to continue inside a no-take reserve boundary. This would be especially important if the no-fishing reserve encompassed a seabird breeding colony.

Several concerns have been raised about the Observer Program incidental take data, including the large number of birds that are reported under "unidentified" or group categories rather than individual species and the large variability in take estimates within and between years (public comments on Draft Programmatic SEIS, CAR 2001). The Observer Program is addressing some of these issues with improvements in field identification methods based on feet and bills, improvements in sampling design and data collection protocols, and improvements in observer seabird training programs. However, there will always be unidentifiable bird remains and there is some value in combining rarely taken species into groups for reporting and analysis purposes. The quality and quantity of seabird data coming out of the Observer Program is largely a function of how much emphasis is placed on collecting seabird data versus other kinds of fishery data. Some of the Alternatives in this PSEIS give the collection of seabird data a higher priority than others. For some types of seabird/fishery interaction data, it may be necessary to have dedicated seabird observers on a subset of vessels that already have fishery observers. These seabird observers would not have fish sampling duties and could collect other types of data not normally collected in the Observer Program. The development of video monitoring techniques may also be useful in this effort, especially on smaller boats that did not carry observers. Of course, the potential value of this data will need to be balanced by the cost of acquiring it.

One concern has been that observers were not accounting for birds that are hooked on longlines as they were deployed but fell off before they were retrieved on board. One study from Australia (Gales *et al.* 1998) indicated that 30 to 95 percent of the birds coming out of the water fell off or were shaken off the gangions before being hauled aboard and were thus missed by observers. However, that study was based on an observer program that did not actively watch the groundline as it was retrieved. In the North Pacific Groundfish Observer Program, observers actually watch the groundline as it is retrieved and do tally birds that fall off before being retrieved on board. This accounts for some of the "unidentified seabird" data. The question of how many birds are hooked as a line is deployed but fall off while the groundline is underwater is an issue that could perhaps be addressed by a series of experiments. These experiments could use birds already taken in the fishery or taken for other scientific purposes. The known numbers of seabirds placed on the line would then be compared to the number retrieved after the line soaked under normal fishing conditions. Such experiments may improve estimates of how many birds are actually taken in the fisheries. An alternative might be to use underwater video cameras to observe the longlines as they are being deployed. This technology is currently being developed to study the impacts of pelagic trawls (Kim Rivera, NOAA Fisheries seabird coordinator, personal communication) but it would probably require substantial research and development for longline applications. Again, the cost of developing this technology may be disproportionate to the value of the data, especially if new avoidance measures dramatically reduce incidental take on longlines.

Concerns for fishery impacts range from population level effects to local breeding colony effects. As a practical matter, population modeling efforts have been limited to those species most frequently taken incidentally in the longline fisheries (northern fulmars) and to species of special concern (the three albatross species). Even though most other species are not monitored closely enough to determine if impacts are occurring on a population level, recent survey trends have raised interest in trying to model possible colony-level impacts on species that breed near intensive fishing efforts. Considering the proximity of major trawl and longline fishing efforts around the seabird colonies of the Pribilof Islands, it seems that this would be an appropriate region to model potential impacts on diving species such as the murres and on surface-feeding species such as the kittiwakes. While the murres are taken incidentally in trawls, a potentially larger impact may take place through fishery-induced changes in predator-prey relationships and other food web interactions with forage fish and important invertebrate prey. This localized impact model would thus be part of and integrated with a larger ecosystem modeling effort called for in some Alternatives.

Many questions need to be addressed regarding how seabirds would factor into an ecosystem model. Recent work by Hunt *et al.* (2000) has attempted to quantify some of the prey consumption parameters for seabirds and marine mammals in the North Pacific. While such broad analyses are valuable for overall energy and mass flow estimates, more localized measurements and assumptions about seabird numbers, seasonal distribution, and diet will be needed for a mathematical model to reflect the dynamics that are important to seabird survival and reproduction. The impact of seabird foraging on prey species, especially around breeding colonies, would also be an important element in any modeling effort.

The ecosystem model would have practical applications in the Alternative 4 policy which requires the fishery management system to incorporate indices of “ecosystem health” in allocation decisions. The question of what these indices might be for seabirds deserves careful consideration. One candidate for a measurable index is the population densities of selected “indicator” species. There are two challenges with this approach. First, state-of-the-art seabird censussing techniques are still not very precise so there will always be a substantial amount of scientific uncertainty regarding population levels, especially over large areas. Second, populations of animals are never static, even in the absence of humans, so a certain amount of fluctuation should be seen as acceptable or even desirable in a “healthy ecosystem”.

Decisions will have to be made about how much change in an index is acceptable and at what point management should respond. One option is to develop different “levels of concern” based on the direction and amount of change over time, similar to the International Union for Conservation of Nature and Natural Resources’ “red list” ranking system for species, defined but for regions as biologically important to the fishery rather than global population. In any case, even if a set of ecosystem “warning signs” can be developed, the underlying mechanisms of change must be determined before appropriate mitigation can be taken. It must be acknowledged that there may be issues that NPFMC or NOAA Fisheries may not be able to address with changes to the fishery management system. For example, if the population of a seabird indicator species begins to decline because of persistent pesticide pollution from agricultural runoff in Asia, NPFMC will not be able to correct the situation by changing groundfish allocations.

Every impact analysis depends to some degree on knowledge about the distribution and abundance of seabird species in the BSAI/GOA, especially in areas away from breeding colonies and during the non-breeding season when most direct interactions with the fisheries occur. While a great deal of data has been collected over the years, much of it was collected in the 1970s and 1980s (Outer Continental Shelf Environmental Assessment Program) and is not readily accessible because it is stored in various places and formats. The USGS/Biological Resource Division, in cooperation with NOAA Fisheries, USFWS, and the Minerals Management Service, has recently begun compiling this information into a standardized database format that will eventually be available to the public. Preliminary results from this North Pacific Pelagic Seabird Database have been used to analyze the degree of distributional overlap between selected species and different groundfish fisheries in the Ecosystem Considerations for 2003 report (NPFMC 2002). This report contains several maps that are good examples of how graphic information system technology can be used to facilitate understanding and analysis of seabird/fishery interactions. However, the basic abundance and distribution data for all seabird species needs to be updated for these efforts to be most useful.

5.1.2.9 Marine Mammals

To unequivocally assess the effects of groundfish fisheries on marine mammal populations, definitions of marine mammal population parameters are needed to measure the intensity and direction of the effects. Population parameters and metrics needed include: current population size (n), population trajectory, definition of carrying capacity (K) and/or optimal population size for each species/stock.

To assess the effects of groundfish fishery harvests on the marine mammal prey field the following information is needed: marine mammal energetic requirements; contribution of each prey species to energetic requirements (proportion in diet); adequacy of existing standing biomass of prey (current K for each marine mammal population); standing biomass of prey before and after fishery; and point at which vital rates/K are affected due to food limitation. Currently, this level of information is not available. Some of these issues are under investigation through various research programs; the answers to some of these questions may never be known.

Research is needed to examine methods for quantifying fishery linked (i.e., human) disturbance on marine mammal populations. Specific examples include: rate at which various gear types are lost or discarded which present risk of entanglement; effects of disturbance on baleen whales caused by vessel traffic, fishing operations, or sound production.

Identification of Species Specific Research Needs :

Spotted Seals: Importance of EBS & Aleutian Islands pollock in the diet of spotted seals (diet information in Bristol Bay, Pribilof Islands, and eastern Aleutian Islands).

Elephant Seals: Research is needed into the diet of elephant seals in the GOA.

Killer Whales: Research is warranted to examine the consumption of groundfish by killer whales in the GOA and BSAI.

Steller Sea Lions: NOAA Fisheries has identified the following potential causes of the decline of Steller sea lions: nutritional stress related to competition with fisheries for prey or climate-related changes in prey distribution, abundance or quality; predation by killer whales; disease; contaminants; and other human-related direct mortality (e.g., illegal shooting, incidental takes in fisheries, subsistence hunting).

The largest information gaps in understanding what has caused the decline of Steller sea lions or preventing their recovery are in the area of nutritional stress. In particular, they involve the following issues: measuring nutritional stress in a random sample of the population; determining prey and prey field requirements to sustain healthy individual sea lions; understanding sea lion use of habitat and how this changes with age and season; discerning natural from fishery-induced changes in the prey field.

Research programs have been developed by NOAA Fisheries and our research collaborators in the North Pacific to address these gaps and others related to the remaining potential causes of the decline. This research, however, will not obtain answers quickly, and some questions, particularly regarding causes of the decline observed decades ago, may never be answered. The priorities for NOAA Fisheries AFSCs FY03 Steller sea lion research program are:

- Steller sea lion foraging and marine habitat use (particularly by older juveniles).
- Steller sea lion vital rate determination (survival, fecundity).
- Steller sea lion enumeration (pup counts).
- Steller sea lion diet studies.
- fishery effects on prey populations.
- killer whale assessment and trophic ecology.
- the role of climate change and oceanographic processes in prey distributions.
- development of forage fish assessment techniques.
- assessment of the effects of contaminants and disease.

While little evidence currently exists to suggest that contaminants and disease are contributing to the lack of recovery, there are research programs whose objective is to continue investigating their potential impact on the population. With regard to illegal shooting, however, there are virtually no data on which to base any estimate of mortality, and no programs currently in place to obtain them.

5.1.2.10 Socioeconomic

- Compile information on catch by area and catch per unit effort by area in order to more fully ascertain the effects of closing areas on the temporal and spatial distribution of the groundfish fisheries. This data would be most accurately and efficiently collected from catcher vessels and processors using electronic log books.

- Conduct historical analyses and develop models to explain and predict fishermen's responses to temporal and spatial closures.

- Collect and analyze information to provide a more accurate account of local and regional employment patterns in the harvesting and processing sectors of the groundfish fisheries.

- Perform post-implementation studies of management actions, such as closures. Collect and analyze economic and socio-cultural data to determine whether changes in the human environment were a result of management actions or caused by external factors.

- Conduct additional research to determine the non-market value of Bering Sea and GOA marine ecosystems using appropriate economic methodologies.

- Extend mandatory economic data reporting requirements to the groundfish fisheries, including reporting of fixed and variable cost data, as well as vessel and processors ownership information. Such mandatory economic data will be collected in accordance with confidentiality standards.

- Regularly update the sector and regional profiles, to examine changes over time, including post-action effects of different management regimes.

5.1.2.11 Ecosystem

The probability of introduction of non-native species through ballast water exchange from fishing vessels coming from areas where invasions have already occurred has been identified as a serious threat in the State of Alaska's Aquatic Nuisance Species Management Plan. This plan identifies the need for Alaska to develop mandatory ballast-water exchange laws.

Measures of diversity are subject to bias and we do not know how much change in diversity is acceptable (Murawski 2000). More research is needed to derive meaningful ecosystem indicators of change, including those related to diversity. Particularly, it is important to understand the natural range of variability in diversity measures and determine whether there are diversity thresholds that are important determinants of ecosystem function. It is important to conduct species-level work such as determining life history parameters and abundance of target and non-target species to ensure that species level diversity is being protected. Since we are unable to study every organism in sufficient detail, a system of prioritizing research on species should be devised that takes bycatch amounts in fisheries and sensitive life history characteristics into account in the research prioritization.

The lack of population level assessments for some of the species in the forage species group means that species level effects on those species are unknown. Better understanding of the factors influencing forage species dynamics and spatial/temporal distribution will help us better separate the role of climate and fishing in influencing the dynamics of these species.

More research is required to evaluate whether the amounts of pollock removed are having a population-level effect on the fur seals. Ongoing research is needed to quantify predator needs of mammals, birds, and other predators in space and time would improve our ability to evaluate the effects of fishing removals of prey.

Understanding the role of climate variability in species and ecosystem level production changes is needed. See NOAA Climate and Productivity Initiative for FY2005 and the ongoing NOAA Fisheries *Fisheries and the Environment* research plan for some details on this.

The effect of shark bycatch on shark populations reaching MSST is unknown at present and research directed at better assessment of population levels of these sensitive (late maturing, low fecundity, low natural mortality) species is needed to determine the potential for groundfish fisheries to impact these populations.

Further examination of the potential for fishery removals to induce changes in system level characteristics should be examined using ecosystem models of the BSAI and GOA. These system level characteristics are very difficult to assess outside of a modeling framework but more field research on predator/prey interactions and predator functional responses would improve the predictions of ecosystem and multi-species models. Evaluations of system maturity from these models rely heavily on our assumptions about primary productivity and benthic infauna biomass, two aspects of marine production that are not well studied in the BSAI and GOA baseline.

Some of the species in this forage group are not well studied (such as stichaeids and gunnels) and life history parameter determinations should be a priority in the future to better assess the risk of falling below acceptable population thresholds of abundance.

Many years of survey data and life history parameter determinations for skates, sharks and grenadier species may better define population trends and whether further protection might be warranted.

Members of the HAPC biota guild serve important functional roles in providing fish and invertebrates structural habitat and refuge from predation that are not well studied. The abundance of these structural species necessary to provide protection is not well known and it may be important to retain populations of these organisms that are well-distributed spatially in order to fulfill their functional role. Better understanding of the life history characteristics, distribution, and functional roles of these organisms is needed to better protect their role in the ecosystem.

Genetic diversity has not been well assessed in the baseline, more genetic work on target species that may have more localized spawning concentrations would be important.

Relative to Alternative 2: If a target fishery were to develop on forage species such as capelin, there is potential for the combined effects of fishing on many forage species to affect predators. However, the amounts of forage needed by predators is uncertain. More research is needed to determine predator forage needs and level of forage biomass necessary for successful foraging.

The amount of seabird mortality induced by trawl third wires is not well-known and requires further study.

Relative to Alternative 3: More research on developing ecosystem indicators; enhancing collection of data on climate, ecosystem production, and predator/prey interactions; defining predators needs; and defining the role of climate variability in population fluctuations are needed in order to adopt and use ecosystem-indicators in a total allowable catch (TAC)-setting, and for using ecosystem considerations in setting biological reference points. See the NOAA FY2003 Climate and Productivity Initiative and the Stock Assessment Improvement Plan for details on some of the research that might be required.

Relative to Alternative 4: A substantial research program would need to be initiated to determine foraging needs of dependent species; life history parameters, genetics and abundance and distribution of species proposed for target fisheries. Fishery bycatch of nontarget species and gear effects on habitat would also be evaluated before a fishery could be opened. Natural levels of ecosystem variability and the influence of climate on ecosystem production would also need to be determined.

5.2 Management and Enforcement

This section begins with a discussion of management and enforcement considerations in the groundfish fisheries (see Section 5.2.1), and the factors influencing management complexity (see Section 5.2.2). Section 5.2.3 provides the basis for comparing the alternatives under discussion in this Programmatic SEIS. The effects of the alternatives, including the preferred alternative, on management and enforcement are analyzed for each alternative in Sections 5.2.4-5.2.8. The comparative effects of the alternatives are summarized in Section 5.2.9.

5.2.1 Management and Enforcement Considerations

This section provides information about the effects of the alternatives on management and enforcement for the groundfish fisheries off Alaska. For this discussion, management and enforcement responsibilities include the following:

- Data collection, research, and analysis to prepare annual stock assessments.
- The annual groundfish specifications process through which TAC limits and prohibited species catch (PSC) limits are established.
- The ongoing process of amending the FMPs and regulations to implement fishery management measures recommended by NPFMC or NOAA Fisheries.
- Monitoring of commercial fishing activities to estimate the total catch of each species and to ensure compliance with fishery laws and regulations.
- Actions to close commercial fisheries once catch limits have been reached.
- Actions taken by NOAA Fisheries Enforcement, the U.S. Coast Guard (USCG), and NOAA General Counsel to identify, educate, and, in some cases, penalize people who violate the laws and regulations governing the groundfish fisheries.

Management of the groundfish fisheries in the BSAI and GOA and enforcement of management measures governing those fisheries comprise a complex system for overseeing fisheries that range geographically over an extensive area of the North Pacific Ocean and Bering Sea. Management of these fisheries is more fully described in Appendix B.

NOAA Fisheries manages the fisheries off Alaska based on TAC amounts for target species and PSC amounts for species that may not be retained. The TAC and PSC amounts are further subdivided by gear type, area, and season. As the complexity of the management regime has grown, the number of TAC and PSC subdivisions has grown as well. For example, in 1995 for the BSAI there were 40 TAC allocations, 38 PSC allocations and two CDQ allocations. In 2003 for the BSAI, there were 152 TAC allocations, 78 PSC allocations, and 34 CDQ allocations. Each allocation represents a possible need for NOAA Fisheries to take management actions, such as closing fisheries, reallocating incidental catch amounts, or investigating overages. When a directed fishery in one area is closed, the boats that participated in the fishery often move to another area or change to another target. This, in turn, often leads to the need for additional management actions.

Though the number of allocations has increased, the quantity of fish available for these allocations has not, and NOAA Fisheries is required to manage increasingly smaller blocks of fish. To do this adequately requires the use of increasingly sophisticated catch-monitoring tools, such as observer coverage, electronic reporting, vessel monitoring systems (VMS), and the use of at-sea scales. Though these tools increase the quantity, quality, and timeliness of the data available to NOAA Fisheries management, they also increase the demands on staff to effectively make use of a larger and more complex data system.

Current fishery management recognizes that a meaningful enforcement program must accompany management measures for them to be effective. As management becomes more complex, the difficulty of adequately enforcing the regulations grows. As the size and complexity of the regulatory environment increases, the burden on enforcement personnel to fully understand the nuances and implications of regulations increases as well. NOAA Fisheries/Alaska Region enforcement maintains approximately 36 agents and officers stationed in nine Alaskan ports for monitoring groundfish landings: Juneau, Anchorage, Dutch Harbor, Homer, Ketchikan, Kodiak, Petersburg, Seward, and Sitka. In addition, enforcement personnel regularly travel to other Alaskan ports to monitor landings and conduct investigations. Enforcement personnel associated with NOAA Fisheries, Northwest Region assist in the monitoring of Alaska Region groundfish harvest, primarily individual fishing quota (IFQ) sablefish, landed at ports in the Northwest Region. Also, USCG personnel conduct enforcement activities, monitor vessel activity, conduct at-sea boardings and aircraft overflights, and assist NOAA Fisheries enforcement personnel in monitoring dockside landings.

A key component of management and enforcement is education and outreach. Complex management programs are accompanied by a regulatory structure that can be difficult for the fishing industry to understand and comply with. This is exacerbated when regulations change rapidly. When fishermen believe that regulations are unduly burdensome or unnecessary, they are less likely to comply voluntarily. Thus, successful implementation of the regulations is dependent on outreach programs that explain the goal of regulations and why they are necessary. NOAA Fisheries Management, NOAA Fisheries Enforcement, and the USCG all conduct extensive outreach and education programs that seek not only to explain the regulations, but to help the fishing industry understand the rationale for those regulations.

5.2.2 Factors Influencing Management Complexity

Complexity of Quota Management

Annual groundfish TAC amounts and PSC limits are either established in regulations or through the annual groundfish specification process (described in further detail in the TAC-setting Process paper, in Appendix F-1). These area-specific TACs may be further apportioned by harvesting or processing sector, season, gear, or vessel size class.

NOAA Fisheries initially estimates how much of each groundfish species will be caught as incidental catch in other directed groundfish fisheries throughout the year. The amount available as a directed fishing allowance is determined by subtracting the estimated incidental catch needs from the total amount available for the species or species group. For some species, such as rockfish, NOAA Fisheries usually determines that the entire TAC will be needed as incidental catch and no directed fishery will be allowed. These species are closed to directed fishing at the beginning of the year through a notice in the Federal Register (FR). For other species, sufficient TAC exists to authorize directed fisheries in most management areas.

NOAA Fisheries must conduct real-time monitoring of the catch of groundfish to predict when a catch limit will be reached and close the directed fishery before the directed fishing allowance is exceeded. Closure notices must be published in the FR, which requires NOAA Fisheries to decide on a closure date from one to five days before the closure must be effective. The office of the FR is closed on weekends and Federal holidays. The requirement to publish closures in the FR is an important reason why NOAA Fisheries is limited in how quickly it can assess catch data and close a fishery. In-season closure notices are not required for individual quota programs such as the halibut and sablefish IFQ Program or the CDQ fisheries, because individual quota holders are responsible for maintaining catch within assigned quota limits.

In general three types of closures are triggered by in-season actions. The first is a target species quota closure issued when a TAC, or apportionment of a TAC, is harvested. The second is a prohibited species closure in which vessels participating in a fishery approach a prohibited species bycatch allowance before harvesting all of the groundfish species available to them. The third is closure of a target species fishery when the catch of an incidentally caught species approaches its overfishing limit.

Under the current in-season management system, a species is either open, or on bycatch or prohibited status at any given point in time. When a species is open, vessels are allowed to target and retain it with no restrictions on the amount harvested. Once a particular species TAC or prohibited species bycatch allowance specified for a fishery has been reached, NOAA Fisheries closes the directed fishery for that species. Vessel operators are then limited in the amount of the species closed to directed fishing that they may retain. If the harvest of a given species goes beyond the TAC and approaches the ABC, NOAA Fisheries will prohibit retention of that species for the remainder of the year.

NOAA Fisheries uses information from a variety of sources to determine how much groundfish and prohibited species are caught in the groundfish fisheries. This information is used to determine when to close a directed fishery so that the groundfish or PSC limit will not be exceeded. In general, data submitted by both observers and by at-sea and shoreside processors are used to accrue catch against a quota. The non-CDQ fisheries generally are managed through the blend, which combines information from observers on vessels and information submitted by processors in a weekly production report to determine the best estimate of catch for each processor and week. In some cases, NOAA Fisheries requires more timely submission of catch data. For example, AFA shoreside processors are required to submit pollock landings data daily through the electronic shoreside logbook. For fisheries with small quotas or those rapidly approaching a catch limit, in-season managers also rely on daily catch data and anecdotal information from the industry to decide when closures should occur.

Any increase in the number of quota categories that must be monitored and closed on time increases the complexity of the fisheries management system. The difficulty of accurately determining when a quota will be reached and when to close a fishery increases as the number of quota categories increases and the amount of quota available in each category decreases.

Complexity of Area Boundaries

Enforcement of regulations that close specific areas to vessel activity is the responsibility of the USCG and NOAA Fisheries Enforcement. Enforcement of closed area regulations is more difficult and time consuming as the complexity of the area boundaries increase. Large, rectangular areas, such as NOAA Fisheries 3-digit reporting areas in the BSAI and GOA (e.g., 518, 541, 620, see Figures 1.2-2 and 1.2-3) are less complex to monitor from aircraft, vessels, or through VMS (see NMFS 2001b [Steller sea lion SEIS Section 4.11.3] for a more detailed description of a VMS) than are concentric circles around a point, particularly if these circular closures overlap each other. Complex area closures are more difficult to monitor and enforce than simple area closures for a number of reasons. It is more difficult to accurately communicate complex area boundaries to those being regulated and to agency personnel, as is apparent from the numerous revisions that have been made to tables, maps, and regulations as the complexity of the Steller sea lion area closures has increased in recent years. In addition, although computer and satellite technology is sophisticated enough to accurately determine the location of a vessel relative to almost any area boundary, the sheer number of closed areas and the complex, irregular boundaries require enforcement personnel to check vessel positions and activities relative to closed area boundaries more frequently, which could reduce the number of vessels or areas that can be monitored during a flight or vessel cruise.

Increasing Number and Complexity of Directed Fishing Closures

Increasing the number of directed fishing closures and the complexity of the boundaries of the closed areas complicates enforcement. The catch accounting system developed by NOAA Fisheries, and described in detail in Appendix B, was designed to collect the best available data to estimate total catch (retained and discarded) from all vessels fishing for groundfish. The catch accounting system was not designed to determine which directed fishery a vessel is participating in for areas smaller than a federal reporting area, or whether the vessel was complying with maximum retainable amounts in that smaller area.

When an area is closed to directed fishing by vessels using a particular gear type, fishing can continue in the area by vessels using other gear types or by vessels directed fishing for species other than the closed species. To determine whether a vessel is fishing legally in an area, the composition of retained catch *from that area at any time during a fishing trip* must be assessed to determine whether any applicable maximum retainable amounts have been exceeded. Making this determination while a vessel is at sea is difficult for catcher processors and nearly impossible for catcher vessels.

For catcher processors, the report of processed product in the daily catch and production logbook is assessed to check compliance with maximum retainable amounts. However, to accurately check compliance with maximum retainable amounts, catch from areas with different directed fishing status must be recorded separately in the logbook. For example, assume that directed fishing is closed in a sub-area of a larger NOAA Fisheries management area, but is open elsewhere in the management area. This means that catch of the closed species up to the maximum retainable amount could be retained inside the closed area, but all catch of the species could be retained outside the closed area. If a vessel caught fish both inside and outside the closed area in a particular day, it is not possible to assess whether they complied with maximum retainable bycatch amounts inside the closed area unless they kept records of catch made inside the closed area separate from catch made outside the closed area. Current logbook formats require catcher processors to report catch by a variety of factors that relate to different directed fishing closures and maximum retainable amounts (day, gear, management program), reporting area (3-digit area codes), and two special areas for managing crab bycatch. However, catcher processors are not required to report catch separately in their logbooks, for example, inside and outside Steller sea lion critical habitat or specific Steller sea lion management areas where different directed fishing closures could occur for pollock, Pacific cod, Atka mackerel. The format of the catcher processor and mothership logbooks need to be revised to keep up with area-specific directed fishing closures.

It is nearly impossible to check compliance with maximum retainable amounts for catcher vessels at-sea. The weight of each species onboard a catcher vessel cannot be reliably determined until the catch is removed from the vessel, sorted by species, and weighed. If a catcher vessel delivers catch from areas with different directed fishing closures, it is impossible to verify at the time of delivery how much catch came from each area that the vessel fished. If accurate accounting of the location of catch and compliance with maximum retainable amounts by unobserved catcher vessels is required, the following options should be considered: 1) require offload of catch from specific areas before continuing to fish in areas with different directed fishing closures (different maximum retainable amounts); 2) apply the most restrictive maximum retainable amounts to the entire catch at the time of delivery (even though the vessel may have caught some fish in areas with less restrictive maximum retainable amounts); 3) use a VMS to determine if the vessel fished inside special management areas at any time during the trip and, if so, apply the most restrictive maximum retainable amounts to the entire delivery, or 4) require observers to monitor catch for vessels fishing in areas with different directed fishing closures. VMS on unobserved vessels is of limited value in determining what directed fishery a vessel was in, what proportion of the catch came from closed areas, or whether the vessel complied with maximum retainable amounts. VMS provides location data, but it does not provide data about total catch or catch composition.

5.2.3 Basis for Comparing the Effects of the Alternative

The alternatives provide policy goals and objectives for fishery management that will be implemented by measures that fall within the range provided in the analytical framework (see Section 4.2). Most of these management measures are already used in some form under the current regime, including catch limits to control the amount of a species harvested in the commercial fisheries; prohibition of commercial fisheries in certain areas or during certain times of the year; regulations that limit or define the type of fishing gear that may be used or the manner in which the fishing gear may be used; and rights-based fishing systems. Table 5.2-1 summarizes how the specific management measures change over the alternatives.

Six categories of management measures will be used to assess the significance of the alternatives in their effect on management and enforcement complexity (relative to the baseline condition described in Section 4.4). The six management measure categories are as follows:

- Managing harvest within specified catch limits (TAC & PSC).
- Monitoring and enforcing compliance with area closures (including seasonal, gear, directed fishery).
- Monitoring and enforcing compliance with bycatch (discard) reduction standards.
- Managing and enforcing gear modifications requirements and gear restrictions.

- Management complexity due to rights-based management programs.
- Managing observer programs and data collection.

5.2.4 Alternative 1

Alternative 1 continues the management of the groundfish fisheries based upon the present risk-averse policy. The guideline for implementing this policy is the current (2002) BSAI and GOA FMPs as amended, and the 2002 regulatory environment. Management measures that were approved by NPFMC through the June 2002 meeting are also assumed to be incorporated in this implementing guideline.

The Alternative 1 management measures differ from the baseline only with respect to those measures that were only approved but not yet fully implemented at the 2002 cut-off date. These include full retention for demersal shelf rockfish (DSR) in southeast Outside for the hook-and-line and jig fisheries, and the seabird avoidance measures approved by NPFMC in December 2001 but not yet implemented.

Monitoring and Enforcing Compliance with Bycatch (Discard) Reduction Standards

The DSR retention management measures applies only to fixed gear fisheries in the southeast Outside District of the eastern GOA. The implementation of the retention standard will be managed by the State of Alaska, and is thus unlikely to cause a significant increase in management complexity to NOAA Fisheries managers.

Managing and Enforcing Gear Modifications Requirements and Gear Restrictions

The seabird avoidance measures approved by NPFMC in 2001 require staff time for writing regulations and preparing training material to educate fishers as to the nature of the additional measures. The additional seabird avoidance measures were initiated at the request of the longline industry, to reduce the risk of a premature closure of the fishery due to short-tailed albatross interaction. Proven incentives for industry to adopt the avoidance measures should allow enforcement within existing enforcement activities.

Summary

As compared to the baseline suite of management and enforcement measures, Alternative 1 may result in some additional time to monitor and enforce DSR retention and the use of seabird avoidance methods. However, because of their localized effects, it seems unlikely that these efforts will result in an overall increase in the complexity of management and enforcement.

5.2.5 Alternative 2

Alternative 2 represents a more aggressive harvest strategy that would be implemented based upon the assumption that the present policy is overly conservative and that higher harvests can be taken without overfishing the target groundfish stocks. Alternative 2 would be implemented through management measures that fall within the range of two example FMP bookends (see Section 4.2). Both bookends 1) increase the BSAI harvest by redefining the cap on optimum yield; 2) repeal bycatch and incidental catch restrictions, with the exception of PSC limits; and 3) repeal the 2001 gear modifications for hook-and-line gear intended to decrease interactions with seabirds.

FMP 2.1 also contains additional changes to existing management measures, including eliminating PSC limits, repealing all closure areas and gear restrictions save those required to avoid jeopardy or adverse modification under the ESA, repealing the Improved Retention/Improved Utilization (IR/IU) standard, eliminating all non-AFA rights-based management, repealing the Observer Program, and rescinding monitoring through VMS devices.

Managing Harvest Within Specified Catch Limits (TAC & PSC)

Although both Alternative 2 bookends would result in an increase in the BSAI groundfish quota, they differ in the way they redefine the optimum yield cap. FMP 2.1 defines the optimum yield cap as the sum the OFLs of the managed species or species complexes, and sets the ABC level equal to OFL. This removes the buffer between ABC and OFL that exists under the current system. FMP 2.2 sets the optimum yield cap equal to the sum of ABCs, which still would result in a substantial decrease in the buffer between ABC and OFL in the BSAI. (For background information about TAC, ABC, OFL and optimum yield, see the TAC-setting Process paper in Appendix F-1.)

The current management system provides a buffer between TAC/ABC and OFL for many species, as NOAA Fisheries is required to take management action to prevent further catch of that species if the catch of any species reaches its OFL. This may mean closing other directed fisheries in which that species might be taken as incidental catch. Fishery managers try to limit the catch of a particular species in directed fisheries and as incidental catch to less than the TAC. However, if TAC is exceeded by small amounts, the OFL generally is not reached due to the buffer. Under Alternative 2, the consequences of reaching the catch limit may be the same as the consequences of reaching OFL. Therefore, NOAA Fisheries managers would need to be more conservative in their management of the directed fisheries and incidental catch to ensure that a TAC was not exceeded. Alternative 2 likely would lead to earlier fishery closures to protect certain species from reaching OFL. It is also likely that more directed fisheries would be curtailed because an incidentally-caught species had reached OFL than occurs under the existing management system.

Repealing the Observer Program except for AFA monitoring requirements, and lifting bycatch and incidental catch restrictions under FMP 2.1, would increase the need to manage conservatively. The data used to monitor catch limits would be less reliable, and directed species quotas would need to take into account the level of incidental catch that would likely be taken in other fisheries. As above, this would potentially result in earlier fishery closures. FMP 2.1 also eliminates all PSC limits, however, which would decrease management complexity by removing an entire category of catch limits that currently need to be monitored by NOAA Fisheries.

Monitoring and Enforcing Compliance with Area Closures (Including Seasonal, Gear, Directed Fishery)

Although FMP 2.2 does not change the existing area closures, FMP 2.1 eliminates all closure areas except those that are required to avoid jeopardy or adverse modification to Steller sea lions. The repeal of bycatch restrictions, including PSC limits, under this bookend also means that those areas that are triggered closures after a certain catch limit is reached will also no longer be implemented. As a result, FMP 2.1 would result in a substantial relaxation of management and enforcement complexity.

On the other hand, the elimination of VMS in the directed pollock, Pacific cod and Atka mackerel fisheries under FMP 2.1 would create difficulties for the effective enforcement of the Steller sea lion closure required under ESA. Traditional methods to monitor compliance with Steller sea lion area closures, including periodic USCG overflights and USCG cutter operations, do not fully meet the NOAA Fisheries' need to monitor fishing activities in and around Steller sea lion rookeries, haulouts, and areas designated as critical habitat because of their complexity and their irregular boundaries. Reverting to these methods would require a substantial increase in effort.

Monitoring and Enforcing Compliance with Bycatch (Discard) Reduction Standards

FMP 2.1 repeals the current IR/IU requirements for pollock and Pacific cod and does not implement the DSR retention program. This would reduce operational regulations on the fishing industry, reduce recordkeeping and reporting requirements, and reduce the staff resources needed to monitor compliance.

Managing and Enforcing Gear Modifications Requirements and Gear Restrictions

The 2001 seabird avoidance measures that are repealed under this alternative are not currently implemented in the 2002 baseline, therefore there is no change to management or enforcement complexity.

Management Complexity Due to Rights-Based Management Programs

Alternative 2 maintains the statutorily mandated rights-based management programs authorized under AFA, for the BSAI pollock fishery and the CDQ program. The absence of any objectives to eliminate excess capacity and the race-for-fish leads to the repeal of all other rationalization programs under FMP 2.1, and the cessation of work on further rationalization of the groundfish fisheries. This would eliminate the IFQ program for sablefish, and associated community quota purchase programs, and the License Limitation Program (LLP). The elimination of the LLP is likely to increase management complexity to some degree, due to the likely increase in the number of vessels participating in the fishery. The repeal of the IFQ program, on the other hand, would likely result in a decrease in management complexity, as its implementation since 1995 has had the opposite effect.

Managing Observer Programs and Data Collection

Repealing the Observer Program, except for AFA monitoring requirements, under FMP 2.1 would result in foregone data about the amount and location of catch, and species composition of the haul. Non-AFA pollock monitoring accounts for approximately 80 percent of groundfish observer days annually (Appendix F-10). Observers also record information on interactions with marine mammals and ESA-listed seabirds. The observer data is used to groundtruth industry reporting, and the lack of such data would require NOAA Fisheries to assume a certain degree of under-reporting and consequently manage the fisheries more conservatively to avoid overfishing. The agency currently contributes about $3,000 per year to manage the Observer Program, with the remainder of the costs paid by industry, and some of these costs would be saved by repealing the non-AFA portion of the program (Appendix F-10).

FMP 2.1 also repeals the use of at-sea scales, which would result in less accurate data and consequently would decrease the ability of fishery managers to accurately manage TAC in order not to exceed OFLs.

Summary

Alternative 2 will require more conservative management, particularly in the BSAI, due to the redefinition of optimum yield that reduces the buffer between TAC and OFL and the repeal of bycatch restrictions. The repeal of bycatch restrictions would allow some budget and staff to be redirected to other management and enforcement priorities, resulting in a conditionally significant beneficial rating. The FMP 2.1 end of the range, however, repeals several existing management measures that would significantly alleviate management complexity, particularly the IFQ program, the Observer Program, PSC limits, IR/IU, and closure areas. An FMP 2.1 illustration of Alternative 2 would be significantly beneficial in terms of reducing management complexity. Basing the assessment of Alternative 2 as a whole on the assumption that the alternative would be implemented somewhere in the middle of the range, and that should any one of the FMP 2.1 measures be implemented it would represent a substantial reduction in management complexity.

5.2.6 Alternative 3

Alternative 3 would seek to accelerate the existing precautionary management measures through community or rights-based management, ecosystem-based management principles and, where appropriate and practicable, increased habitat protection and additional bycatch constraints. This policy recognizes the need to balance many competing uses of marine resources and different social and economic goals for fishery management. Alternative 3 would be implemented through management measures that fall within the range of two FMP bookends (see Section 4.2). Both bookends 1) initiate new research and re-examine existing management practices; 2) implement rationalization for the groundfish fisheries; 3) break out new species for TAC setting; and 4) improve monitoring data.

The bookends do differ in their implementation, however. FMP 3.1 eliminates the existing vessel incentive program. FMP 3.2 incorporates additional quota specification adjustments, and develops an expanded system of closure areas. Bycatch incentive programs are instituted, the Observer Program coverage is increased, and mandatory VMS is extended to vessels greater than 125 ft length overall (LOA).

Managing Harvest Within Specified Catch Limits (TAC & PSC)

Alternative 3 would increase the number of individual TAC limits managed by NOAA Fisheries by breaking out species from species complexes for TAC setting. Additionally, PSC limits are established in the GOA for salmon, herring and crab. Increasing the number of individual catch limits increases the need for accurate, complete, and timely catch data from fishermen in order to manage the commercial fisheries within catch limits. NOAA Fisheries is responsible for monitoring commercial fishing activity by all vessel types, to estimate the amount of each species caught, and to know the date and location of the catch. NOAA Fisheries uses this information to limit or prohibit commercial fishing so that the catch limits are not exceeded. Obtaining the data necessary to manage current catch limits, as well as additional catch limits recommended under this alternative is particularly difficult for unobserved vessels or for vessels that do not have the capability to transmit observer data to NOAA Fisheries. Reassessment of agency priorities or additional staff resources may be necessary for data collection, research, and analysis to establish catch limits based on new criteria.

FMP 3.2 implements further adjustments to the TAC-setting process by incorporating uncertainty corrections into the quota assessments. This measure would increase the buffer between TAC and OFL to allow for uncertainty, and would thus provide more leeway for fishery managers for in-season actions.

The development of the uncertainty correction in FMP 3.2, and the establishment of new PSC limits in the GOA and the reduction of existing limits in the BSAI and GOA under Alternative 3, also necessitate allocation of staff resources to prepare the analysis to support the revised quotas.

Monitoring and Enforcing Compliance with Area Closures (Including Seasonal, Gear, Directed Fishery)

Alternative 3 prioritizes the development of an marine protected area (MPA) system, that may or may not encompass existing closure areas. This effort is likely to require staff analytical support as well as additional research efforts to situate the closure areas. Although FMP 3.1 makes no actual changes to the closure system currently in place in the BSAI and GOA, FMP 3.2 designs series of comprehensive closures.

In FMP 3.2, the existing Steller sea lion protection measures are left intact. Additionally, two other kinds of closures are implemented, namely no-take marine reserves and no bottom contact MPAs. Depending on the complexity of the areas, the closure of areas or times all fishing can be effectively enforced using aerial or at-sea surveillance by the USCG, a VMS tracking system, or information supplied by observers on the vessels. No bottom contact MPAs, however, present more of an enforcement challenge. Effective monitoring and enforcement requires the ability to assess whether the gear is coming into contact with the bottom, which would require technology not currently used on the groundfish boats.

The no-take marine reserve and no bottom contact MPA closures do, however, supplant the existing mix of closure areas that are often specific to certain directed fisheries. Such closures require assessment of the catch onboard the vessel to determine whether the vessel is complying with catch composition requirements associated with particular directed fisheries, and are consequently complex to monitor and enforce.

Additional agency resources would also be needed under Alternative 3 for data collection, research, and analysis to identify critical or essential habitat areas to be protected by the closures.

Monitoring and Enforcing Compliance with Bycatch (Discard) Reduction Standards

FMP 3.1 eliminates the vessel incentive program, which would, in a minor way, reduce operational regulations on the fishing industry, reduce recordkeeping and reporting requirements, and reduce the staff resources needed to analyze and revise regulations and to monitor compliance.

Under FMP 3.2, the reductions in bycatch limits would be achieved by industry as a result of increased flexibility inherent in the rationalization of the fisheries (see Section 4.7.9). NOAA Fisheries management and enforcement experience with rationalization and rights-based management programs, including bycatch management under these programs, has been that they result in increased complexity. The impacts on complexity of rights-based management programs is discussed further in that section below.

Managing and Enforcing Gear Modifications Requirements and Gear Restrictions

As discussed under Alternative 1, the seabird avoidance measures approved by NPFMC in 2001 and implemented under Alternative 3 require staff time for writing and regulations, and preparing training material to educate fishers as to the nature of the additional measures. Additional seabird protection measures would also be researched under this alternative, in cooperation with USFWS.

The gear restrictions implemented under FMP 3.2 would be designed to allow vessel compliance with the no bottom contact MPA requirements discussed in the time and area closure subsection above.

Management Complexity Due to Rights-Based Management Programs

Rationalization is one of the distinguishing features of Alternative 3. Both bookends develop a rationalization program, although FMP 3.1 takes a more gradual fishery-by-fishery approach and FMP 3.2 proceeds with comprehensive rationalization. Both bookends incorporate community protection concerns in their implementation of rationalization programs.

NOAA Fisheries (NMFS 2001a, Section 4.1.5.2) contains a lengthy discussion about many of the management issues related to the rights-based fishing systems currently in existence in the Alaska Region, including the IFQ and CDQ programs and fishing cooperatives established under the AFA. Each program was implemented together with existing traditional management measures, such as overall catch limits, limits on seasons or areas, gear restrictions, and Observer Programs. However, they also required implementation of additional administrative and catch monitoring regulations to manage and enforce programs based on the assignment of fishing rights to individuals or groups. In some cases, such as the IFQ and CDQ programs, NOAA Fisheries no longer manages the catch limits through closures of directed fishing by a group of vessels once a catch limit is reached. Instead, catch limits are assigned to individuals or groups, who are required to provide accurate and timely reports of catch and to stop fishing once a catch limit is reached.

Rights-based systems present some potential difficulties and some advantages for fisheries managers. Because they are likely to change the practices of harvesters (e.g., less emphasis on maximizing catch rates) they are likely to lead to discontinuities in fishery-dependent data. Commercial catch per unit effort is likely to change independent of stock sizes, and the relative catch rates of different species or cohorts may also change. Any stock assessment models that rely on fishery-dependent data may require recalibration. However, rights-based systems also have the potential to provide new useful information to managers. The prices of quota shares or use rights, if transferable, should indicate the net value of the fishery and changes in prices can be useful indicators of the economic impact of regulatory changes. Prices of transferable individual quotas on catch and bycatch (including prohibited species) also provide information on the relative value of allocations to different fisheries and sectors.

Experience with the IFQ and CDQ programs and pollock cooperatives suggests that expansion of rights-based systems to other fisheries is likely to result in substantial increases in the costs of monitoring, enforcement, and administration. Cost recovery fees will at least partly offset management costs that would otherwise be publicly funded. To implement rights-based fishing systems, additional agency resources would be required to develop the process through which fishing rights are assigned; to adjudicate appeals about the assignment of fishing rights to individuals or groups; to administer the annual assignment of catch amounts and transfers of fishing rights; to monitor catch of individual or group quotas; and to penalize people violating regulations.

Managing Observer Programs and Data Collection

Alternative 3 introduces a variety of research and analytical objectives that impact management primarily through the need for additional resources for data collection, research and analysis. Increasing data collection requirements for observers requires assessment of the priority of these data relative to other demands on the observers' time.

The objective to improve data quality applies to both observer and industry data. Changes to the data collected by the Observer Program require assessment of the impact of adding more duties for the observer. Increasing the breadth and precision of industry logbook data would require management and enforcement staff resources for program development and maintenance.

The expansion of observer coverage to 100 percent on all vessels over 60 ft LOA may be difficult to implement in the first year or two due to the changes that the requirement creates in the numbers of observers required and the timing of when observers are required, either competing with existing fisheries that need observers or requiring observers at a time of year when they had not been required before. An increase in observer deployments could require additional resources in the Observer Program, NOAA Fisheries Enforcement, and NOAA General Counsel to ensure their ability to manage and support a larger program, depending on the scope of the increase.

Finally, recommendations to expand the use of VMS to all groundfish vessels over 125 ft LOA, together with observer data or vessel logbook data, to increase the precision of catch location data would require management and enforcement staff resources for program development and maintenance.

Summary

Alternative 3 contains a number of changes for management and enforcement. Rationalization of the fisheries, and the increased emphasis on improving data and research efforts, as well as the potential for redesigning the existing closure system, would tend to create a considerably more complex management and enforcement scenario than exists in the baseline case, resulting in additional need for staff and budget resources.

5.2.7 Alternative 4

Alternative 4 represents an extremely precautionary approach to managing fisheries under scientific uncertainty. It shifts the burden of proof to the users of the resource and NPFMC/NOAA Fisheries to demonstrate that the intended use would not have a detrimental effect on the environment. This policy assumes that fishing does produce adverse impacts on the environment, but due to a lack of information and uncertainty, we know little about these impacts. The initial restrictive and precautionary conservation and management measures would be modified (strengthened or relaxed) when additional, reliable scientific information becomes available. Alternative 4 would be implemented through management measures that fall within the range of two FMP bookends (see Section 4.2). Both bookends require more data collection, research and monitoring due to shifting the burden of proof.

The bookends differ substantially in their method of implementation. FMP 4.1 adapts the existing fishery management environment to comply with the Alternative 4 policy, by imposing harvest, bycatch and other conservation constraints on the groundfish fisheries. The implementing management measures include adjustment of the quota specification process, establishment of closure areas and gear restrictions, establishment of additional PSC limits and bycatch limits for non-target species, protection measures for seabirds, effort-based regulations, expanded observer coverage and mandatory VMS and motion-compensated scales. FMP 4.2 implements a more extreme management regime, by suspending all fishing in federal waters off Alaska until such time as individual directed fisheries can be shown to have no adverse impact on the environment.

Managing Harvest Within Specified Catch Limits (TAC & PSC)

The adjustments to the TAC-setting process specified under FMP 4.1 generate a variety of management impacts. Managing TAC on smaller spatial scales, and breaking out species from their species complexes where possible, increases the number of individual catch limits to monitor and enforce. The level of attention required by inseason management staff would increase substantially not simply by expansion of the number of inseason actions but also by increased attention to management of data and monitoring and interacting with the fleet. This requires accurate and timely catch data from industry, and analytical agency support to manage the quantity of data. Additionally, reducing the TACs under this bookend would also require staff resources to prepare the analysis to support revised quotas.

Additionally, PSC limits are established in the GOA, and catch limits will be developed for non-target species. Again, this would increase management and enforcement complexity by increasing the number of catch limits that would have to be monitored and managed. Placing a priority on catch limits for non-target species likely would result in closure of directed fisheries for target species due to bycatch of non-target species before the target species catch limit was fully harvested. In addition, because most non-target species currently are discarded at sea, this alternative would rely more heavily on data collected by observers for estimating catch and would increase the need to extrapolate data from observed vessels to estimate at-sea discards by unobserved vessels. Additional agency resources also may be needed for stock assessment (data collection, research, and analysis) to establish catch limits for species that currently are not assessed and do not have catch limits.

The accuracy of the data available to assess and monitor catch limits would be improved, however, through the expansion of the Observer Program and the requirement for motion-compensated scales to weigh all catches at-sea or at shore-based processing plants.

Monitoring and Enforcing Compliance with Area Closures (Including Seasonal, Gear, Directed Fishery)

The implementation of closure areas under this FMP should reduce management complexity by reducing the variation in the types of closures. All closure areas under this bookend are either no-take reserves (closed to all commercial fishing) or no-trawl MPAs. Also, all fishing effort, and trawl effort in particular, is substantially reduced under Alternative 4. Staff resources would be required to prepare the analysis to support the design of closure areas. However, closures to all fishing, or to vessels using fishing gear that can be easily identified, can be effectively enforced using aerial or at-sea surveillance by the USCG, or information supplied by observers on the vessels.

Additionally, monitoring and enforcement would also be assisted by the requirement that all groundfish vessels carry VMS. Management measures such as comprehensive closure areas require VMS for effective monitoring and management. While VMS alone is not sufficient to effectively implement the closure areas, VMS is an essential component of monitoring and management. The benefits of a VMS system are significantly increased by extending the VMS requirement to all groundfish vessels. The baseline case of having vessels turning the units on and off because they are required to operate them only in particular areas or while targeting a particular species of groundfish reduces the effectiveness of the system and increases agency operational costs and complexity. Removing this complexity under this alternative would be beneficial.

Monitoring and Enforcing Compliance with Bycatch (Discard) Reduction Standards

FMP 4.1 expands the IR/IU program to apply to all target species. Other elements of Alternative 4 would significantly decrease the size of the fleet due to a reduction in catch limits and extensive closure areas. The monitoring and enforcement of this program expansion would increase management complexity, but the impact would not be substantial due to the reduction in the fleet.

Managing and Enforcing Gear Modifications Requirements and Gear Restrictions

The introduction of effort-based regulations such as trip limits, vessel size or horsepower limits, gear size limits, or area registration, increases management and enforcement complexity.

Trip limits are a maximum amount of fish that can be caught on a fishing trip or the maximum amount that can be onboard a vessel at any time while fishing in an area. They currently exist in two Alaska fisheries managed by NOAA Fisheries: the 6,000 pound trip limit in the area 4E halibut CDQ fishery and the 300,000 lb trip limit for pollock in the GOA. Trip limits for catcher vessels do not present any new or difficult in-season management or enforcement issues. A specific trip limit would be established for a fishery and catcher vessel deliveries would be monitored to determine whether participating vessels had exceeded the trip limit. However, determining the appropriate amount of the trip limit to accomplish specific objectives of slowing the pace of fisheries is complicated, particularly in fisheries without quota allocations among different gear types and vessel categories, all of whom fish at the same time during some parts of the year. In addition, it is not clear how trip limits would be adapted for catcher processors, because catcher processors fish for a much longer time in a trip. Sometimes a "trip" can be an entire season.

Imposing additional limits, whether trip, vessel, horsepower or gear size, increase the need for data collection, research and analysis to identify and evaluate appropriate actions, and require additional resources to monitor and enforce.

Area registration would require a vessel owner to register with NOAA Fisheries each season before they participate in directed fisheries. They may be restrictions on the number of areas or species that may be registered per season. NOAA Fisheries would be required to establish registration forms, accept registration forms from fishermen, acknowledge receipt of registration (something fishermen have onboard vessel to show compliance with registration requirements), and provide a database of registration information to fishermen and enforcement officers (which might link up with VMS).

The primary management and enforcement issues associated with seabird protection measures are providing the staff resources necessary to conduct the research to identify and evaluate appropriate gear modifications and the difficulty of enforcing restrictions on gear and fishing operations on unobserved vessels. In addition, the recommendation to develop protection measures (which could include elements such as bycatch limits or a bycatch monitoring program) would require possible changes in observer duties, and increases in management and observer program staff involvement in the seabird protection program.

Managing Observer Programs and Data Collection

FMP 4.1 expands observer coverage to 100 percent on all vessels over 60 ft LOA. The bookend also proposes to require 30 percent observer coverage on groundfish vessels less than 60 ft LOA. An observer onboard a vessel can help NOAA Fisheries improve estimates of the amount and location of catch, and the target species. However, observers on catcher vessels are limited in the information they can collect about total catch weight and species composition due to the fishing operations (sorted or unsorted catch) and tools available for weighing and sampling catch. To date, Council and NOAA Fisheries have not required observers on vessels less than 60 ft LOA due to concerns about safety, cost, and accommodations for the observers. However, the 60 ft LOA cut-off between observed and unobserved vessels is an arbitrary length established because of the decision to base observer coverage requirements on vessel categories by length. Observer data from vessels less than 60 ft LOA would contribute greatly to information about catch and at-sea discards by this vessel class.

Substantial increases in observer coverage requirements may be difficult to implement in the first year or two due to the changes that the requirement creates in the numbers of observers required and the timing of when observers are required—either competing with existing fisheries that need observers or requiring observers at a time of year when they hadn't been required before. An increase in observer deployments could require additional resources in the Observer Program, NOAA Fisheries Enforcement, and NOAA General Counsel to ensure their ability to manage and support a larger program, depending on the scope of the increase. For instance, timely debriefing of returning observers directly affects observer availability.

The requirement for motion-compensated scales and mandatory VMS on all vessels would require additional resources for equipment certification, and also would require additional staff effort to monitor and analyze the VMS data. The cost of the VMS units has to date been reimbursed by NOAA Fisheries, for up to $2,000. Should the Agency continue with this policy, additional funding would be required to support the extension of VMS to all vessels.

FMP bookend 4.2 would also require a considerable staff and budget commitment in order to develop the criteria and the standards of proof to assess each of the directed fisheries. While the suspension of the commercial fisheries would free up staff, the complexity of designing a new commercial fishing regulatory environment that can be proven to have no adverse effect on the environment would be immense and would presumably require many specialists. Additional data collection and research would likely be required to bolster the fishery assessments, assuming that a higher standard of proof would be necessary to authorize the resumption of fishing. However, all data collection and research would need to be conducted with experimental permits as there would be no data collected in conjunction with commercial fishing, and the data would be obtained at considerably greater additional expense to the agency. The suspension of fishing would likely take a minimum of two years, to develop the criteria and assess directed fisheries. Currently, those fisheries that are under rights-based management, such as BSAI pollock and the sablefish IFQ program, contribute to their management costs through a cost-recovery program. Although a comparable staff load would likely be required to craft the restructured management regime, no management costs would be recovered during the suspension of fishing.

Summary

The management and enforcement complexity under Alternative 4, as represented within the bookend range of FMP 4.1 and FMP 4.2, would be significantly greater than the baseline. The shifting of the burden of proof would implement new types of management measures and expand on the use of existing budget, staff and analytical needs beyond the capability of the existing management and enforcement structure.

5.2.8 The Preferred Alternative

The Preferred Alternative (PA) represents a combination management approach, incorporating forward looking conservation measures that address differing levels of uncertainty. The alternative would be implemented through management measures that fall within the range of two FMP bookends (see Section 4.2 for more detail). Both bookends 1) initiate new research and re-examine existing management practices; 2) implement rationalization for the groundfish fisheries; 3) establish PSC limits for all prohibited species in the GOA; 4) evaluate seabird avoidance measures for the trawl and longline fisheries; and 5) improve monitoring data.

Additional management measures are specific to PA.2. The bookend, however, also implements additional changes to groundfish management. PA.2 adjusts quota specification, develops an expanded system of closure areas, and institutes other bycatch incentive programs while eliminating the existing Vessel Incentive Program (VIP).

Managing Harvest Within Specified Catch Limits (Total Allowable Catch and Prohibited Species Catch)

The PA would increase the number of individual limits managed by NOAA Fisheries by establishing PSC limits in the GOA for salmon, herring and crab. Additionally, in PA.2, species are broken out for TAC-setting. Increasing the number of individual catch limits increases the need for accurate, complete, and timely catch data from fishermen in order to manage the commercial fisheries within catch limits. NOAA Fisheries is responsible for monitoring commercial fishing activity by all vessel types, to estimate the amount of each species caught, and to know the date and location of the catch. NOAA Fisheries uses this information to limit or prohibit commercial fishing so that the catch limits are not exceeded. Obtaining the data necessary to manage current catch limits, as well as additional catch limits recommended under this alternative is particularly difficult for unobserved vessels or for vessels that do not have the capability to transmit observer data to NOAA Fisheries. Reassessment of agency priorities or additional staff resources may be necessary for data collection, research, and analysis to establish catch limits based on new criteria.

PA.2 implements further adjustments to the TAC-setting process by incorporating uncertainty corrections into the quota assessments. This measure would increase the buffer between TAC and OFL to allow for uncertainty, and would thus provide more leeway for fishery managers for inseason actions.

The development of the uncertainty correction in PA.2, and the establishment of new PSC limits in the GOA and the reduction of existing limits in the BSAI and GOA under the PA, also necessitate allocation of staff resources to prepare the analysis to support the revised quotas.

Monitoring and Enforcing Compliance with Area Closures (Including Seasonal, Gear, Directed Fishery)

The PA prioritizes the development of an MPA system, that may or may not encompass existing closure areas. This effort is likely to require staff analytical support as well as additional research efforts to review the efficacy of existing area restrictions as well as to situate new closure areas. Although PA.1 makes no actual changes to the closure system currently in place in the BSAI and GOA, PA.2 designs a series of comprehensive closures.

In PA.2, the existing Steller sea lion protection measures are left intact. Additionally, two other kinds of closures are implemented, namely no-take marine reserves and no bottom contact MPAs. Depending on the complexity of the areas, the closure of areas or times to all fishing can be effectively enforced using aerial or at-sea surveillance by the USCG, a VMS tracking system, or information supplied by observers on the vessels. No bottom contact MPAs, however, present more of an enforcement challenge. Effective monitoring and enforcement requires the ability to assess whether the gear is coming into contact with the bottom, which would require technology not currently used on the groundfish boats.

The no-take marine reserve and no bottom contact MPA closures do, however, supplant the existing mix of closure areas that are often specific to certain directed fisheries. Such closures require assessment of the catch onboard the vessel to determine whether the vessel is complying with catch composition requirements associated with particular directed fisheries, and are consequently complex to monitor and enforce.

Additional agency resources would also be needed under the PA for data collection, research, and analysis to identify critical or essential habitat areas to be protected by the closures.

Monitoring and Enforcing Compliance with Bycatch (Discard) Reduction Standards

PA.1 eliminates the vessel incentive program which, while reducing operational regulations on the fishing industry, recordkeeping and reporting requirements, and the staff resources needed to analyze and revise regulations and to monitor compliance, would not ultimately impact the ability of the agency to monitor/enforce compliance with bycatch reduction standards.

Under PA.2, the reductions in bycatch would be achieved by the industry as a result of increased flexibility inherent in the rationalization of the fisheries (see Section 4.9.9 for further detail). NOAA Fisheries' management and enforcement experience with rationalization and rights-based management programs, including bycatch management under these programs, has increased management complexity. The impacts of the increase in complexity of monitoring and enforcement inherent in rights-based management programs is discussed further in that section below.

Managing and Enforcing Gear Modifications Requirements and Gear Restrictions

The seabird avoidance measures implemented for trawl fisheries under PA.2 would require staff time for writing and regulations, and preparing training material to educate fishers as to the nature of the additional measures.

Gear restrictions may also need to be implemented under PA.2, that would be designed to allow vessel compliance with the no bottom contact MPA requirements discussed in the time and area closure subsection above.

Management Complexity Due to Rights-based Management Programs

As with Alternative 3, rationalization is one of the distinguishing features of the PA. Both bookends develop a rationalization program, although PA.1 takes a more gradual fishery-by-fishery approach and PA.2 proceeds with comprehensive rationalization. Both bookends incorporate community protection concerns in their implementation of rationalization programs.

The Overcapacity qualitative analysis paper (Appendix F-8) contains a lengthy discussion about many of the management issues related to the rights-based fishing systems currently in existence in the Alaska region, including the IFQ and CDQ programs and fishing cooperatives established under the AFA. Each program was implemented together with existing traditional management measures, such as overall catch limits, limits on seasons or areas, gear restrictions, and observer programs. However, they also required implementation of additional administrative and catch monitoring regulations to manage and enforce programs based on the assignment of fishing rights to individuals or groups. In some cases, such as the IFQ and CDQ programs, NOAA Fisheries no longer manages the catch limits through closures of directed fishing by a group of vessels once a catch limit is reached. Instead, catch limits are assigned to individuals or groups, who are required to provide accurate and timely reports of catch and to stop fishing once a catch limit is reached.

Rights-based systems present some potential difficulties and some advantages for fisheries managers. As rights-based management systems are likely to change the practices of harvesters (e.g., less emphasis on maximizing catch rates), they are likely to lead to discontinuities in fishery-dependent data. Commercial catch per unit effort is likely to change independent of stock sizes, and the relative catch rates of different species or cohorts may also change. Any stock assessment models that rely on fishery-dependent data may require recalibration. However, rights-based systems also have the potential to provide new useful information to managers. The prices of quota shares or use rights, if transferable, should indicate the net value of the fishery and changes in prices can be useful indicators of the economic impact of regulatory changes. Prices of transferable individual quotas on catch and bycatch (including prohibited species) also provide information on the relative value of allocations to different fisheries and sectors.

Experience with the IFQ and CDQ programs and pollock cooperatives suggests that expansion of rights-based systems to other fisheries is likely to result in substantial increases in the costs of monitoring, enforcement, and administration. Cost recovery fees will at least partly offset management costs that would otherwise be publicly funded. To implement rights-based fishing systems, additional agency resources would be required to develop the process through which fishing rights are assigned; to adjudicate appeals about the assignment of fishing rights to individuals or groups; to administer the annual assignment of catch amounts and transfers of fishing rights; to monitor catch of individual or group quotas; and to penalize people violating regulations.

Managing Observer Programs and Data Collection

The PA introduces a variety of research and analytical objectives that impact management primarily through the need for additional resources for data collection, research and analysis. Increasing data collection requirements for observers requires assessment of the priority of these data relative to other demands on the observers' time.

The objective to improve data quality applies to both observer and industry data. Changes to the data collected by the observer program require assessment of the impact of adding more duties for the observer. Increasing the breadth and precision of industry logbook data would require management and enforcement staff resources for program development and maintenance. An increase in observer deployments could require additional resources in the Observer Program, NOAA Fisheries Enforcement, and NOAA General Counsel to ensure their ability to manage and support a larger program, depending on the scope of the increase. For instance, timely debriefing of returning observers directly affects observer availability.

Finally, recommended changes to observer data or vessel logbook data, to increase the precision of catch location data, would require management and enforcement staff resources for program development and maintenance.

Summary

The PA contains a number of changes for management and enforcement. Rationalization of the fisheries, and the increased emphasis on improving data and research efforts, as well as the potential for redesigning the existing closure system, would tend to create a considerably more complex management and enforcement scenario than exists in the baseline case, resulting in additional need for staff and budget resources.

5.2.9 Comparison of the Alternatives

The significance of each alternative is determined relative to the baseline, in terms of the alternative's effect on the complexity of management and enforcement in terms of budget, staff, data, and analysis needs. The ratings are included in Table 5.2-2.

CHAPTER 6

List of Preparers

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Chapter 6 List of Preparers

6.1 Programmatic Supplemental Environmental Impact Statement Steering Committee

Laurie Allen, Director, Protected Resources Division, NOAA Fisheries Headquarters.

Dr. James Balsiger, Regional Administrator, Alaska Regional Office, NOAA Fisheries

Ronald Berg, Deputy Regional Administrator, Alaska Regional Office, NOAA Fisheries.

Nancy Briscoe, Senior Counselor for Environmental Compliance, The Office of General Counsel Fisheries, NOAA Fisheries.

James Coe, Deputy Director, Science & Research, Alaska Fisheries Science Center, NOAA Fisheries.

Steve Davis, Fishery Biologist, Alaska Regional Office, NOAA Fisheries.

Tony DeGange, Special Assistance for Ecosystems, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Dr. Doug DeMaster, Director, Science & Research, Alaska Fisheries Science Center, NOAA Fisheries.

Kevin Duffy, Acting Commissioner, Alaska Department of Fish and Game, Anchorage, Alaska.

Tamra Faris, Fisheries Biologist, Alaska Regional Office, NOAA Fisheries.

Earl Krygier, Extended Jurisdiction Coordinator, Alaska Department of Fish and Game, Anchorage, Alaska.

Lisa Lindeman, Alaska Regional Counsel, Office of the Alaska Regional Counsel, Juneau, Alaska, NOAA Fisheries.

Dr. Richard Marasco, Director, Resources Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries.

Joseph McCabe, Paralegal Specialist, Office of the Alaska General Counsel, Juneau, Alaska, NOAA Fisheries.

Chris Oliver, Executive Director, North Pacific Fishery Management Council.

Lauren Smoker, Attorney-Advisor, Office of the Alaska General Counsel, Juneau, Alaska, NOAA Fisheries.

6.2 Project Team List

Project Leaders

Steve Davis, Programmatic SEIS Project Manager. Fishery Biologist, Alaska Regional Office, NOAA Fisheries. Provided overall project management and leadership of the Alaska Groundfish Programmatic SEIS Project Team. Led scoping meetings, prepared the SEIS outline, and drafted sections in all chapters of the document. Directed and coordinated agency and contract analysts located in Anchorage, Juneau, and Seattle. 20 years of fishery management experience in Alaska. Has drafted or led the preparation of more than 30 National Environmental Policy Act Environmental Impact Statements and Environmental Assessments. Served on the National Research Council's Bering Sea Ecosystem Committee. Has published a substantial body of work in the field of fisheries management and bycatch. Served on the staff of the North Pacific Fishery Management Council (Senior Biologist and Deputy Executive Director), and its Gulf of Alaska Groundfish Plan Team. *B.S. in Biology, University of Puget Sound; M.S. in Fisheries Science, College of Fisheries, University of Washington.*

Dr. Anne Babcock Hollowed, Supervisory Fisheries Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Provided leadership and direction to analysts tasked with model development and analysis of alternatives. Assisted in the preparation of the evaluation of biological impacts of alternatives on walleye pollock, reviewed the gear restrictions and allocation and Total Allowable Catch-setting quality analysis papers and assisted in the preparation of other sections. She has 22 years experience as a fisheries biologist and has worked on North Pacific fisheries issues for the last 19 years. *M.S. in Biological Oceanography, Old Dominion University; Ph.D. in Fisheries, University of Washington.*

Contributors

Kerim Aydin, Fisheries Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Aided in preparation of ecosystem effects of alternatives. Three years experience with NOAA Fisheries, *Ph.D. (2000) from the School of Aquatic and Fisheries Sciences, University of Washington, Seattle*.

Sally Bibb, Economist and Community Development Quota Program Coordinator, Sustainable Fisheries Division, Alaska Regional Office, NOAA Fisheries. Prepared Environmental Consequences section on Effects of the Alternatives on Enforcement and Management, contributed to Community Development Quota program descriptions. Fifteen years experience in fisheries management and research. *M.A. in Agricultural Economics, Washington State University.*

William G. Clark, Quantitative Scientist, International Pacific Halibut Commission. Assisted with various report sections dealing with Pacific halibut. Extensive experience in stock assessment and population dynamics; presently senior International Pacific Halibut Commission assessment scientist. *B.A. Economics, University of Michigan; Ph.D. Fisheries, University of Washington.*

David Clausen, Research Fisheries Biologist, Auke Bay Laboratory, Alaska Fisheries Science Center, NOAA Fisheries. Contributed to analysis of the effects of proposed fishery management alternatives on Gulf of Alaska shortraker/rougheye rockfish, other slope rockfish, and pelagic shelf rockfish. Twenty-five experience with NOAA Fisheries working on Alaskan groundfish. *B.A. in Biology, Occidental College, California.*

Catherine Coon, Fisheries Analyst/Geographic Information System specialist, North Pacific Fishery Management Council. Prepared tables on history of regulatory closure areas. Seven years experience as fisheries biologist. *M.S. in Fisheries Science, University of Alaska, Fairbanks.*

Dean Courtney, Research Fisheries Biologist, Auke Bay Laboratory, Alaska Fisheries Science Center, NOAA Fisheries. Prepared impact of alternatives sections on Gulf of Alaska Pacific ocean perch and Gulf of Alaska northern rockfish. Four years experience with the Auke Bay Laboratory working on sablefish and rockfish. *M.S. in Fisheries, University of Alaska, School of Fisheries and Ocean Science.*

Jane DiCosimo, Senior Plan Coordinator, North Pacific Fishery Management Council. Nineteen years experience as a fisheries biologist with State and Federal agencies. Assisted in preparation of Fishery Management Plan summaries and prepared sections reflecting current management regime with regard to target and non-target species. *B.A. Rutgers University; M.S. Virginia Institute of Marine Sciences, College of William and Mary.*

Elaine Dinneford, Fisheries Analyst, North Pacific Fishery Management Council. Provided catcher vessel harvest data. Over 22 years experience evaluating, maintaining, and presenting Alaska fisheries harvest data for the State of Alaska Commercial Fisheries Entry Commission and North Pacific Fishery Management Council. *B.S. in Microbiology Humboldt State College, California.*

Dr. Martin Dorn, Fisheries Research Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Assisted with the writing of the section on target species impacts. Fifteen years of experience in fishery biology/population dynamics and groundfish stock assessment modeling. *M.S. in Biomathematics, Ph.D. in Fisheries, University of Washington.*

Gary Duker, Technical Publications Writer/Editor (Biological Sciences), Office of the Science and Research Director, Alaska Fisheries Science Center, NOAA Fisheries. Edited second version of the Programmatic SEIS and also assisted with layout of the second version. Ten years experience as a fisheries biologist and 16 years experience as a writer/editor for NOAA Fisheries. *B.S. in Biology, San Diego State College; M.S. in Fisheries Science, University of Washington.*

Matthew Eagleton, Fisheries Biologist, Habitat Conservation Division, Alaska Regional Field Office, NOAA Fisheries. Co-member Marine Habitat/Essential Fish Habitat. Contributed to analysis of the baseline environment in Chapter 3 and alternatives analysis in Chapter 4. Technical review and input to the Essential Fish Habitat/Marine Protected Area Qualitative Analysis Paper. Provided guidance and recommendations specific to the provisions of Essential Fish Habitat and Marine Protected Areas. Over 15 years experience with NOAA Fisheries Research Platforms and Alaska Regional Management. Former NOAA Corps Officer with specific emphasis on Alaska fisheries including fishery stock and oceanic investigations aboard the *NOAAS Miller Freeman, NOAAS John N. Cobb,* and *NOAA 1273* operating in the Bering Sea, Aleutian Islands, Gulf of Alaska, North Pacific Ocean, and Beaufort Sea, respectively. *B.S. in Biological Sciences, Montana State University; NOAA Corps Commissioned Officer, U.S. Merchant Marine Academy, Kings Point, New York.*

Diana Evans, NEPA Specialist, North Pacific Fishery Management Council. Assisted in project management and development of revised draft alternatives. Prepared Fishery Management Plan Amendment analysis, assisted with Fishery Management Plan summaries. Assisted with drafting policy analysis. Three years experience preparing environmental impact statements on pelagic and groundfish fisheries off Hawaii and Alaska. *B.A. Geography and Linguistics, University of California, Berkeley; M.S. Geography, King's College London, University of London.*

Ron Felthoven, Industry Economist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Provided comments on the impacts of each alternative on overcapacity and on the current programs implemented to reduce overcapacity. Two years as an economist with NOAA Fisheries. *M.S. and Ph.D. in Natural Resource and Environmental Economics, Department of Agricultural and Resource Economics, University of California, Davis.*

Jennifer Ferdinand, Fishery Biologist, North Pacific Groundfish Observer Program. Authored the Observer Program Qualitative Analysis paper. Worked in the Observer Program office and currently works with the Information Services task on data quality issues. Main author of the "North Pacific Groundfish Observer Manual," distributed annually. Also co-authored the Observer Program's Management Control Review in 2000. *B.S. Environmental and Forest Biology, State University of New York College of Environmental Science and Forestry, Syracuse, New York.*

Shannon Fitzgerald. Fishery Biologist, Fisheries Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Currently works as the specialist for seabird/fishery interactions at the Alaska Fisheries Science Center and was until recently the Observer Services subtask leader in the North Pacific Groundfish Observer Program. Provided reviews for the seabird and observer program components of the document. Has observer program experience in several programs off and on over the last 20 years, including the Tuna/Porpoise, High Seas Driftnet, Alaska Groundfish Joint Venture, and Alaska domestic groundfish programs. Seabird experience focusing on fishery interactions has been ongoing for the last 13 years. This includes specific work in the high seas driftnet observer program, several research cruises in the North Pacific Transition Zone, acting as the seabird specialist withing the North Pacific Groundfish Observer Program, and close collaboration with Washington Sea Grant during studies to test various seabird deterrent devices in demersal longline fisheries. Fitzgerald has also done extensive marine mammal surveys that include the Eastern Tropical Pacific, Antarctic, the North Pacific Transition Zone, and Alaskan waters. *B.S. Wildlife Biology, University of Minnesota; M.S. Wildlife Ecology, University of Wisconsin.*

Lowell Fritz, Fisheries Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Assisted in the preparation of alternatives and determination of alternative impacts. Twelve years experience as a fisheries biologist with NOAA Fisheries, and 12 years experience as a marine biologist with Rutgers University, New Jersey, and College of William and Mary, Virginia. *M.S. in Marine Science, Virginia Institute of Marine Science, College of William and Mary.*

Dr. Jeff Fujioka, Mathematical Statistician, Auke Bay Laboratory, Alaska Fisheries Science Center, NOAA Fisheries. Worked on preparation of impact of alternatives section on habitat. Developed habitat impact model applied in habitat analysis. Thirty-five years experience in fisheries biology, 20 years experience in groundfish research. *Ph.D. in Fisheries, University of Washington.*

Brandee Gerke, Fishery Biologist, Protected Resources Division, Alaska Regional Office, NOAA Fisheries. Co-authored the marine mammal section of Chapter 4. Over six years experience specializing in state and federal marine resource issues in Alaska. Marine mammal and fishery project involvement includes assessment of Steller sea lion and groundfish fishery interactions, technical review of Steller sea lion research projects, analyses for evaluating proposed critical habitat for endangered Northern Right Whales, and conducting effects analyses of various federal projects on marine mammals in compliance with the Endangered Species Act, Marine Mammal Protection Act, and National Environmental Protection Act. *B.S. Fisheries Science, Oregon State University; M.S. Fisheries, University of Alaska, Fairbanks.*

Jay Ginter, Fishery Management Biologist, Sustainable Fisheries Division, Alaska Region, NOAA Fisheries. Prepared sections of the fishery management process and early (pre-1976) history of the groundfish fisheries. Twenty-three years experience working in federal fisheries management, the most recent 18 years have been in the Alaska Region. *M.S. in Marine Environmental Studies, State University of New York; additional graduate study in Marine Fisheries Management, University of Washington.*

Jim Hale, Technical Writer-Editor, Analytical Team, Alaska Regional Office, NOAA Fisheries. Edited the document for clarity and consistency. With over 15 years of technical writing experience in private and public sectors, he has given technical writing seminars to staff at Alaska Department of Fish & Game and at Alaska Department of Transportation (where he also served as a writing consultant). He has taught English literature and composition at Rutgers University, Central Washington University, and the University of Alaska Southeast; has held fellowships from the Folger Institute for Renaissance Studies in Washington, D.C., and from the U.S. Department of Higher Education; and has published essays and presented papers on topics ranging from the politics of 17^{th} century theology to subsistence fishing issues in the poetry of contemporary Alaska Natives. *B.A. in Literature, Ramapo College; M.A., M.Phil., Rutgers University.*

Dr. Jonathan Heifetz, Fishery Research Biologist, Auke Bay Laboratory, Alaska Fisheries Science Center, NOAA Fisheries. Co-author of the effects of the alternatives on essential fish habitat. Reviewed the Gulf of Alaska Pacific ocean perch and essential fish habitat sections of Chapter 3 and the marine protected areas and essential fish habitat qualitative analysis paper. Nineteen years experience as a fisheries biologist involved with stock assessment and effects of fishing gear on benthic habitat. *M.S. in Fisheries, Humboldt State University; Ph.D. in Fisheries University of Alaska, Fairbanks.*

Nick Hindman, Fisheries biologist, Sustainable Fisheries Division, Alaska Region, NOAA Fisheries. Co-authored "Descriptions of Fisheries in the Bering Sea and Aleutian Islands" in Chapter 2. Nine years experience managing commercial fisheries, six years experience conducting fisheries research. *B.S. in Fisheries, University of Idaho*.

Dr. Dan Holland, Economist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Assisted with developing the Alternative 6 model regime; preparing data for the models used to make the catch, exvessel value and product value projections for the six alternative model regimes; summarizing those projections; and describing the expected effects of the Alternative 6 model regime. Four years experience assessing fishery management issues including two years at the Alaska Fisheries Science Center. *Ph.D. in Economics, University of Rhode Island.*

Dr. James Ianelli, Fisheries Research Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Developed the multispecies management model used as background for the Programmatic SEIS and assisted in the preparation of a number of subsections. Over 20 years of experience in fisheries research and contributes annually to a number of stock assessment and fishery evaluation documents. *Ph.D. University of Washington.*

Jim Ingraham, Oceanographer, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Assisted in the preparation of Chapter 3.3, Physical Oceanography of the Fisheries Management Units. Forty years of experience in physical oceanography with NOAA Fisheries in Seattle, WA. *M.S. in Oceanography, University of Washington, Seattle, Washington.*

Dr. Daniel Ito, Fisheries Research Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Assisted in the coordination and preparation of alternatives and determination of alternative impacts, as well as assisted in the preparation of other sections. Over 25 years experience as a fishery biologist with NOAA Fisheries. *Ph.D. in Fisheries, University of Washington.*

Nicole Kimball, Fisheries Analyst, North Pacific Fishery Management Council. Prepared sections on effects of the current regime on marine mammals and seabirds and was a major contributor to the Fishery Management Plan amendment summaries. More than four years experience as an analyst with the North Pacific Fishery Management Council, three years as a coastal planner, and two years as an environmental scientist. *B.S. in Natural Resource Management and M.A. in Environmental Policy Tufts University.*

James Lee, Writer-Editor, Office of the Science and Research Director, Alaska Fisheries Science Center, NOAA Fisheries. Edited document and assisted with layout. Seventeen years experience in fisheries research with the Alaska Department of Fish & Game, Oregon Department of Fish & Wildlife, and NOAA Fisheries. *B.S. in Fisheries and Technical Journalism, Oregon State University.*

Steve G. Lewis, Geographic Information System Analyst and Coordinator, Analytical Team, Alaska Region, NOAA Fisheries. More than four years of experience in the Fisheries Geographic Information System field. Past projects include Essential Fish Habitat mapping and Internet applications, staff member on the Steller Sea Lion Reasonable and Prudent Alternatives Committee, developer of interactive Steller Reasonable and Prudent Alternatives closure selector, and several user-friendly applications for finding spatial closures and corresponding regulations. Analytical projects have included working within a team to develop meaningful spatial measures and providing descriptive spatial statistics for the Programmatic SEIS. Project included developing a complex Catch-In-Areas and redistribution of effort database. *B.Ed, Secondary, University of Alaska - Southeast, Juneau.*

Patricia Livingston, Fishery Research Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Prepared effects of the alternatives on the ecosystem and assisted in the preparation of the ecosystem section of Chapter 3. Twenty-five years experience in trophic ecology and ecosystem modeling of North Pacific ecosystems. Program leader of Resource Ecology and Ecosystem Modeling Program. *M.S. in Quantitative Fisheries Management, and MPA in Natural Resource Administration, University of Washington.*

Dr. Thomas R. Loughlin, Wildlife Biologist, National Marine Mammal Laboratory, Alaska Fisheries Science Center, NOAA Fisheries. Helped prepare marine mammal section and reviewer for impact sections. Twenty-five years as a marine biologist. *M.A. in Biology, Humboldt State University; Ph.D. UCLA.*

Sandra Lowe, Research Fisheries Biologist, Resource Ecology and Fisheries Management, Alaska Fisheries Science Center, NOAA Fisheries. Assisted in the preparation of the impacts of the alternatives on target groundfish species. Conducted review of the Atka mackerel section of Chapter 3. Twenty years experience as a fisheries biologist working on stock assessments of North Pacific groundfish. Member of the North Pacific Fishery Management Council's Gulf of Alaska Plan Team since 1987, and has chaired the Plan Team since 1991. *M.S. in Fisheries, University of Washington.*

Dr. Robert McConnaughey, Fisheries Biologist, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, NOAA Fisheries. Member of Habitat Working Group. Also contributed to sections on fishing gear effects, benthic invertebrates, Habitat Areas of Particular Concern and Bering Sea substrates. *B.S. in Zoology and M.S. in Marine and Estuarine Environmental Sciences, University of Maryland; Ph. D. in Fisheries Science, University of Washington.*

Jon McCracken, Economist, North Pacific Fishery Management Council. Assisted in preparation of Fishery Management Plan summaries. Four years experience as a Council analyst, 12 years as an economist. *B.A. Economics, University of Northern Colorado; M.S. Resource Economics, University of Alaska, Fairbanks.*

Mark W. Nelson, Fisheries Biologist, Stock Assessment Scientist, Pacific States Marine Fisheries Commission. Wrote the forage species section of Chapter 4 and reviewed the forage species section of Chapter 3 in the current document. 5 years experience working on the trophic interactions of groundfish species in Alaskan waters and on the West Coast. Currently on staff at Pacific States Marine Fisheries Commission developing a stock assessment for the forage species category. *B.S. Fisheries Biology, and currently working on a M.S. Fisheries Biology, University of Washington, Seattle, Washington.*

Victoria O'Connell, Fisheries Biologist, Groundfish Project, Southeast Region, Alaska Department of Fish and Game. Prepared impact of alternatives section on demersal shelf rockfish. Twenty years of experience as a fishery biologist related to research and management of commercial marine fisheries. *B.S. University of Washington, School of Fisheries.*

Dr. Clarence Pautzke, Executive Director, North Pacific Research Board (starting January 1, 2002), and ex-Executive Director of the North Pacific Fishery Management Council (1988-2001). Advising the U.S. Secretary of Commerce on management of fisheries in the federal 3 to 200 mile Exclusive Economic Zone off Alaska since 1988. Prepared the Evolution of Fishery Management Plans. Eight years experience as the Council's Deputy Director from 1980 to 1988, and Assistant to the Executive Director of the Pacific States Marine Fisheries Commission in Portland, Oregon, from 1978 to 1980. *Ph. D. in Oceanography, University of Washington, Seattle.*

Kim Rivera, Wildlife Biologist, Protected Resources Division, Alaska Regional Office, NOAA Fisheries. Contributed to the Environmental Consequences section on seabirds, contributed material to Affected Environment sections about Endangered Species Act Considerations for seabirds, and coordinated review by US Fish and Wildlife Service of some seabird sections. Nine years experience with NOAA Fisheries. *M.S. in Zoology, Colorado State University.*

Dr. Craig S. Rose, Research Fisheries Biologist, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, NOAA Fisheries. Participated in preparing summary of research on effects on fishing on seabed communities and analysis of effects on essential fish habitat. Twenty-five years experience as a fisheries biologist, and team leader of the Alaska Fisheries Science Center fishing gear research program for 15 years. *M.S. and Ph.D. in Fisheries Biology, University of Washington.*

Susan Salveson, Assistant Administrator, Sustainable Fisheries Division, Alaska Region, NOAA Fisheries. Prepared Description of Fisheries in the Bering Sea/Aleutian Island and Gulf of Alaska. Twenty years experience as a fisheries biologist. *M.S. in Fisheries Biology, University of Alaska, Southeast.*

Jennifer Sepez, Anthropolgist, Economics and Social Science Research Program, Alaska Fisheries Science Center, NOAA Fisheries. Reviewed and commented on sections on Subsistence, Environmental Justice Existing Conditions, Community Development Quota Program, and Historical Overview. Also reviewed Alaska Natives Qualitative Analysis Paper. *M.A Cultural Anthropology, and Ph. D. Environmental Anthropology, University of Washington.*

Maria Shawback, Graphic Artist/Secretary, North Pacific Fishery Management Council. Formatted and finalized the Programmatic SEIS Fishery Management Plan Amendment summaries document for publication and coordinated the graphics and layout throughout. Eight years experience working with computer graphics, websites, and providing administrative support, the last year with the North Pacific Fishery Management Council. *BFA in Commercial Art, Utah State University, Logan, Utah.*

Kim Shelden, Marine Biologist, National Marine Mammal Laboratory, Alaska Fisheries Science Center, NOAA Fisheries. Review of Section 3.8 (cetaceans). Thirteen years evaluating abundance and distribution of marine mammals in Alaska, Washington, and California waters. *B.S. Environmental Science/Marine Studies, Rutgers University; M.M.A. Marine Policy/Conservation Biology, University of Washington.*

Dr. Michael Sigler, Mathematical Statistician, Auke Bay Laboratory, Alaska Fisheries Science Center, NOAA Fisheries. Prepared impacts of the alternatives on sablefish in Alaska. Nineteen years experience with stock assessment and population dynamics. *B.S. and M.S. Cornell University; Ph.D. University of Washington.*

Dr. Paul Spencer, Research Fisheries Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Contributed to the effects of the alternatives on essential fish habitat section, and prepared the impact of the alternatives section on Bering Sea/Aleutian Island Pacific ocean perch, other red rockfish, flathead sole and other flatfish. Conducted reviews of the Bering Sea/Aleutian Islands Pacific ocean perch and other rockfish sections of Chapter 3. Seventeen years experience in fisheries biology/population dynamics and stock assessment modeling. *Ph.D. in Oceanography, University of Rhode Island.*

Dr. Diana L. Stram, Plan Coordinator/Oceanographer, North Pacific Fishery Management Council. Served as an analyst and dedicated project coordinator between NOAA Fisheries and contractor. Provided assistance to the Project Manager throughout document development and preparation. Assisted in the development of programmatic alternatives for the revised draft, drafted sections of the revised document and assisted in the review and synthesis of comments on the previous draft and preparation of the comment analysis report. Eight years experience in oceanographic research and coastal resource management, two years experience in Alaskan fisheries-related Environmental Impact Statements/Environmental Assessments. *B.A. Geology, Colgate University; Ph.D. Oceanography, University of Rhode Island.*

Dr. Joe Terry, Economist, Economic and Social Sciences Research Program Leader, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Assisted with developing the Alternative 3 model regime; preparing exvessel price data used in the catch optimization models, preparing the catch distribution data that were used to apportion catch optimization model output by processing sector and vessel category, preparing product value per unit of retained catch data used to estimate product value by processing sector, and reviewing several sections. Twenty-six years of experience assessing effects on fisheries off Alaska. *Ph.D. in Economics, University of California, Santa Barbara.*

Dr. Grant Thompson, Fisheries Research Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Prepared the evaluation of biological impacts of alternatives on Pacific cod as a target species. Conducted reviews of the Pacific cod section of Chapter 3 and the Total Allowable Catch-setting and spatial and temporal management qualitative analysis papers. Twenty-two years experience in fisheries research. Currently a stock assessment analyst and is responsible for contribution to two stock assessment and fishery evaluation documents for the North Pacific Fishery Management Council. *M.S., Ph.D. Oregon State University.*

Benjamin J. Turnock, Fishery Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Prepared the Arrowtooth flounder and other flatfish in the Gulf of Alaska sections. Twenty years experience as a fishery biologist working on stock assessment of marine fish, population dynamics modeling and population estimation methods of fish and marine mammals. *Working on a Ph.D. in Fisheries Science at the University of Washington.*

Tom Wilderbuer, Fishery Biologist, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, NOAA Fisheries. Prepared impact analyses sections on Bering Sea and Gulf of Alaska flatfish species. Twenty-two years experience as a fishery biologist working on stock assessment of flatfish populations off Alaska. *M.S. degree in Fisheries, University of Washington.*

David Witherell, Deputy Director, North Pacific Fishery Management Council. Prepared discussion of ecosystem-based management and history of habitat protection measures. Eighteen years of experience as a fisheries biologist. *M.S. in Fisheries Biology, University of Massachusetts, Amherst.*

6.3 Consultant Team List

Project Leaders

Jon Isaacs, Associate Planner, Director of Business Development, URS Anchorage. Consultant team project manager. Assisted with Environmental Impact Statement scoping and issue identification; lead for National Environmental Policy Act process oversight; contributor to cumulative effects analysis. Twenty-eight years of Alaska experience, primarily in National Environmental Policy Act compliance, coastal management and community planning. Participated in preparation of 16 Environmental Impact Statements and numerous Environmental Assessments. *B.A. Environmental Studies, University of California, Santa Barbara; Graduate Studies Planning and Economics, University of Alaska, Anchorage.*

Anne Maki, Consultant Team Deputy Project Manager, URS Anchorage. Responsible for project team coordination and oversight. Co-task leader for ecosystem and resource issues for the consultant team. Contributor to the development of cumulative impact analysis, socioeconomic sections of Chapter 3, socioeconomic cumulative effects in Chapter 4, and the Alaska Native Issues qualitative analysis paper. Over three years of experience preparing National Environmental Policy Act documents. Ms. Maki has a broad technical background including water quality assessment and ecological risk assessment. *B.S. Environmental Science and Communications, Indiana University, Bloomington, Indiana; M.S. Environmental Science - Water Quality, University of North Texas, Denton, Texas.*

Task Leaders

Sue Ban, Project Biologist, URS Anchorage. Co-task leader for cumulative impact analysis for the consultant team. Coordinated historical review and development of cumulative impact analysis approach; assimilated impact analyses from environmental consequences narratives, co-author of the target fish and the essential fish habitat sections of Chapter 3. She was also the primary author for the marine protected areas and essential fish habitat qualitative paper. Prepared comment analyses, response to comments, the Comment Analysis Report for the first Draft Programmatic SEIS. Eighteen years of experience in Environmental Impact Statements/Environmental Assessments and ecological risk assessments under National Environmental Policy Act. *B.S. Biology, Pennsylvania State University; M.S. Biological Oceanography, Florida Institute of Technology.*

Marcus Hartley, Senior Economist, Northern Economics, Inc. Serves as the Socioeconomics task leader for the project consultants. Coordinated preparation of the sector and regional profiles. Twelve years of direct experience as a fisheries economist in Alaska, four years as Senior Economist for the North Pacific Fishery Management Council, and three years as senior economist with Northern Economics. Has prepared more than 15 Environmental Impact Statements/Environmental Assessments on fisheries in Alaska. *B.A. History, Lewis and Clark College; M.S. Agriculture and Resource Economics, Oregon State University.*

Joyce Payne, Biologist and Certified Entomologist, URS Anchorage. Assisted consultant team in the historical review of cumulative impacts issues. Coordinated efforts on Chapter 3 and developed the past effects criteria for analysis; co-authored Chapter 3 sections general approach and methods and Fishery Management Plan analysis; and documentation of response to comments. Ms. Payne has a broad background of technical experience in bioassessments, fauna and flora surveys, environmental sampling, data management, educational material development, and implementation of National Pollutant Discharge Elimination System compliance programs. *B.S. Agricultural Biology, and M.S. Agricultural Biology, Entomology Option, New Mexico State University.*

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CHAPTER 7

Lister of Agencies, Organizations and Persons to Whom Copies of the Programmatic Supplemental Environmental Impact Statement are Sent

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Ribbon Seal	Section 3.8.8 (background) Sections 4.5.8.5, 4.6.8.5, 4.7.8.5, 4.9.8.5, 4.9.8.5 (bookend impacts)
Ringed Seal	Section 3.8.7 (background) Sections 4.5.8.5, 4.6.8.5, 4.7.8.5, 4.9.8.5, 4.9.8.5 (bookend impacts)
Rock Sole	Section 3.5.1.6 (background) Sections 4.5.1.6, 4.6.1.6, 4.7.1.6, 4.8.1.6, 4.9.1.6 (bookend impacts)
Rockfish	Section 3.5.1.12, 3.5.1.23, 3.5.1.24 (background) Sections 4.5.1.12, 4.5.1.13, 4.6.1.12, 4.6.1.13, 4.7.1.12, 4.7.1.13, 4.8.1.12, 4.8.1.13, 4.9.1.12, 4.9.1.13 (bookend impacts)

Issues:	Sections:
Skates	Section 3.5.3.4 (background) Sections 4.5.3, 4.6.3, 4.7.3, 4.8.3, 4.9.3 (bookend impacts)
Sources of Data	Section 2.5.2 (background)
Spatial/Temporal Management of Total Allowable Catch	Appendix F-2 (qualitative analysis)
Spectacled Eider	Section 3.7.9 (background) Sections 4.5.7.8, 4.6.7.8, 4.7.7.8, 4.8.7.8, 4.9.7.8 (bookend impacts) Appendix F-6 (description and qualitative analysis)
Sperm Whale	Section 3.8.19 (background) Sections 4.5.8.7, 4.6.8.7, 4.7.8.7, 4.8.8.7, 4.9.8.7 (bookend impacts)
Spotted Seal	Section 3.8.5 (background) Sections 4.5.8.5, 4.6.8.5, 4.7.8.5, 4.8.8.5, 4.9.8.5 (bookend impacts)
Squid	Section 3.5.3.1 (background) Section 4.5.3, 4.6.3, 4.7.3, 4.8.3, 4.9.3 (bookend impacts)
Statutory Requirements	Section 2.2.2 (background) Section 4.11.1.1 (policy impacts)
Steller Sea Lion	Section 3.8.1 (background) Sections 4.5.8.1, 4.6.8.1, 4.7.8.1, 4.8.8.1, 4.9.8.1 (bookend impacts) Appendix F-4 (descriptions and qualitative analysis)
Steller's Eider	Section 3.7.10 (background) Sections 4.5.7.8, 4.6.7.8, 4.7.7.8, 4.8.7.8, 4.9.7.8 (bookend impacts) Appendix F-6 (description and qualitative analysis)
Storm-Petrels	Section 3.7.7 (background) Sections 4.5.7.7, 4.6.7.7, 4.7.7.7, 4.8.7.7, 4.9.7.7 (bookend impacts) Appendix F-6 (description and qualitative analysis)
Structure of the Alternatives/SEIS	Section 1.7 (document organization) Section 2.6 (alternatives) Section 4.2.1 (analytical framework/ bookends)

Issues:	Sections:
Subsistence	Section 3.9.5 (background) Sections 4.5.9.4, 4.6.9.4, 4.7.9.4, 4.8.9.4, 4.9.9.4 (bookend impacts) Appendix F-9 (description and qualitative analysis)
Total Allowable Catch (TAC)-Setting Process	Appendix F-1 (description and qualitative analysis) Sections 4.10.2.2, 4.10.3.2, 4.10.4.2, 4.10.5.2, 4.10.6.2 (policy impacts)
Terns	Section 3.7.14 (background) Sections 4.5.7.6, 4.6.7.6, 4.7.7.6, 4.8.7.6, 4.9.7.6 (bookend impacts) Appendix F-6 (description and qualitative analysis)
Threatened and Endangered Species	Section 3.4 (background)
Toothed Whales	Section 3.8 (background) Sections 4.5.8.6, 4.5.8.7, 4.6.8.6, 4.6.8.7, 4.7.8.6, 4.7.8.7, 4.8.8.6, 4.8.8.7, 4.9.8.6, 4.9.8.7 (bookend impacts)
Walleye Pollock	Section 3.5.1.1, 3.5.1.13 (background) Sections 4.5.1.1, 4.6.1.1, 4.7.1.1, 4.8.1.1, 4.9.1.1 (bookend impacts)
Walrus	Section 3.8.3 (background) Sections 4.5.8.5, 4.6.8.5, 4.7.8.5, 4.8.8.5, 4.9.8.5 (bookend impacts)
Yellowfin Sole	Section 3.5.1.5 (background) Sections 4.5.1.5, 4.6.1.5, 4.7.1.5, 4.8.1.5, 4.9.1.5 (bookend impacts)

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